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The Engineer's Service to Society

Presidential Address at the A.S.M.E Annual Meeting, 1920, Dealing with the Influence of the Engineer in Constructive Adjustment—Property Rights and Human Rights—Relations Between Employer and Employee

By FRED J. MILLER, CENTER BRIDGE, PA.

IN what turned out to be his inaugural address as President of The Federated American Engineering Societies at its first meeting held in Washington last month, Herbert Hoover said many things that showed very clearly the long distance we have traveled within recent years in our search for industrial peace and industrial efficiency.

Speaking of the part being and to be taken by engineers in this movement and after referring to the grave dangers that may result from contention and warfare between the various economic groups, each seeking to promote its own interests, he said:

> The engineers should be able to take an objective and detached point of view. They do not belong to the associations of either employers, or of labor, of farmers, of merchants, or bankers. Their calling in life is to offer expert service in constructive solution of problems, to the individuals in any of these groups. There is a wider vision of this expert service in giving the group service of engineers to group problems.

Further on he said:

> The employer sometimes overlooks a fundamental fact in connection with organized labor in the United States. This is that the vast majority of its membership and of its direction are individualists in their attitude of mind and in their social outlook; that the expansion of socialist doctrines finds its most fertile area in the ignorance of many workers, and yet the labor organizations, as they stand today, are the greatest bulwark against socialism. On the other hand, some labor leaders overlook the fact that if we are to maintain our high standards of living, our productivity, it can only be in a society in which we maintain the utmost possible initiative on the part of the employer; and further, that in the long run we can only expand the standard of living by the steady increase of production and the creation of more goods for division over the same numbers.
>
> The American Federation of Labor has publicly stated that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance, not only to the Federation of Labor but also to the other great economic organizations interested in this problem, such as the employers' associations and the chambers of commerce.

Last March, speaking before the Chamber of Commerce at Boston, he said:

> We must surround employment with assurance of just division of production. We must enlist the interest and confidence of the employees in the business and in business processes. To do these things requires the coöperation of labor itself, and to obtain coöperation we must have intimate organized relationship between employer and employee. They are not to be obtained by benevolence. They can only be obtained by calling the employees to a reciprocal service.

In a story published in one of our magazines last year, the author, Ellen N. La Motte, remarked: "The ability to perceive the obvious is a rare and disconcerting gift."

I wish to call your attention to some obvious things; not only because they are related to, or intimately connected with, the work of the engineer, but also because I believe that engineers in general have more than some others this rare and sometimes disconcerting gift.

It is clear that ours is the professional society of the industries, none of which are or can be carried on without the work of the mechanical engineer, who not only provides the machinery, but also plans the plant and organizes and manages the force of workers.

The engineer must increase the effectiveness of labor, not by driving, by oppression, or suppression—the education and training of the engineer are not needed for that—but by the application of brains in industrial organization and management of men as well as of materials.

A certain deservedly popular railroad president, now retired, used often to say, in his charming after-dinner speeches, that the humblest employee of his road might aspire to its presidency. Thereupon we were regaled by a new broadside of editorials based upon the assumption that the man tamping ties ten hours per day at a wage of $1.10 had no cause for complaint, because not being president of the road at a salary of $50,000 per year was entirely his own fault. We have gotten past that sort of thing because it is clearly seen that if we are to have railroads some one must tamp ties and the welfare of the tie tamper is the concern of the public, especially where the man is an actual or potential citizen and is able not only to express his dissatisfaction in his vote but to pass on to his children his attitude toward the industrial and social organization.

We must face the fact that so far as we can see a large proportion of working people must continue throughout their lives to work, under the direction of others, at tasks intrinsically wearisome and distasteful; and when accompanied by long hours, harsh treatment and wages below the standard of comfortable family maintenance, actually dangerous to our social well-being.

We must remember also that in matters which concern the public welfare and with regard to the general policy to be followed by the nation all must have a voice, including now the women of the nation. It will be a mistake for those who direct industries or who take part in them in any capacity, to assume that the conscience of the nation will not assert itself upon the social effect of misdirected industrial activity.

It is not a misfortune that it does so, annoying as it sometimes appears to be, for it distinctly leads to the maintenance of a proper standard of civilized existence and also tends to protect the fair, enlightened and public-spirited employer from the unfair competition of the other kind of employer.

No one class may safely control in matters of public policy, but all may safely do so, and unless all do, there will be little chance of permanent stability or security.

Our Past-President, Doctor Hollis, has characterized different periods of history as:

The 17th century, the period of exploration
The 18th century, the beginning of religious tolerance
The 19th century, the sowing of the seeds of democracy
The 20th century, the period of crowded invention, and this
The 21th century, the period of adjustment.

If this is correct, as I believe it is substantially, then I hope and believe that the influence of the engineer will be in the direction of constructive adjustment—such an adjustment as will show recognition of the fact that there are both property rights and human rights, and that if human rights are, as Lincoln declared them to be, superior to property rights, then it is still to be remembered, nevertheless, that security of all genuine property rights is a necessary condition of human rights.

The improvement of the human race that is always going on takes many different directions and goes forward in many different fields. The engineer shares with his fellow human beings the results of the efforts of others, and his own peculiar contribution to the cause of human progress must always continue to be an

increasing power to control the forces and modify the materials of Nature for the benefit of mankind. A very important part of this work is what we term the problem of industrial relations, which, it is certain, can never be satisfactorily solved except by the methods of the engineer; and it is equally certain that it can never be settled until settled right; that is to say, not until all concerned—the employed, the employer and the public—are convinced that substantial justice has been secured and is being maintained.

Of course there are and always have been employers who have been fair toward their employees—have been real leaders of men, able to arouse and maintain enthusiastic coöperation. Notable successes have been founded mainly upon this human ability or quality. In too many cases, however, the most profound thought that seems to have been applied to an industrial problem has led to the conclusion that industrial management consists in hiring as cheaply as possible and driving as hard as possible.

The day for that sort of thing is passing and industry generally is beginning to be conducted upon a much higher plane of intelligence. It is being recognized that there is a science of industrial management. Engineers have, so far, developed and formulated it; they must go on with it and conduct the country's industries in accordance with it, recognizing that the old order has passed away. Management of an industrial group is not a matter of brute force, but of intelligent skill, fairly and sympathetically applied with a view to getting the best possible results, not only for the employer, but for the workers and for the public as well.

If research is important in physics and in chemistry it is at least equally important in the domain of industrial science, and when fundamental facts or laws have been made known by such research we must face them; not to do so may mean disaster.

In general, the engineer bases his opinion and his acts upon definitely ascertained and carefully studied facts. We must do the same in our industrial-management problems, and when we do, most of our industrial difficulties disappear.

I have myself known of a large factory, believed by its owners to be well managed, but in which among the employees there was much unrest, much distrust of the management, general bad feeling and lost motion, to be transformed completely under the influence of new management with an enlightened policy and a plan which included no spies nor underhanded methods of any kind, but instead, methods of correcting administrative faults, for helping every employee to be successful with his work and to earn as well as receive high wages.

The better spirit that pervaded the place was remarkable and was reflected not only in greatly improved human relations, but also in greatly reduced labor costs and in the total cost of goods produced, while at the same time the employees earned substantially more money, usually without greater effort than before and sometimes with less effort than before.

We have been hearing a great deal about a falling off in production per man-hour, and there has been a good deal of that. But the fact is that too many of our industrial establishments have been conducted upon the hire, drive, and "fire" plan. I am speaking now of industries in general and of all kinds, not solely of the engineering industries with which we are best acquainted.

In ordinary times when there are more men looking for jobs than there are jobs, that method will answer, though it is never a good method. Men will stand for more or less harsh and unsympathetic treatment when not to do so may mean deprivation for themselves and those dependent upon them.

But in times such as those we have been passing through that method breaks down and the difference between real leaders of men and mere ignorant drivers becomes apparent. There are establishments in which the output per man-hour has not decreased and some in which it has been all along greater than in the prewar period. Some have of course been favored, others hampered by exceptional circumstances, and the necessity of replacing with new help, those who were called for military duty tended strongly to reduce efficiency, in some industries much more than in others. But in general, those who suffered least in that respect were those whose policy was and had been an enlightened and intelligent one rather than the opposite, as indeed we should expect would be the case.

Contact Between Employer and Employee

Too often "results" are demanded by financiers and others who know little or nothing of industrial matters—who are far distant from the locality where the work of production is carried on and ask no questions as to methods, or whether of two local executives producing equal results so far as the books show, one has built up confidence and good will while the other has bred distrust and hatred among the body of employees.

Unfortunately morale and esprit de corps are not itemized on balance sheets, and some of those who are at the head of large manufacturing concerns know little or nothing about manufacturing except balance sheets prepared by men who also know little or nothing of management science and do not suspect that there is any such thing.

The growing number of engineers who stand high in the councils of large manufacturing concerns gives promise of better things in this respect.

In the older and simpler times when the workers very generally came into direct contact with those who were to use what the workers produced, the workers could not forget that they were rendering service to the public; nor could the public forget or overlook that fact. While those who work are today just as truly rendering service to the public, we have between the worker and the consumer whom he serves, a retail merchant, a jobber or wholesaler, the directors of transportation systems, a board of directors with its officers, a superintendent and a foreman.

The foreman is usually the only link in this long chain that the worker knows much about. This would seem to make plain the fact, repeatedly proved by experience, that our foremen should be provided with the machinery, so to speak, of true leadership and then carefully and systematically selected and trained for such leadership. That is a part of the work of the industrial engineer.

It is becoming generally recognized that, whether or not the head of a large industrial corporation will upon request confer with his employees, any group of them, or any freely chosen representative of them, about conditions of employment and of living, is not a question between him and his employees solely, but that the general public may be and often will be interested in the matter. A corporation is created and exists by authority of the people; they may depend upon it for imperative necessities of modern civilized existence; they are responsible for the maintenance of law and order in times of industrial warfare and must usually contribute to the support of workers and others whose means of livelihood are suspended or destroyed by these upheavals. Also they have in most cases provided by means of protective tariffs for the maintenance of prices for the corporation's products higher than the free working of economic laws would permit. The public is thus, in a vital sense, a partner in interest in much of what the corporation does or does not do and we must face the fact that this interest will be increasingly insisted upon unless the industries themselves overcome in a fair and equitable manner the difficulties that now confront them. In accomplishing this means must be found for the coöperation of employer and employee.

The best minds seem to be agreed that this cannot be done by force or suppression, but must be done by intelligent and broad-minded study of what industrial conditions really are and how to improve them; especially how to secure and maintain a spirit of coöperation and of enthusiasm in work, without which no great thing can be accomplished.

As our modern industrial life develops it becomes more and more clear that the broader interests of all of us, whether humble employee or mighty head of an industrial organization, are interwoven and inseparable. Formerly it seemed clear that the public was interested in industrial strife only where public service functions might be disturbed or suspended; but events have made it clear that, from the standpoint of public health, public education, service to the country in time of war or other emergencies, and of the general well-being of society, present and future, industrial strife concerns everybody; and there is a growing public sentiment according to which any industrial executive who refuses to confer with his employees, with their freely chosen representative, or with the representatives of any group of them, about the condi-

if not the probability, that legislation as an expression of this public sentiment may follow.

Such a conference, properly and fairly conducted, will at least enable each side to know just where the other stands and why. Often this is sufficient to point out a clear way to a satisfactory adjustment. And a conference about business matters of mutual interest is not the handing over of one's business to employees or their representatives. Even if no concessions are or can be made, such a conference is almost sure to promote mutual understanding and good feeling; and I speak from personal knowledge and experience when I say that it may and often has prevented what might have been serious disturbances.

Such conferences however, in order to be effective for good, must be as friendly and courteous as other ordinary business conferences between men whose duty it is to coöperate for a common purpose and for mutual advantage; men who, in other words, desire to, or must, maintain a decent friendly relation, not an antagonistic or a patriarchal relation.

If it be understood that any matter which any employee, or any group of employees, wishes to have adjusted can be brought to the attention of the management, either by an individual, by a committee of employees freely chosen by the men for that purpose, or by any other agency whatever that seems advisable to the workers themselves, acting freely and without coercion, and that such a matter will be regarded as a legitimate business affair and especially that no prejudice will arise against any member of such committee for having thus served his fellow-employees, very much misunderstanding will be avoided. If this plan is followed there will be no need for spies among the employees, spies being themselves not preventives of trouble and misunderstanding but promoters of them, often deliberately and intentionally so.

If the conditions of employment are fair and right, if there are few or no substantial reasons for dissatisfaction, if the channels of communication between owner and workers are kept free and open, agitators and trouble makers will seldom if ever make much headway.

Sometimes, however, under present conditions, a strike may be unavoidable. When it takes place if the management will make it plain to the men that they are not blamed for having the ambition to improve their condition; if there are no bitter denunciations; if there are no newspaper interviews condemning the men as being mentally incompetent or intentionally unfair and unreasonable; if it is regarded simply as a human error, or as a fever which will soon pass away; and that when it does, such of the strikers as have been decent and orderly and can be reemployed will be welcomed back, singly or in groups; if foremen and superintendents who have known the men they now find acting as pickets and have been in the habit of greeting in friendliness, will continue to do so; a satisfactory settlement will be much more easily, more quickly, and more surely reached than by the usual plan of recrimination and bitter denunciation.

This more advanced attitude must not be assumed for the purpose, however, but must be the reflection of a genuine feeling of sympathy and of tolerance. It is human nature for a man to be much more influenced by the opinion and advice of one who is friendly and sympathetic than of one who is contemptuous, harsh, or filled with hatred.

In commending this plan of procedure, which I realize may seem to many employers impracticable or impossible, I speak, nevertheless, upon the basis of experience, not only of my own, but of that of others, in large as well as smaller organizations, and it is not advanced as being in the interest of employees only, but of employers as well.

Foremen Trained for Leadership

Particularly do foremen usually need to be trained, or educated, if you please, to know how to treat men in order to get their enthusiastic coöperation and their best efforts. The foreman being ordinarily the only man representing an employer with whom the worker comes into contact, the "local color," so to speak, of are on record, for instance, in which the good intentions of an employer in providing rest rooms for women employees were, unknown to the employer, set at naught by a foreman who cared nothing for rest rooms, but believed in driving women so long as they could stand at their machines.

Too little attention has been given to this and foremen need to be trained for leadership and led to understand that most workmen, if properly handled, are as ambitious to "make good" as they are themselves, and that by sympathetic leadership and teaching where needed, excellent workmen can often be developed from what at first may seem like very unpromising material. This is not mere theory or idealism, but is based upon wide observation and a very considerable personal experience in establishments run upon all sort of plans, from very good to very bad.

Difficulties with men are often due to causes that are obscure. A group of workmen who resisted a perfectly fair and mutually advantageous proposition pertaining to their work, were not understood until it was finally discovered that a thoughtless and ruthless "comptroller" recently placed in power, had, merely for his own convenience, arbitrarily made a change in their pay day which had seriously inconvenienced them. He had no more thought of consulting them about it or consulting the superintendent under whom they worked, than as though they were so many soldiers, compelled to obey without question any regulations made concerning them. By this they were for the time being convinced that the company cared nothing for their interests and, reciprocally, they cared nothing for the company's interests and were suspicious of any proposition made to them.

I am not, of course, to be understood as saying that they were right in that, but we are dealing with human nature and must take men as they are and make the best of them. Workmen are, after all, about the same as other people, will respond to given treatment in about the same way, and act about the same under given conditions. When we fully realize this we shall be on the right road to an understanding of them and of how to get along with them.

Successful industrial management has been declared to be, more than anything else, a "state of mind." The various systems we are now hearing so much about vary greatly in their capacity to help in arriving at good conditions, but under the best of them there must be a foundation consisting of a determination to be fair, considerate and entirely candid and aboveboard, or they will be of little use.

If I seem to stress unduly the duties and responsibilities of engineers and employers in these troublous times, it is of course not because I believe the workers to be faultless, but in the daily and in the trade press their shortcomings have been abundantly set forth and the present pressing problem is as to what the engineer and the employer may and ought to do to bring about a better understanding. That can be done, but not by dwelling upon old grievances or by calling hard names. There must be mutual forbearance, mutual understanding, and a general recognition of the fact that men who are to be of any use to society or to the industries must have their personal ambitions, and in order to have them must see some chance of attaining them.

We are hearing constantly more about service as constituting the only just claim to rewards. Certainly the engineer need not fear comparison with others on that score. Yet there are those who, with the best intentions I am sure, charge a large share of our industrial and social difficulties to features of modern industry that have been created and are maintained by the work of the engineer.

Especially do they charge that doing things by machinery instead of by hand, and the multiplication of large manufacturing establishments in which the work is minutely divided, have had a bad effect—have, indeed, made men and women slaves of the machine.

I think we may claim that there is a misapprehension about this and that machinery and large industrial establishments do not nor can they by themselves enslave or oppress human beings.

It is easily demonstrated by reason and by human experience that division of labor, machinery for increasing man's productive capacity and the use of capital in production all tend, by themselves considered, to help the worker—to release him from burdensome tasks and from the necessity for working too hard or too many hours per day for too little money.

Two Kinds of Monopoly

But certain monopolies may and do have the opposite and injurious effects referred to; especially monopoly of the earth's resources and the holding of such resources idle and beyond the reach of labor and capital that might otherwise be applied to them for the satisfaction of the wants of mankind.

And our tax system acts as though it were especially designed to promote this result, to discourage industry of all kinds and to encourage the holding idle of the earth's resources for higher prices to be brought about by pressure of population and the enterprise and labor of others.

Many a manufacturer has been hampered in making enlargements of his plant by the high prices of vacant and idle land needed for that purpose; said high prices having been actually created by the activities of himself and his employees and in no degree by those who had been holding the land idle.

Fourteen years ago our Society held its Spring Meeting in Chattanooga and visited a water-power development in the Tennessee River, near there. At that time the large dam was about half-finished and I was told by a prominent member of this Society, himself a manufacturer, that already in anticipation of the coming cheap power, the owners of factory sites on which it might be utilized had doubled or trebled the prices at which they were holding them.

We hear much of the blessings to humanity of the cheap water power that may be developed in large quantities from our streams. As a matter of fact, it will be found that in nearly every case where water-power rates are substantially less than the cost of steam power, the total cost of the water power is nevertheless about the same as for steam; for the owner of available land on which to build factories and who, as such, has rendered no service of any kind either in producing power or in any other way, pockets the difference in prime cost—not the engineer, the manufacturer, nor the consumer of the goods produced.

Moreover, while as a general thing the manufacturer whose efforts and enterprise build up these values is taxed heavily for doing it, the vacant-land owner escapes with nominal taxation on the ground that his property is non-productive, if you please.

I mention these things, not because it is the engineer's special province to deal with them, but it is at least as much his business as that of any other citizen and it has a direct and vital effect upon his work and his opportunities for employment, or for going into business.

If it is the engineer's business to render service, then it is equally his duty to see to it that so far as possible all others do the same, and he has only to look about him to see that very many do not render service, yet are "clothed in purple and fine linen." The cure is not to take away their purple and fine linen, but simply to see to it that their having it is not by reason of their being able to restrict the opportunities of others for access to Nature's storehouse of raw materials and to work for the general welfare.

It is to be hoped that the day will soon come when every able-bodied and able-minded man will find it necessary to render actual service for what he receives and in fair proportion to what he receives. When that has been accomplished we need not concern ourselves overmuch about the way in which he spends his money. It will be clearly and of right his money, and the opportunities for spending it in such a way as to injure society will be much less than now.

That engineers are giving much more thought to these matters than formerly and are perceiving their important bearing upon the work and life of the engineer and all workers, is indicated by the fact that the President of the American Institute of Electrical Engineers, in his presidential address last year, discussed them, and the President of the American Society of Civil Engineers, the well-known Chief of the Reclamation Service, in his presidential address also discussed them; and we three, at least, are in agreement concerning them and their commanding importance, particularly in their effect upon the work of the engineer in whatever field of endeavor he may be engaged.

Of course an engineer or a manufacturer may be also the possessor of special privilege or a monopoly of one kind or another; but comparatively few of them really are, and where an engineer has acquired enough property to be called even moderately well off in these days of colossal fortunes, it will be found that his success in this is based upon the value of service which he has contributed to the general welfare, and those who envy such a man or who would limit his activities or his prosperity are very few and have practically no effective influence.

We can think of some engineers who have acquired what, until recently at least, would have been considered wealth. But they have usually done this in strictly competitive lines of business, engaged in by others, and open to all comers upon equal terms.

Compare the case of Corliss, for instance, and his early practice of selling his new improved engine upon the basis of a stated share of the saving in fuel for a limited time, with those usually absentee owners of the anthracite coal fields of Pennsylvania who create no coal, dig nor transport any coal, do nothing about coal except to own the ground in which it was placed by Nature long ages ago, "for the benefit of mankind," as we are fond of saying. Some of these owners are reported to have been recently doubling and more than doubling the royalties they collect for the mere privilege of employing engineers and miners and using machinery in the production of coal; the state of Pennsylvania helping them to retain their grip upon the coal supply by taxing their as yet unused coal lands at ridiculously low valuations as "unproductive farm lands," if you please; while real farmers in that state are taxed heavily not only upon their lands but upon everything else that can be found in their possession.

Herein is the backbone of the anthracite monopoly which is a grievous burden upon industries and upon coal users, and obstructs not only the production of coal but of all manufactured things in the production of which coal is a prime necessity. Being a citizen and a taxpayer in the state of Pennsylvania gives me the right, if nothing else does, to criticise its unenlightened and grossly unjust taxing system.

There are those, however, who will say that Corliss made his money by the possession of a monopoly, because his engine improvements were patented. But engineers especially need to clearly perceive the vital difference between such a monopoly as Corliss enjoyed and those monopolies of the earth's resources to which I have referred. Corliss had, for a limited time only, a monopoly of that which he had himself created, and any one who chose to do so went on using the plain slide-valve engine after the Corliss appeared, and all surely would have done so had not the terms offered by Corliss for the use of his improved engine been advantageous for the purchaser as well as for Corliss. In other words, the benefits arising from the improvements of Corliss were shared, first, by the purchaser of the engine, then by users of power, and finally by everybody.

Nearly always the same is true of any invention. It will not come into use unless purchasers of it share the benefits of what, before the invention, did not exist. Have we equal freedom of choice in the matter of fuel, not invented by man but created by Nature and an indispensable necessity of modern civilized existence?

Some thirty years ago a member of this Society invented a steam-engine governor from which he received a fortune in royalties based upon a certain charge per horsepower of engines to which it was applied. It is safe to say that that governor was never applied to one engine without benefiting both the engine builder and its purchaser by an amount far exceeding what was paid for its use. We are playing directly into the hands of those who advocate the socialization of all property and of all human activities when we for one moment admit that the inventor of any such thing is to be classed with those who monopolize that which is the common heritage of all of us—that which no man created and without which human existence cannot be maintained.

It would of course be wrong to condemn individuals who simply take advantage of a system that has long been tolerated by their

(Continued on page 8)

cotton-finishing plants in which, under ordinary conditions, the steam required for processing is greater than that for power development. The generation of power and of steam and the applications to the driving of process machinery are traced briefly from the boilers to the motor applications. Charts are presented showing the steam consumption and the proportion of the exhaust steam converted into work and available at the exhaust for different types of prime movers. Illustrations of typical drives are included.

In the finishing processes in the textile industry, such as bleaching dyeing, mercerizing, printing, calendering, etc., the quantity of steam required for processing and for the heating of manufacturing space may be from two to four times that required for power.

Opinion as to the lowest working steam pressure for process work consistent with steady output and a minimum production of "seconds," is almost as varied as the number of plants. It has been found, however, that with ample heat transfer surface, pressures of from 10 to 15 lb. gage, with an average of 12 lb., will take care of fully 80 per cent of the requirements in finishing.

It follows, therefore, that all power may be generated as a by-product by utilizing engines or turbines as reducing valves. Steam at boiler pressure is thus reduced to the low pressure of the exhaust line without thermal loss other than the heat converted into work and, in case of reciprocating engines, the loss in cylinder condensation.

From the economic standpoint power cost will be merely the fuel equivalent of conversion and condensation, labor and material

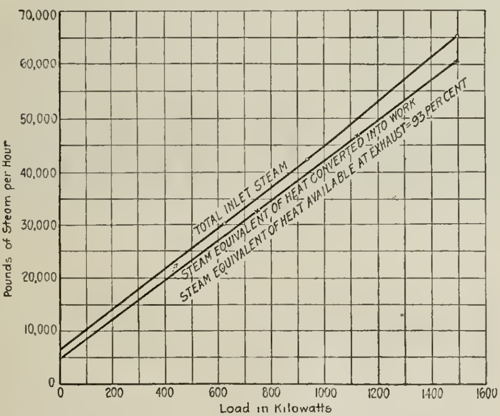

Fig. 1 Steam Consumption and Available Exhaust from a 1500-kw. Non-Condensing Turbo-Generator

Steam pressure at throttle, 175 lb. per sq. in.; back pressure at exhaust, 12 lb per sq. in.; steam flow at full load per hour, 65,000 lb.; equivalent steam available at exhaust, per hour, 60,600 lb.; inlet steam available at exhaust, 93 per cent.

costs in attendance upon and maintenance of equipment, and fixed charges on power-plant machinery. Under these circumstances purchased power can seldom compete with self-generation, provided the installation be large enough to keep the overheads and operating labor costs to a low figure per kilowatt-hour of output.

Boilers

For obvious reasons water-tube boilers are coming into more points of superiority over horizontal or vertical fire-tube boilers which manifest themselves in central station use apply in the selection of boilers for a finishing plant. The working steam pressure should range from 150 to 200 lb., the higher figure being preferable where its use does not add unduly to the first cost of boilers. A moderate degree of superheat is desirable, although not essential. Superheat reduces condensation in steam lines and results in somewhat better economy of engines or turbines, but there may be objections on account of the superheaters and their maintenance.

Among the items of minor equipment which are becoming increasingly popular may be mentioned soot blowers and reliable feedwater regulators.

Fuel and Firing Devices

The kind of fuel used is intimately associated with its method of burning. The use of steam sizes of anthracite, except where

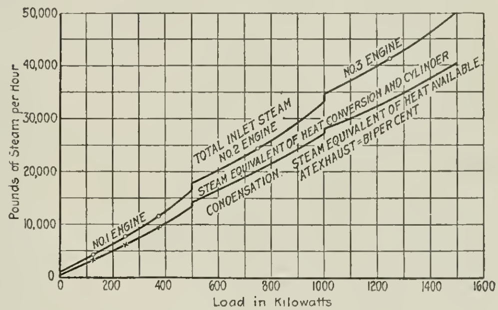

Fig. 2 Steam Consumption and Available Exhaust from Three 500-kw. Non-Condensing Engine Generators

Steam pressure at throttle; 175 lb. per sq. in.; back pressure at exhaust, 12 lb per sq in.; steam flow at full load, per hour, 50,000 lb.; equivalent steam available at exhaust per hour, 40,600 lb.; inlet steam available at exhaust, 81 per cent

mixed with bituminous coal, is not increasing. The market is restricted, and few types of stokers for this fuel have been developed. High boiler ratings easily reached with bituminous coal cannot be duplicated with anthracite; hence the installed boiler capacity and the first cost of boiler plant must be greater than with soft coal. Increasing fuel costs, higher freight rates and labor advance all work under normal market conditions toward the reduction in consumption of the lower grades of anthracite, particularly at points remote from the coal fields.

As in all other industries, bituminous coal leads in the proportion of fuel utilized by finishing plants. The newer installations for soft coal have underfeed stokers, of which there are now several reliable types on the market. Where the cost of large brick or steel chimneys is prohibitive, induced-draft fans may be installed, and this apparatus is always provided with economizer installations.

Fuel oil is the ideal fuel, but high price and possibility of shortage during times of emergency have combined to restrict its use. There are many advantages and economies in its use, and very recently there has been evidence that the large oil producers are entering the field to secure new business. Quick steaming, cleanliness and reduction in labor are the foremost economics, but no large plant should go to oil fuel without providing means for quickly converting a portion of its capacity to coal burning in case of acute and prolonged shortage of oil.

The use of powdered coal as a boiler fuel is just beginning to emerge from the experimental stage. Under favorable conditions the efficiency of combustion will be high, but offsetting this are such points as: liability to dust explosion; cost of drying and

[1] M. E., Day Zimmermann, Inc., Jun. Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

grinding; nuisance from fine ash which will be deposited on adjacent property; and high brickwork and refractory maintenance.

Prime Movers

The selection of primary drive is a matter which will depend to an extent on the size of the plant and the schedule of operation. In certain districts water power is still available during a considerable portion of the year, and this power is usually utilized by the mills as a part of privileges and grants dating back to the original acquisition of the mill property.

The water-power companies will likewise sell surplus water power under contract conditions, but the charges for such excess

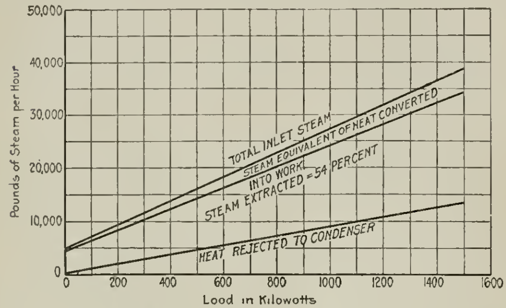

Fig. 3 Steam Consumption and Available Exhaust from 1500-kw. Extraction Turbo-Generator

Steam pressure at throttle, 175 lb. per sq. in.; extraction pressure, 12 lb. per sq. n.; vacuum in condenser, 28 in.; steam flow at full load, per hour, 39,000 lb.; steam extracted at full load, per hour, 27,000 lb.; inlet steam extracted, 69 per cent.

power will likely be in excess of rates for purchased power. This is due principally to the fact that individual mills have small wheels of low efficiency, and the power company, where itself engaged in the hydroelectric business, can develop a horsepower hour through its larger and more efficient machinery on less water than the

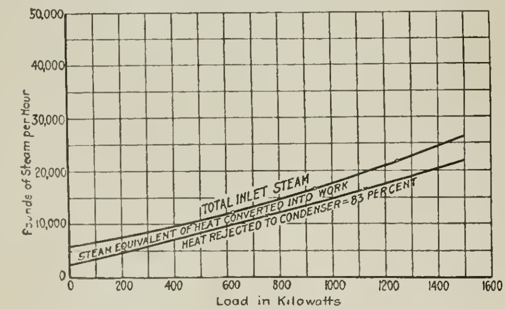

Fig. 4 Steam Consumption of a 1500-kw. Condensing Turbo-Generator

Steam pressure at throttle, 175 lb. per sq. in ; vacuum at exhaust, 28 in.; steam flow at full load per hour, 26,400 lb.; inlet steam rejected in circulating water, 83 per cent.

individual mill. Likewise conditions of load factor and diversity, together with control of storage water, generally put the power company in a more favorable position to utilize the water than to sell it.

Where water-power privileges have been acquired in terms of horsepower without time limit as to use, the individual mill can generally afford to continue any existing development up to its original privileges, particularly if some departments requiring power in excess of process steam are likely at times to operate when the rest of the plant is idle. Water-power privileges form a convenient means of developing power for night lighting and for the overtime operation of mechanical departments.

Naturally the available water power is subject to considerable seasonable variation, and a plant desiring continuity of operation must of necessity have sufficient steam-power stand-by to take care of its requirements under low-water conditions. The chances for duplication in investment are therefore obvious, so that the development of power from water should in every case be subject to careful analysis.

Steam power in the smaller mills may be developed in economical engines, but for plants requiring any considerable amounts of power the turbine drive from all points of view is preferable. Any steam engine, no matter how efficient, is subject to cylinder condensation, which represents a dead loss, whereas a turbine will extract from the steam only such energy as is converted into work, retaining the remainder of the latent and sensible heat in the exhaust steam.

This point is worth emphasizing, because it may happen that a certain type of steam engine has an actual water rate per unit of output lower than the same size of turbine. However, the net heat available for processing will always be greater with the turbine.

There is a field of application for the bleeder type of turbine in which steam may be extracted from an intermediate stage for processing or for building-heating requirements. The excess

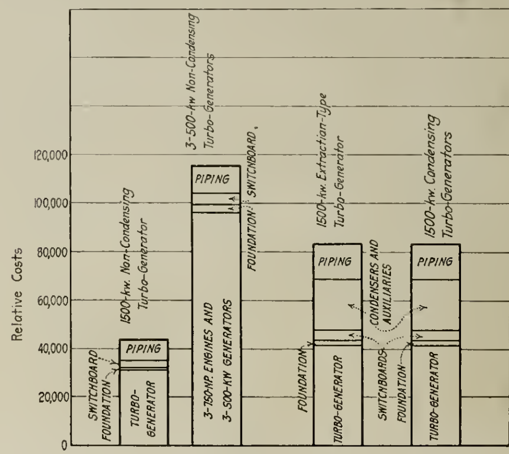

Fig. 5 Relative Installation Costs of Four Different Types of Prime Movers

steam to make up power demand passes to a condenser. The latent heat in this condensed steam may in part be recovered by utilizing circulating water for processing and for make-up boiler feedwater. There will, however, be at all times an unavoidable loss of heat rejected at condenser outlet.

Figs. 1 to 4 show for prime movers of four different types the relative steam consumption per unit of output and the relative heat consumption under conditions where exhaust steam can be fully utilized at all seasons of the year. Assuming in each case that the primary drive is connected to an electric generator, the relative costs, based on a 1500-kw. size, will be approximately as shown in Fig. 5.

Electric Drive

Except in smaller mills where belt drive may be used in connection with a steam engine, the tendency is now entirely toward electrification, both by groups and by individual machines.

The electrical characteristics of generators and motors must be determined after a study of the local requirements for variable speed as against constant-speed drives. In certain instances the selection will be influenced by the amount of electrical equipment already installed in the mill and the power characteristics of the local public utility on whom it may be desired to depend for standby service.

The three main subdivisions of power applications to finishing plants are:

moderate speed variation not in excess of 2 to 1 to accommodate variation in fabric and process. This includes certain forms of mangles and cans, sheet ranges, starch mangles, mercerizers, khaki, sulphur and indigo dyeing machines and steamers.

c Such power as is required to drive process machinery where the demands for variation in speed are in excess of 2 to 1. This class of equipment includes long tenters, aging boxes and multi-color printing machines.

For variations in speed in excess of 2 to 1, the direct-current motor occupies the leading position, unless it be desired to resort to some form of mechanical speed-changing device.

In the class of finishing plants considered, the operations of tentering and printing will frequently require speed ratios outside the range of commercial forms of alternating-current motors. Hence the proportion of power consumed by motors driving tenters and printing machines to the entire mill requirements, is an important factor in deciding whether the entire electrification shall be direct current, or whether a combination of alternating and direct current be applied. A suitable direct-current voltage is from 230 to 250 volts.

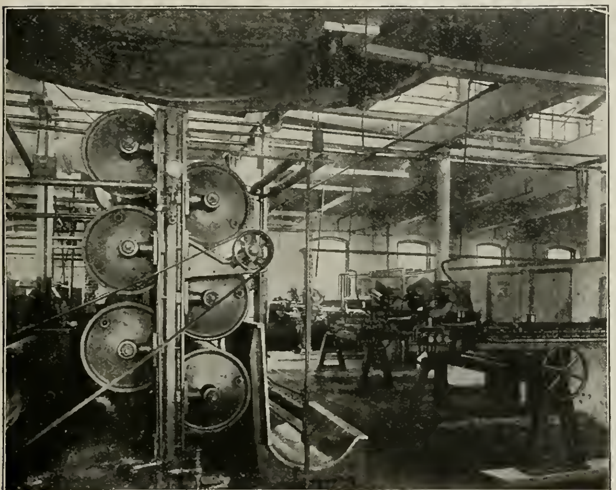

Fig. 6 Installation of Compensating Roll for Synchronizing Two Variable-Speed D.C. Motors

In the larger mill projects the electrical characteristics of generators are generally 3-phase, 60-cycle, with voltages varying according to the choice of the designer and his method of solving the power problem.

The voltages in use are 220, 440, 550 and 2200, the two intermediates being the most popular. The lowest voltage calls for large sizes of conductors and conduits, and the highest cannot be used directly on all mill motors, hence transformers for stepping down to motor voltage must be installed. In such a development direct current may be obtained from rotary converters or motor-generator sets. Although the rotary converter has a higher efficiency and may occupy less floor space than the motor-generator set, the use of the latter is preferable because of its ability in effecting power-factor correction.

Modern alternating-current generators are designed on a basis of maximum current output, hence in such finishing plants as have a large proportion of inductive motor load it may be well to specify a load power factor of 70 per cent or 75 per cent when selecting generators, rather than the more usual 80 per cent used in central-station practice

will have a lower water rate for the off-peak load.

Another method successfully applied is to provide some excess capacity in the steam exciter and by means of a selector switch transfer the lighting load from the normal supply of three-wire 100-volt alternating current to two-wire 110-volt direct current. Likewise the shops may be equipped with a 110-volt direct-current motor taking its power from the turbo-exciter and driving the shops when the manufacturing departments are idle.

Where the size of the equipment justifies the expense, generator coolers should be installed in connection with high-speed alternating-current turbo-generators. These generator air washers not only permit of high capacity of the generators during extremely warm weather, but likewise remove coal and ash dust, lint and any other foreign matter whose presence might damage the generator windings.

Motor Application

Constant-speed groups or individual drives are best operated by induction motors controlled by motor-starting switches convenient to the operator and protected against injury by overload and low-voltage trips.

For constant-speed drives having heavy starting duty it may be necessary to use slip-ring motors with drum controllers and with resistances in the controller circuit for starting duty only. A safety or oil switch should be provided in the primary circuit.

Another group of drives falls in the class where the requirements of the process are met by a speed reduction of two to one, or where the lowest speed needed at any time will be 50 per cent of the maximum speed. It is not always necessary under these conditions to resort to the direct-current motor, since a slip-ring motor with secondary resistance banks designed for continuous running at any point of the controller has been found suitable for mangles, cans, open tenters and sheet ranges.

The control equipment consists of a drum controller and resistance for the secondary circuit. The incoming feeder should be protected by an oil switch with overload and low-voltage releases.

It should be borne in mind in applying slip-ring motors for variable speed that, except for the limitation of maximum speed imposed by the frequency of the alternating current, a slip-ring motor has speed and electrical characteristics very similar to the series type of direct-current motor. Consequently variations in load arising from such adjustments as the set on rolls or the friction of cloth over cans and rollers will produce variations in speed without any change of controller position.

The applications of variable speed with higher ratios by means of direct-current motors opens up a wide field in the selection of control equipments. Various manufacturers have developed outfits to suit local conditions and the ideas of the designer. These controls vary all the way from the simple faceplate rheostat for varying the field strength of a shunt-wound direct-current motor to the more elaborate push-button control contactor panels.

A form of safety device which should never be omitted is some form of push-button or snap-switch release whereby the back tender on printing machines or tenters may from his position instantly shut down the entire equipment.

It is usually convenient to use two motors for driving long tenters, one driving the tenter equipment proper and the other operating the mangle and cans. In order to preserve proper synchronism between the two motors, a compensating equipment such as is illustrated in Fig. 6 may be applied.

Since in the raw materials utilized in finishing plants steam and power rank second only to gray goods and drugs, the necessity for measuring the power and steam consumption of all departments

is obvious. This can be accomplished by the simple application of integrating wattmeters to power feeders and of flow meters to steam lines. The number of electric and steam meters need not be excessive and their cost will soon be returned in the form of better knowledge on the part of the executive as to plant conditions, and in the ability to locate immediately and check wastes and losses. An actual steam distribution is shown in Fig. 7 for both the heating and non-heating seasons.

In some cases there may be a tendency toward thermal unbalance occurring during periods of low production in the non-heating season, or during periods of the working day when the power load is building up more rapidly than the process steam consumption. Any loss of this kind may be checked readily by the installation of a storage heater, in which the heat-transfer surface is proportioned in accordance with the rate of discharge of exhaust steam, and the volumetric or storage capacity in accordance with the duration of the period of unbalance and the

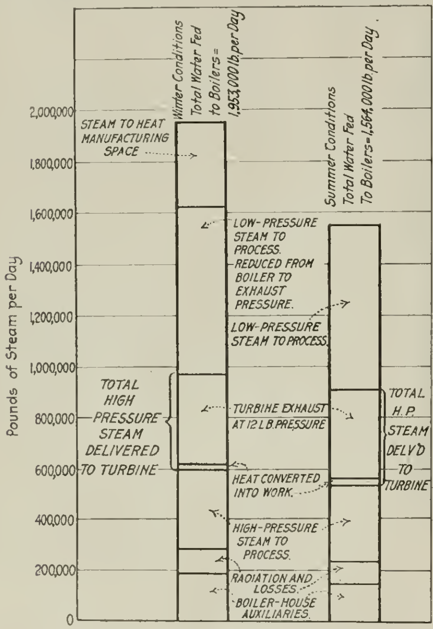

Fig. 7 Steam Distribution (Heating and Non-Heating Seasons) for Finishing Plant with Correct Heat Balance

X: Total high-pressure steam delivered to turbine.

heat to be absorbed in that period. This hot water can be drawn upon for washing or for whatever purpose hot water is required in the process.

A general plan of power application based on a complete heat balance such as has been described in this paper will lead to very substantial economies in fuel, labor and maintenance costs in the power department over the more general use of engines for group or individual drive. Particularly at this time, because of advancing freight rates, scarcity of fuel, high prices prevailing and unsatisfactory transportation conditions, have fuel costs and power economies assumed national significance. Indeed, the Government has recognized the prime importance of this problem in its relation to the conservation of natural resources through the superpower survey being conducted by the Department of Interior.

THE ENGINEER'S SERVICE TO SOCIETY

(Continued from page 4)

fellow-citizens, and is generally looked upon as respectable and proper. It is not individuals but the system that is wrong, and wrong because it permits and even entices men to take steps to secure large rewards without doing anything of real value in return for them; particularly to make themselves a heavy burden upon the industries which the engineer is trying to develop and upon which he depends for his opportunities to render service.

All clear thinkers, I believe, support and will maintain the just rights of property; but it is becoming clearer every day that a necessary condition for safe-guarding property rights is, first and above all, the safe-guarding of human rights. In fact, security of property rights rests, finally, upon the maintenance of human rights.

It is not true that "the world owes every man a living," but the world does owe every man an exactly equal opportunity to earn a living.

And let us not be deceived by the newly invented factor of production called "ability," which, it is asserted, rests somehow upon an economic basis different from that of labor. Labor, in the broad sense—the economic sense—is any kind of useful endeavor, mental or manual. There are only three factors in production of wealth: land or Nature's resources; labor, mental or physical; and capital. The invention of so-called "ability" as a fourth factor has no basis in reason or experience and its only function is to confuse our reasoning about industrial and economic problems and to bring us to erroneous conclusions concerning them. Especially has it been invoked in attempts to justify exorbitant gains by those who rendered no service in return and were often mere gamblers. A burglar or a pickpocket may exercise ability in his profession, and even the right kind of ability is of no use unless exercised, and then it is labor.

If it is true that any considerable portion of our American workers are being led astray by ultra-radical teachings, then such teachings may be most effectively combated by such teaching as the engineer is in a position to give. But it will not answer to simply assert that there is nothing the matter and that we should all be content with things as they are, or as they were in a time now past and gone. There must be, in such teaching, evidence of a real understanding of what conditions really are and of a sympathetic attitude toward any reasonable and fair ambition to improve them.

It must be shown, as it easily can be, that profits, in normal times and in competitive lines of business and manufacturing, are usually and on the average not greater than they need to be to attract to them capital and men capable of carrying them on; and that business men and manufacturers as well as workers, often suffer from the power of special privilege and inadequately regulated monopolies.

The fact is that our economic and social science has not kept pace with the work of the engineer; for he, in his own work, is by temperament and training an innovator. He lives to persuade other people to do new things, or to do old things in entirely new ways. This being so, it would seem to be logical that he himself should at least maintain a sufficiently open mind to avoid resisting a new thing concerning which he has not cared to, or has had no opportunity to, investigate.

Whether it be a new idea in industrial management; revision of our tax system so as to remove burdens from beneficial activities and to discourage monopolies; a League of Nations to preserve the peace of the world, so that the results of the work of the world can be wholly useful instead of largely wasteful, destructive and pernicious; we engineers, especially, ought not to remain bound by mere custom, which, as Guizot said:

". . . .contracts our ideas with the circle it has traced for us; it governs by the terror it inspires for any new and untried condition; it makes us believe the walls of the prison within which we are inclosed to be the boundary of the world, and beyond all is undefined, confusion, chaos, where, it makes us feel, we should not have air to breathe."

Customs and usages have their places and their values, but when new problems present themselves we must not shrink from the contemplation of what are, or may seem to be, new remedies, so long as they are founded upon established principles of justice and fair dealing.

form of the thread on the work, or in other words, the form of the tooth on the hob is not reproduced on the threaded part. The present paper is the result of a mathematical investigation of this subject and points out the corrections in the form of thread-milling hobs which can be readily made and also produce threads sufficiently correct as to form for all practical purposes. The profile of the thread cut with a hob is a combination of two distinct curves. First, a small fillet is formed at the root of the thread which is the path of the outside corner of the hob. No correction in the form of the hob is possible to correct this point. Second, the larger part of the flank of the thread consists of a slightly curved profile which is formed by the overlapping paths of the infinite number of cutting points which form the cutting edge of the hob. Mathematically, a curved correction can be applied to the form of the hob which will correct this profile entirely. Practically, a straight-line correction can be applied which is almost exact, as the amount of the actual curvature on the flanks of the thread is seldom greater than one-tenth of a thousandth part of one inch. The greater the angle of helix of the thread, the greater the amount of correction necessary. The complete paper deals with both externally and internally threaded parts, but in the present abstract only externally threaded parts are considered. The general conditions of side-cutting are identical, however, in both cases.

When a thread is chased in a lathe and the cutting tool has proper clearance and is set so that the plane of the cutting edges contains the axis of the thread, the exact form of the tool will be duplicated on the work. Assuming that the thread is completed, if the tool in its cutting position is brought into contact with the flanks of the thread, it will have a line bearing only. If sufficient clearance can be provided on the tool, this holds true regardless of the pitch of the thread, the angle of the flanks, or its diameter.

When a thread is hobbed, however, the axis of the hob being parallel to the axis of the thread, the path of any one cutting point is a circle, and this circle will interfere with the helix of the thread to an amount depending upon the pitch of the thread, the angle of the flanks, and the diameters of both hob and thread.

It is assumed in this discussion that the cutting teeth of the hob are backed off sufficiently to prevent any dragging of the relieved portion of the tool on the work. The interference between the cutting edge of the hob and the helix of the thread therefore results in the removal of additional metal, thus distorting the form of the thread. The amount of this distortion varies as the values of any of the following factors change: the pitch of the thread, the form of the thread, the diameter of the work, and the diameter of the hob.

It will be shown that correction for some of this distortion inevitable with this method of manufacture is impossible. The amount of this distortion, however, can be reduced in many cases by the proper relation between the diameters of work and hob. It will also be shown that most of the distortion can be corrected by a suitable alteration in the form of the cutting tool.

The Hobbing of Screws

In Fig. 1, which shows a diagram of a hob and screws, let

- R = radius of any cutting point on the hob
- r = radius of deepest point on work touched by R
- N = number of threads per inch
- A = angle of rotation of hob
- B = angle of point of contact of R at angle A
- C = $^1/_2$ included angle of thread
- r' = radius of point of contact of R on work.

Formulas will first be derived to show the interference between the path of any cutting point on the hob and the flanks of the point R from the deepest point on the work touched by R will be designated as y. In other words,

$$y = r' - r \qquad [1]$$

The longitudinal (or axial) distance R of the cutting point from the flank of the theoretical thread will be designated by x. A plus value of x will indicate a clearance, while a minus value will indicate an interference or side-cutting.

In order to determine the value of y the triangle shown in heavy lines in Fig. 1 must be solved. The known factors will be taken as r, R, and B. We first have

$$\frac{(R + r) \sin B}{R} = \sin 180° - (A + B)$$

$$\sin 180° - (A + B) = \sin (A + B)$$

$$\frac{(R + r) \sin B}{R} = \sin (A + B) \qquad [2]$$

From this equation we determine the value of A. Solving the triangle for r', we have

$$r' = \frac{R \sin A}{\sin B} \qquad [3]$$

and when the value of r' is determined, the value of y is established from Equation [1].

As the hob revolves away from the common center line of the

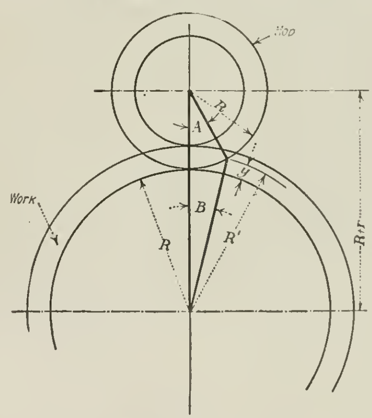

Fig. 1 Diagram of Hob and External Screw

hob and work, the cutting points on one side of the tooth of the hob, due to the helix of the thread, will have a clearance with the flank of the thread, while the cutting points on the other side of the tooth of the hob will develop an interference. But the side of the hob which clears the helix as the cutting point revolves away from the common center line will interfere as the cutting points approach to the common center line, and the nature and extent of this interference will be symmetrical and equal on both flanks of the thread as long as the form of the thread is symmetrical.

The amount of interference depends upon the value of B and the pitch of the thread, or number of threads per inch, N. Thus

$$\text{Interference Due to Helix} = \frac{B}{360N} \qquad [4]$$

If the included angle of the flanks of the thread is greater than zero (which is the case for all but square threads), as the cutting point of the side of the cutting tooth departs from the common center line of the hob and work a clearance develops between the cutting point on the hob and the flanks of the thread. The amount of this clearance depends upon the value of y and the included angle of the thread, and referring to Fig. 2 it will be seen

[1] Engr. of Standards, Niles-Bement-Pond Co., and Pratt & Whitney Co., Assoc.-Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

that its value, ignoring for the present the helix of the thread, may be expressed as:

$$\text{Clearance} = y \tan C \qquad [5]$$

The value of x is therefore found by subtracting the amount of interference given by Equation [4] from the amount of clearance given by Equation [5], or

$$x = y \tan C - \frac{B}{360N} \qquad [6]$$

As an example of the use of the above formulæ, we will assume that we wish to hob a thread which has a radius r or 0.5625 in. at the minor diameter with a hob whose radius R is 2.250 in. at its outside diameter with 4 threads per inch. A thread with a relatively large helix angle is taken as the first example in order to show the nature of the resulting side-cutting of a hob. The thread has an included angle of 60 deg., making C = 30 deg., and N = 4. The value of B is taken from 0 deg. to 12 deg., which gives the following values for x and y:

For B = 0°	2°	4°	6°	8°	10°	12°
x = 0	−0.00114	−0.00176	−0.00194	−0.00157	−0.00064	−0.00084
y = 0	0.00043	0.00176	0.00386	0.00691	0.01092	0.01589

The above as well as intermediate values are plotted in Fig. 3-A at the left, and the actual path of the cutting point is shown at the right. These curves show the general form of the side-cutting of any point on the cutting face of a thread hob.

This cutting face of the hob is made up of an infinite number of points. As the positions of these points vary, the ratio between R and r varies, as also does the helix angle of the thread, and therefore each cutting point travels in a different form of path. Thus, in order to determine the resulting form of a thread cut with a hob it will be necessary to plot the paths of a few other points. A point 0.20 in. higher on the flank of the thread will therefore next be taken. This gives R = 2.050, and r = 0.7625, as before, C = 30 deg. and N = 4, and the values for x and y with these factors are as follows:

For B = 0°	1°	3°	5°	7°	9°
x = 0	−0.00061	−0.00126	−0.00117	−0.00032	−0.00136
y = 0	0.00015	0.00143	0.00398	0.00786	0.01318

These values are plotted at the left in Fig. 3-B. The actual path of the cutting point is shown at the right.

A third point 0.40 in. above the bottom of the thread will also be taken. This point is beyond the top of the thread, but it is taken to accentuate the distortion developed by hobbing. In this case R = 1.85, r = 0.9625, C = 30 deg., and N = 4. The values for x and y with these factors are as follows:

For B = 0°	1°	3°	5°	7°
x = 0	−0.00057	−0.00093	−0.00026	−0.00151
y = 0	0.00022	0.00199	0.00566	0.01104

The above values are plotted at the left in Fig. 3-C. The actual path of the cutting point is shown at the right.

In order to show more clearly the nature of the side-cutting of hobs, the curve in Fig. 4 is plotted in an exaggerated form with the intervals along the y-axis equal to 0.001 in., and those along the x-axis equal to 0.0001 in. The curves shown in Figs. 3-A, 3-B and 3-C are plotted to this scale and brought together proportionately; that is, the origins of these curves are spaced equally from the bottom, but these spaces are not to scale. This distorts still further the exact shape of the curve, but its general properties are correct.

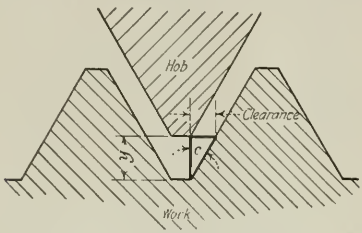

Fig. 2 Diagram Showing Clearance between Hob and Work

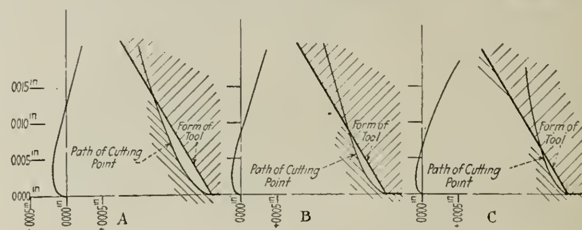

Fig. 3 Curves Showing Paths of Cutting Point

This curve shows the general nature of the distortion in the form of a thread which is caused by the side-cutting of the hob. It will be noted that it is a double curve, the lower part (below the line A–A) being developed by the bottom corner of the hob tooth while the upper part (above the line A–A) is developed by the overlapping paths of successive cutting points on the cutting face of the hob. It is evident that the distortion shown at the bottom of the curve is inevitable and no correction in the form of the hob is possible that will eliminate it. It can be reduced in many cases, however, by making the hob smaller in diameter. On the other hand, the distortion shown in the upper part of the curve can be eliminated by changing the form of the cutting edge on the hob.

The correction of the hob is determined in the following manner: The greatest amount of side-cutting is done by the bottom corner of the hob. In the foregoing example the tabulation shows 0.00194 in. when B = 6 deg. This is not necessarily the exact maximum. If a closer value is required, the tabulations must be made with increments of B of smaller amounts. Tabulations as shown, however, will be correct to the fourth decimal place, which is sufficiently accurate for most purposes.

If the tooth of the hob is narrowed at each point of the cutting edge by the amount which it side-cuts the thread form, the contour of the thread above the line A–A in Fig. 4 will be correct and in most cases it will be found that the correction in a straight line will be sufficiently accurate as the resulting error will be negligible.

Fig. 5-A represents the form of a thread cut with a hob having the form of the cutting edges identical with the true form of the thread. In this figure,

C = half included angle of thread
F = width of flat of thread at the root or minor diam.
r_1 = largest value of r employed (radius of major diam.)
r_2 = smallest value of r employed (radius of minor diam.)
x_1 = maximum minus value of x for r_1
x_2 = maximum minus value of x for r_2
$(r_1 - r_2)$ = depth of thread
$2(r_1 - r_2) \tan C + F$ = width of space at major diameter (outside).

Fig. 5-B illustrates a corrected hob and the form of thread cut with it. In this figure,

$F - 2x_2$ = width of flat at bottom of hob form
$2(r_1 - r_2) \tan C + (F - 2x_1)$ = thickness of hob form at top
C' = half the included angle of corrected hob.

If the cutting edge of the hob is kept as a straight line, the tangent of half the included angle of the hob form will be equal to half the difference between the widths of hob form at the top and bottom divided by the height of the form. Using the values shown in Fig. 5-B, we have the following:

$$\tan C' = \frac{2(r_1 - r_2)\tan C + (F - 2x_1) - (F - 2x_2)}{2(r_1 - r_2)}$$

$$\tan C' = \tan C + \frac{F - 2x_1 - F + 2x_2}{2(r_1 - r_2)}$$

$$\tan C' = \tan C + \frac{x_2 - x_1}{r_1 - r_2} \qquad [7]$$

It will be seen from Equation [7] and also from the figures that a corrected hob will have a greater included angle than the thread

x_3 = maximum minus value of x for r_3

K = difference at r_3 between straight-line correction on hob and true correction

$$\frac{x_2 - x_1}{2} + x_1 = \frac{x_2 - x_1 + 2x_1}{2} = \frac{x_2 + x_1}{2} = \text{correction at } r_3 \text{ when hob form remains a straight line.}$$

$$K = \frac{x_1 + x_2 - x_3}{2} \qquad [8]$$

If the rounding or fillet at the bottom of the thread as shown in Fig. 5-B is objectionable, the point of the hob may be extended by an amount about equal to y_2, provided that such an undercut is permissible. By so

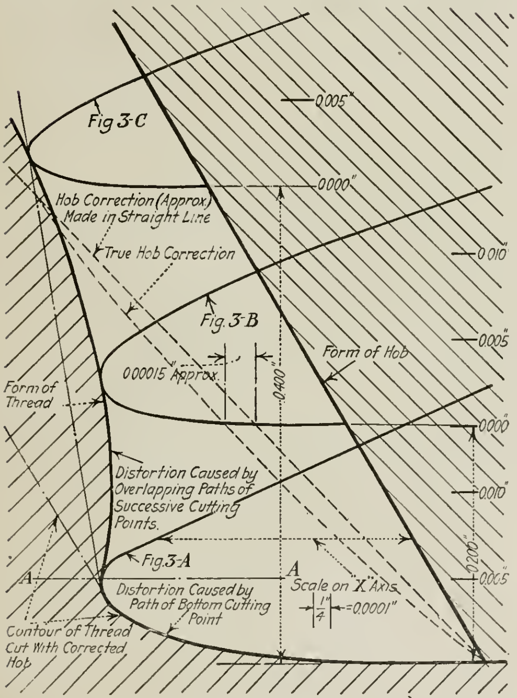

FIG. 4 CURVES SHOWING SHAPE OF CUTTING PATH

doing an almost theoretically perfect thread form will be secured. Theoretically, the point should extend slightly more than y_2, as at this point r becomes smaller and R becomes larger than the values of r_1 and R_1. Referring to Equation [3], this increase in the value of R will increase the value of r'. Referring to Equation [1], this increase in the value of r' and the decrease in the value of r will increase the value of y. But for all practical purposes an extension on the point of the hob of the nearest even dimension to y_2 will usually be sufficiently accurate. On standard threads cut with hobs the resulting error will be in fifth or sixth decimal place.

For the purpose of simplifying calculations tables have been

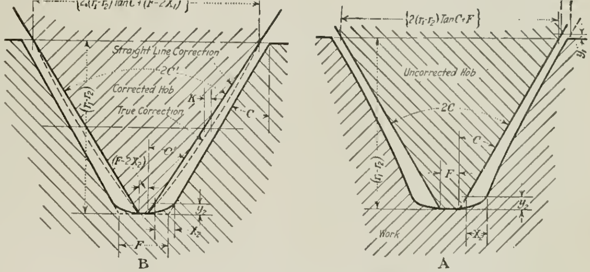

FIG. 5 FORM OF EXTERNAL THREAD CUT WITH UNCORRECTED AND CORRECTED HOB

by the radius of the work to obtain the value of y. The values of y/r may be obtained by interpolation when the value of r/R does not agree with any of those given. The values given under $B/360$ are divided by N and substituted in the equation $x = y \times \tan C - (B/360N)$ to obtain the value of x.

In order to illustrate the use of these tables and to determine the effect of varying the diameter of the hob, values are given in the complete paper for an Acme thread (5 threads per inch, one inch in outside diameter) cut with three hobs, the first one inch in diameter, the second two inches in diameter, and the third four inches in diameter. An Acme thread is selected because the smaller included angle of thread results in more side-cutting, thus making more pronounced the effect of varying the diameter of the hob. The depth of an Acme thread of this pitch is 0.110 in. The included angle is 29 deg. The width of the flat at the root of the thread is 0.0689 in.

The final value of the included angle, $2C''$, as given by Equation [7] is found to be 29° 59′ 26,″ and in the particular case chosen the difference between the angle of the hob and angle of the work is 59 min. 26 sec. The correction is therefore made in a straight line. By means of Equation [8] the difference K between this correction and the true correction at the middle of the flank is also determined as 0.000064 in. This is negligible and can safely be ignored. In fact, it is much less than the probable error in the hob.

From the values derived in the complete paper the following tabulation is also made to show the various effects of varying the diameter of the hob. (See Fig. 5-B.):

Hob. diam. =	1.000 in.	2.0000 in.	4.000 in.
x_2 =	0.002695	0.003475	0.004048
y_2 =	0.008912	0.012344	0.014422
$2C'$ =	29° 59′ 26″	30° 0′ 16″	30° 0′ 54″
$F - 2x_2$ =	0.0635	0.0619	0.0608
K =	0.000064	0.000054	0.000026

From this tabulation it will be seen that the amount of side-cutting at the bottom of the thread (x_2) increases as the diameter of the hob is increased. The height of the fillet at the bottom of the thread (y_2) also increases as the diameter of the hob increases, in fact, it increases about three times as much in this case as x_2. The included angle of the corrected hob ($2C''$) increases very slightly as the diameter of the hob increases. The width of the point of the corrected hob ($F - 2x_2$) varies less than 0.003 in. as the diameter of the hob is increases from 1 in. to 4 in. The dimension K in Fig. 5-B is reduced as the diameter of the hob increases.

The correction for angle used in these solutions is a chordal correction. This shows a slight change in angle as the diameter of the hob varies. A geometrical solution of this side-cutting will show that, except for the fillet at the root of the thread, the profile is unchanged regardless of the diameter of the hob. There-

Continued on page 62

Increasing the Capacity of Old Locomotives

By C. B. Smith,[1] Boston, Mass.

The usual policy of the railroads with reference to the purchase of new locomotives and the conversion of old ones is not, in the opinion of the writer, as well provided for as the demands of the service require. The difficulty lies in the fact that shop facilities are inadequate, a large amount of both time and money being unnecessarily consumed in order to keep locomotives in service. The problems of adapting the old-type locomotives to suburban and local service are discussed and the items which are to be considered in any program for increasing locomotive capacity are listed. The author also cites examples of satisfactory reconstruction which justify the improvement program he advocates, and states that the application of all the desirable auxiliaries to old engines is prohibitive without a radical provision for carrying out such a program.

In these days of the high cost of railroading, responsible officers of the mechanical departments realize that the necessity for reducing the cost of all locomotive operation and maintenance is more urgent than ever. Such saving can be accomplished in two ways, one by using new and modern locomotives, the other by rebuilding old types. The purchase of new locomotives, however, is usually confined to the largest units permissible for each type required, and they are equipped with superheaters and other modern devices as selected by the purchaser. Older engines of modern type, but not originally supplied with superheaters, are also being so equipped at general shoppings of these engines on the greater number of the roads of the country, and as rapidly as local conditions will permit.

On the majority of our roads there are still locomotives of the earlier modern types whose general features of construction are satisfactory, and which only require modernizing to make them economical transportation units. Improvements for such classes of locomotives may include, in addition to superheaters, piston valves in place of slide valves, outside valve gears in place of Stephenson motion, and such other improvements as are usually made upon engines at general shoppings.

The replacement or betterment of the older locomotives "in kind" is becoming more of a problem where suburban and local passenger service and branch-line traffic still require the maintenance of the lighter types of locomotives that can handle such traffic. Such engines are periodically returned to the shops for repairs, and the frequency of these shoppings could be reduced and mileage between them increased if the time were taken at one shopping to modernize them. Extensive reconstruction, however, requires a longer shopping period and reduces the number of engines available for road service.

The items which are to be considered in any program for increasing locomotive capacity are:

1 Superheater
2 Pyrometers
3 Brick arch
4 Valve motion
5 Mechanical stoker
6 Power reverse gear
7 Automatic fire door
8 Feedwater heater
9 Improvements in boiler design when new boilers are required
10 Improved boiler circulation
11 Increasing firebox heating surface
12 Flexible staybolts—breakage zones
13 Covering steam pipes
14 Flange oilers
15 Automatic driving-box wedges on heavy locomotives
16 Steam-pipe joints at smokebox
17 Pneumatic bellringer
18 Chime whistle on freight—more audible to train crew.

These items are numbered for convenient reference and do not necessarily indicate the order of importance.

The aggregate of such improvements results in a locomotive which in proportion to its capacity will produce service results comparable with those of entirely modern construction, and at a cost approximately one-half that for a new locomotive of similar capacity. The difficulty in carrying forward an extensive reconstruction program, however, is in finding the shop facilities either on the railroad or among the locomotive builders in order to advance the work at a satisfactory rate of progress. Nevertheless, despite this difficulty the results which could be obtained from the operation of reconstructed locomotives, if they could all be rebuilt within the next few years, would justify a special effort on the part of railroad managements to bring it about.

On roads where the number of old locomotives which warrant rebuilding are sufficient to require a period of more than three years to complete the work, it would seem necessary to arrange for enlargement of shop facilities in order to hasten the reconstruction. If, however, adequate shopping facilities are not forthcoming, the improvement program for locomotives must be confined chiefly to the application of superheaters and the substitution of piston for slide valves; together with the minor but relatively important betterments that may usually be applied at the shopping period.

Some of the engines built within the past ten years have developed weaknesses in frames and in parts of running gear. It has proved justifiable to reconstruct them by substituting new parts of stronger design and thus avoid recurring breakages which interrupt both the road service of these engines and the repairs to others. On roads whose traffic and service conditions now demand and will continue to demand the use of light locomotives for passenger trains and freight trains on branch lines, the better classes of the light locomotives should also receive their share of improvements along with the heavier power.

Old locomotives requiring new boilers have very generally been scrapped, but where light train service demands no heavier engines than formerly, the writer believes it advisable to rebuild such engines with radial-stay boilers, superheaters, new piston-valve cylinders, main frames when necessary, and outside valve gears. If there is to be no increase in the boiler pressure over that formerly carried by the locomotive and the valve motion has given little trouble by breakages, the Stephenson motion may be connected to the piston valves through the usual rocker-shaft connections.

Old locomotives that are unsatisfactory as to wheel arrangement may be rebuilt and changed to another type and service. One road has converted 2–8–0 type or Consolidation locomotives to 0–8–0 switching service by removing the leading truck, applying a new boiler, new cylinders, outside valve gear, power reverse gear, and modifying the frames as required. The boiler was located to properly balance the engine.

The old eight-wheeled, American-type locomotives having crown-bar boilers with deep fireboxes between frames have become obsolete on many large roads, but on the small roads and on branch-line and local train service in much of the New England territory these engines, modernized as far as consistent, should be carefully considered where the traffic conditions warrant.

Because of limiting weight conditions, Mogul or 2–6–0 type locomotives have been assigned to passenger-train service on some outlying divisions. The application of superheater and piston-valve steam chests with outside steam-pipe connections as the principal features of improvement, has increased the economy of these engines, added one passenger car to their tonnage capacity, and reduced train delays. Outside valve gears were not applied, shop limitations preventing, but their addition is desirable.

Atlantic-type locomotives having outside valve gears have had their capacity and economy increased by the application of the superheater. This work permitted the use of the engine in long-distance through service which was not previously successful.

Consolidation locomotives reconstructed with superheaters, new piston-valve cylinders, outside valve gears, new front-frame sections, and frame cross-ties have also had their capacity increased,

(*Continued on page 16*)

[1] Mechanical Engineer, Boston and Maine Railroad.

Abstract of a paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

The following paper is a discussion of the problem of providing adequate facilities for the proper maintenance of locomotives at engine terminals. The location, size, and general layout of the terminal are dependent on various elements, the two principal factors being character of work to be performed and location of the general locomotive repair shop. The necessity for providing modern facilities is discussed with a view of awakening an interest in this subject, which has an important bearing on the ability of the railroads to handle the increased traffic demands of the country. The various structures which comprise the terminal are treated separately with more or less detail, having in mind that the entire problem must be handled in such a way that it will be of service in modernizing existing locomotive terminals, as well as to provide information of value in designing new terminals. The author has purposely omitted reference to detail construction of buildings as these features generally conform to the railroad's standard practice.

ENGINE terminals play an important part in the operation of the railroad, as the transportation department is at all times entirely dependent upon them for its supply of serviceable power for the movement of both passenger and freight trains. Should the capacity of the terminal or the facilities for making repairs be inadequate, the result will soon reflect itself in more time being required to prepare engines for service and more frequent detention on the road due to failures.

The general layout of the terminals, also the extent of repair facilities to be provided, depend entirely on their location with reference to the general locomotive repair shop. When located in close proximity it is necessary to provide only such facilities as may be necessary to make the general run of roundhouse repairs, depending upon the main shop for the manufacture and supply of a large percentage of materials required for use at the terminal. But when engine terminals are located some distance from the general locomotive repair shops, they should be provided with enlarged facilities so as to perform all the necessary machine, blacksmith, and boiler-shop operations required when making more extensive repairs, and be entirely independent of the main shop. It is important, however, to eliminate at such terminals the manufacture of such standard parts as may be produced elsewhere at less cost when made in quantities. At outlying points where only light repairs are made to maintain locomotives in serviceable condition, such repair facilities as described above are not necessary. In this connection Figs. 1 and 2 are of interest as they illustrate typical layouts of modern locomotive terminals.

The location of the engine terminal with reference to the general locomotive repair shop will have some bearing on the necessity of performing relatively heavy repairs at the terminal. Where they are within reasonable distance of each other, it may be desirable to have a considerable part of the heavy repair work transferred to the main shop, where the repairs can be performed more expeditiously. On the other hand, this class of work has a tendency to interfere with the output of the locomotive repair shop, and especially so if it is found difficult to maintain the necessary quota of class repairs, considering the equipment as a whole. In such cases it would appear more desirable to increase the engine-terminal forces and provide sufficient facilities to at least make Class 5 repairs and the general run of heavy running repairs, including the removal and reapplication of a part or complete set of flues.

Where it is found desirable to perform such heavy repair work, it should preferably be done in a small building located adjacent to the machine shop, and provided with several tracks for holding engines and an overhead crane or power-driven locomotive screw hoist to facilitate the removal of all wheels. This feature is very

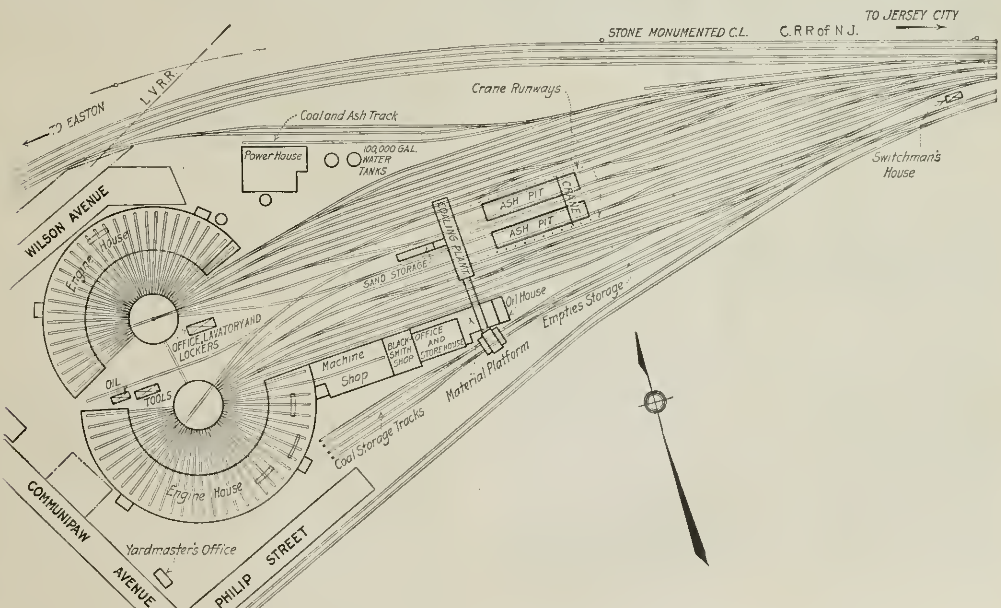

Fig. 1 Engine Terminal, C. R. R. of N. J., Communipaw, N. J.

This terminal handles daily an average of 200 locomotives. It is located 8 miles from the general locomotive repair shop and present facilities only provide for making ordinary repairs

[1] Asst. Supt. Motive Power, C. R. R. of N. J., Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

desirable, especially if heavy locomotives are to be handled. It also increases the track capacity within the roundhouse to that extent and repairs can be made more promptly and economically.

The arrangement of tracks at the engine terminal, including inbound and outbound tracks, will depend entirely on the location and available space assigned. The successful operation of the terminal requires a complete analytical study of the entire project from an operating standpoint, taking into consideration the number and type of locomotives to be handled and the possible future increase in requirements. The number of locomotives to be handled will determine the size and arrangement of facilities to be provided.

The introduction of numerous specialties on modern locomotives together with the necessity for complying with Interstate Commerce Regulations covering the inspection and testing of locomotives and their appurtenances require a more extensive inspection and maintenance force.

Coaling Stations and Sand Storage

The type of coaling station selected must depend on the number of engines handled, the number of tracks which may be available for coaling engines and the kinds of coal to be handled. Some roads in the East use bituminous, broken anthracite, and buckwheat. Where the quantity of coal handled is small, the locomotives can be coaled from an elevated platform using one-ton buckets or by means of a locomotive crane direct from car. When it is necessary to deliver coal to two or more tracks, a mechanical type of coal-handling apparatus is generally installed. (See Fig. 3). Marked improvements have been made in receiving, hoisting, and distributing equipment, which has resulted in a smaller operating force being required. Measuring devices are also installed for recording the amount of coal delivered to tenders. An electric winch should be provided at large terminals at the loaded-coal-car track so that cars can be hauled to position over the track hopper.

The sandhouse should be located at the coaling station. Sufficient wet-sand storage space should be provided as well as means for drying the sand by coal stove or steam. Compressed air should also be available so that the sand can be delivered to overhead storage bins, having suitable outlets to deliver the sand direct to engine by gravity. All important engine terminals should have a complete installation of this character.

Ash Handling

At small engine terminals provisions are made to handle cinders in various ways, one method is to provide a pit located between rails. Cinders are shoveled to track level and loaded into cars by hand or locomotive crane. This system is satisfactory where but few engines per day are handled. At larger terminals a depressed track is installed adjacent to the pit or ash track and the cinders are shoveled by hand into cars.

Limitations of space at some terminals may not permit the use of longitudinal cinder pits. In such cases, transverse pits have been introduced whereby cinders are dropped directly from ashpan into closed hoppers, located between rails, and then deposited into buckets mounted on trucks, which operate on narrow-gage tracks beneath the hoppers. After filling, the cinder bucket is pushed clear of the cinder track and handled by suitable hoisting mechanism, the cinders being deposited directly into cars. Several running tracks can be equipped as stated, requiring but one long transverse pit beneath and using one or two buckets, depending upon the width of the pit.

A number of recent installations provide for the dumping of the cinders directly into large metal buckets beneath the track. Mechanical means are provided to withdraw the buckets laterally and upward, dumping the contents into the cars.

During recent years the tendency when constructing large terminals has been to install pits filled with water. (See Fig. 4). The cinders drop into the water and move toward the center of the pit, due to the inward slope of the outer wall, and are removed either by a locomotive crane or by an overhead crane traversing the entire length of the pit, the cinders being deposited by means of grab buckets directly into cars located on the loading track.

Steam-jet ash conveyors can be installed to advantage where ample supply of steam is available. This system consists of an 8-in. cast-iron pipe made exceedingly hard to withstand wear, with intakes provided at suitable intervals. The cinders are drawn by suction through the main pipe line and then propelled by means of the steam jet direct to car or storage bin, suitably located. Cinders handled in this manner are not wetted down until they enter storage bin, where a water spray is provided. This type of cinder conveyor has proved very satisfactory for handling cinders in power houses and should give good service when installed in connection with small engine terminals.

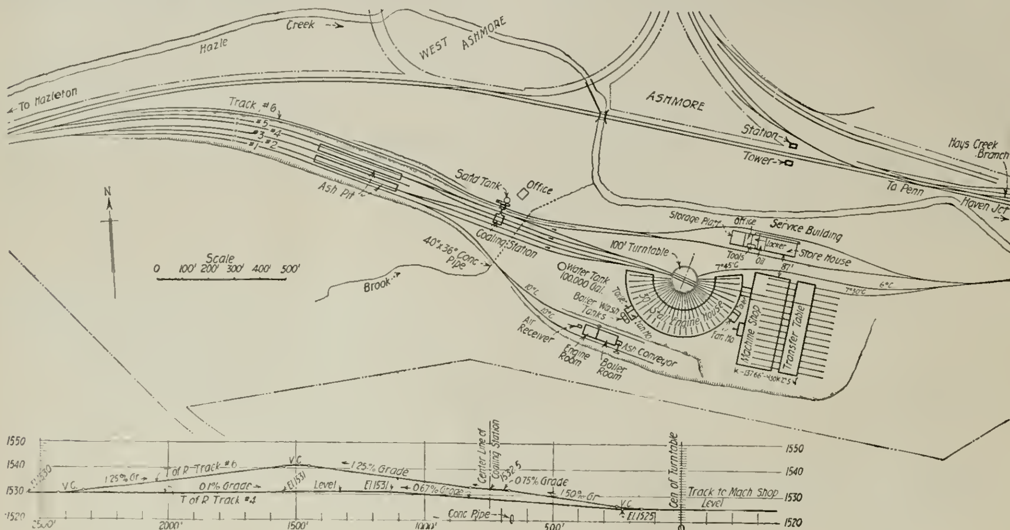

Fig. 2 Engine Terminal, Lehigh Valley R. R., Ashmore, Pa.

This terminal handles daily an average of 70 engines. It is located off the main line and adequate facilities are provided to take care of general repair work in addition to running repairs.

stall 110-ft. tables to insure greater leeway for balancing the locomotive under all conditions.

Through-girder and top-deck types are used according to circumstances. For propelling the table electric tractors are generally used, with current supplied either through conduits brought through the center of the table or from overhead collectors mounted on steel frame. Where electric current is not used extensively, pneumatic turntable tractors can be installed, using air taken from trainline of locomotive or from shop line. In the latter case the air supply is usually brought through the center of the table, using a swivel connection.

Inspection Pits

Inspection pits are now being installed at a number of large engine terminals. These are located on the inbound tracks with the view of making inspection of locomotives before they are placed over the cinder pit. Fires can then be withdrawn when the engines pass over the cinder pit, if inspection develops defects which warrant this procedure, thus saving time and expense involved if engine was inspected within the roundhouse after passing over cinder pit. There are many advantages in having inspection made at this time as the foreman by means of pneumatic tubes can be furnished with both the engineer's and inspector's reports showing work to be done before engines are placed within the shop.

These inspection pits are generally made about 100 ft. long, two in number, and protected with a shed. Special arrangements are provided to permit inspectors to enter the pits. Proper drainage and lighting facilities are also required. In lieu of reporting on inspectors' reports such work as loose nuts, missing cotters, etc., it would be desirable to station at these inspection sheds mechanics who can perform this work at once, thus saving time in locating these defects in the shop after being reported.

Heating and Ventilation—Lighting

Heatinga nd ventilation are of first importance in a modern and efficient roundhouse. A combined heating and ventilating system should supply sufficient air for the quick removal of smoke, gas, and vapors. Ventilating sash, louvers and other openings should be provided at the high points of the room to supplement the forced system by directing the flow of air currents and facilitating the removal of hot gases. This feature should be carefully considered, for in roundhouse ventilation it is not so much a question of diluting the air as it is of establishing a positive flow of air which will carry the gases along with it.

It is sometimes necessary, due to the requirements of local ordinances or because the type of house prevents the use of smoke jacks above the locomotive stacks, to install an exhaust system so as to remove gases directly from the locomotive smokestacks. In the latter case connections are made to the smokestacks by means of swinging hoods. This system is not necessary from a ventilating standpoint, and should only be installed where conditions compel its use.

With the usual type of indirect system the fan rooms, one or two in number depending on the size of the house, should be located midway of the length of the house to be served, thereby reducing the temperature drop of the air in the duct as well as the friction head against which the fan must work. The quantity of air supplied together with the number, size, and location of air outlets depends largely on the type, size, and location of the roundhouse. The amount of heat to be supplied with the air is also a variable factor and should have careful study so as to provide a comfortable working temperature under the conditions obtaining in roundhouse operation.

In roundhouse heating it is too often considered sufficient to supply a certain temperature and change of air without consideration of the variable factors governing a proper design. When given the same study and attention as other heating problems it is quite possible to produce a system uniformly satisfactory and economical in operation and first cost.

of the day when it would naturally be considered necessary. Good natural and artificial light will reduce accidents, provide greater accuracy in workmanship and simplify the supervision of the men. Fig. 5 is an example of a well-lit roundhouse.

Much needed improvement is desired in connection with artificial lighting of engine terminals. In the roundhouse proper, lights mounted on the outer wall and reflected between engine pits have given satisfactory results when augmented by sufficient lights

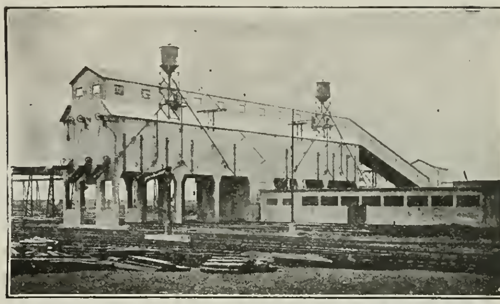

Fig. 3 Coaling Station, C. R. R. of N. J., Communipaw, N. J.

This reinforced-concrete coaling station has a storage capacity of 1600 tons It serves 10 tracks with 3 kinds of coal.

suspended from the ceiling to afford general illumination. Machine-shops, etc., should be provided with a general or overhead lighting and also supplemented by individual lamps conveniently placed, preferably on brackets so that they may be adjusted.

For lighting the roundhouse circle, flood lights should be used

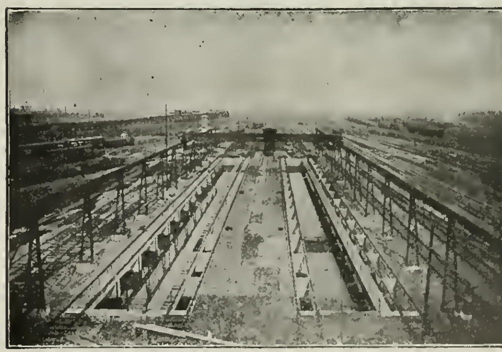

Fig. 4 Ashpits, C. R. R. of N. J., Communipaw, N. J.

This type has been adopted as standard by many roads.

whenever possible as general illumination will add considerably to the safe movement of locomotives to and from turntable and engine house. Ashpits can be illuminated by rows of reflector lights placed on poles, and similar provisions can be made at other points beyond turntable or by the use of flood lights on the top of coaling stations.

Hot-Water Washout and Refilling System

Facilities should be provided for washing out boilers using hot water under pressure and refilling with hot water after washing. Actual time savings can be made compared with the old system of washing out and refilling with cold water: boilers are washed out more thoroughly and strains within, due to expansion and contraction, are considerably reduced, resulting in decreased cost of boiler maintenance. There are two types of installations for this

purpose in general use, one of which utilizes the blow-off water for washout purposes only, while the other utilizes as much of the blow-off water as necessary for this purpose and the remainder, after being clarified, for refilling purposes. As blow-off water is always soft and becomes clarified soon after storage, it is of course the best water for the generation of steam and its reuse in this manner is responsible for the greater efficiency of the latter type of installations.

Hot-water washout and refilling systems can be economically installed in any size to meet the requirements of any engine terminal. Where such systems have been introduced, there is a material reduction in time required to do this work. Boilers have been blown off, refilled, fired, and steam pressure brought up to 100 lb. within from two to three hours. This does not include such time as may be required to make necessary repairs to boilers.

Wheel-Dropping Facilities

The usual wheel-dropping facilities consist of a drop-pit system

Fig. 5 Interior of Roundhouse, C. R.R. of N. J., Communipaw, N. J.

which provides for depressed pits at right angles to shop track, using telescoping pneumatic or hydraulic jacks for lowering and raising wheels, separate pits and jacks being installed for handling driver and engine-truck wheels. Generally but one pair of wheels can be handled at one operation, and if necessary to drop all drivers in order to take up lateral or change tires, considerable time is lost in moving the engine over the drop pit.

Screw-jack locomotive hoists especially designed for unwheeling locomotives are being more extensively used at engine terminals, and their use has made possible a large saving in both time and labor. These hoists operate with a high degree of safety as compared with the drop-pit system; furthermore they can be located within the roundhouse or installed in a separate building, in which case it would be desirable to also install the wheel lathe and other tools and appliances for taking care of heavy running repairs.

Machine, Boiler and Smith Shops

Old and obsolete tools should be replaced by modern machine tools, which insure increased production at lower costs and the work being done more accurately and promptly and power maintained in better condition. Individual motor drive for the larger machines and group drive for the smaller machines is preferable. Ample space should be provided for this department, and the class of work to be performed will determine the number and type of machines required.

Space for the boiler and smith departments is generally provided adjacent to the machine shop. Facilities should include steam hammer, forges with down-draft hoods (number and size to suit work to be performed), punch and shear, plate-bending rolls, straightening plate, flange, fire, etc. Stock flues, sheet iron and bar iron and steel should be kept outdoors in covered racks.

Autogenous cutting and welding outfits are also considered indispensable and are used principally in making repairs to locomotive fireboxes, engine frames, and in reclaiming miscellaneous parts which can readily be repaired by this process. Provision is also made for the pipefitting, tinsmith and air-brake departments in the machine-shop building. Locker rooms and toilet facilities for both shop men and engine crews are essential. Considerable time in making repairs can be saved by providing jib or overhead cranes in the roundhouse and machine shop, to enable heavy parts of engines to be handled with the least amount of labor.

Oil House and Store House

Oil houses should be separated from other buildings, should be of fireproof construction, and of a size to suit the requirements. The storage tanks are generally in the basement and filled from the floor level above from barrels through pipe line and delivered from storage tanks to the faucets by special hand pumps equipped with measuring devices. When large quantities of oil are used, provisions are made to fill storage tanks in the house direct from tank cars.

This should comprise a structure of ample size, conveniently located to machine shop, with platform and track facilities for handling material to and from cars, building provided with sufficient natural and artificial light, steel shelving, bins, etc., separate alcove for electrical repair shop and provision for office staff on second floor.

Power House

Important engine terminals should be provided with a power plant of sufficient size to take care of the future as well as immediate needs of the terminal. In a number of cases this plant is required to provide steam for thawing snow at switches on main-line track leading to the terminal passenger station and supply heat and light to station buildings, and function in general as a service station. Labor-saving devices should be installed in the way of coal- and ash-handling machinery, automatic stokers and large-capacity overhead coal-storage bunkers. Consideration should also be given to operating with condensers, requiring cooling tower if fresh water is used, the surplus water being delivered to flood ashpit for locomotive cinders if this type is used. Tanks of ample capacity should be located at power house with water mains of proper size supplying water for shop use and filling of tenders at terminal tracks, locating water columns away from switches in cold climates to prevent freezing. At smaller terminals, discarded locomotive boilers are used to furnish steam for power and heat. A close study made of these installations will often reveal the fact that in many cases savings can be effected by the use of modern water-tube boilers.

INCREASING THE CAPACITY OF OLD LOCOMOTIVES

(Continued from page 12)

and have been successfully used in regular freight service on a mountain division greatly needing such power.

When rebuilding locomotives there is a favorable opportunity for replacing old tenders as well, transferring the latter to older locomotives for spare use or as substitutes for damaged equipment. When the condition of old steel tender frames requires that they be replaced, the one-piece steel casting and a larger-capacity tank should be used as both will reduce future expense in repairs. The success of autogenous welding eliminates any objections to the use of large steel castings for fear of breakages.

Tanks should be reconstructed in coal space to permit gravity delivery of the greatest amount of fuel that is possible at the coal gates within reach of the fireman's shovel. Application of power-operated coal pushers should be made to tanks where alterations for the gravity delivery of coal cannot be satisfactorily made and where the service conditions will show a saving in expense by its use over hand methods of shoveling forward coal while on the road or at short lay-over stations. Moving forward the rear coal board or plate on tanks and building higher side plates or "dickies" is one method which has been successful in making the maximum amount of coal accessible at the gates.

that it is your desire that I should discuss the subject with particular reference to the steam railroad. For the purpose of outlining briefly my own views concerning the larger problem, I would like your permission to read from a report which I submitted to the Council of National Defense in November 1917:

A nation should have a national transportation system and such a system should embrace and make proper use of all available and suitable agencies. The fullest possible economic coöperation should be encouraged and required between all such agencies. Inasmuch as the business of transportation for hire partakes of a monopolistic character, all agencies so used should be subject to governmental regulation in the public interest.

Among the many agencies of transportation, the following are in most common use: the natural and artificial waterways with the various craft designed to operate thereon; the highways with the different vehicles and contrivances designed to operate thereon; and the specialized roads, such as electric and steam railways with the special equipment designed for each. Other agencies may be developed.

The coördinated transportation system of a nation should be so adjusted that each agency will perform the particular function for which it is best adapted, and, speaking broadly, that country which is provided with the most efficient transportation system—other things being equal—ought to be the most prosperous.

Mr. Theodore N. Vail once told me that for many years it had been his ambition to so develop the telephone system that a man in his own home in any part of the United States could talk with a man in his own home in any other part of the United States, and he very nearly, if not quite, lived to see the realization of his ideal. To my mind the means of transportation should, in effect, be just as universal and all-embracing as the means of communication, and the ideal which Mr. Vail sought to achieve as regards the telephone should be an inspiration to accomplish also the highest development in transportation. Unfortunately, however, we have not yet developed a single agency of transportation of such universal adaptability as the telephone. If we are to have a complete and well-articulated national transportation system, it can only be had, as things are now, by the coördination of a number of different transportation agencies, including the steam and electric railways, the utilization of coastwise and inland waterways, the full economic use of the highways, improved and unimproved, the use of the motor truck, and such other transportation agencies as may be best suited to the particular requirement. Of all the transportation agencies at this time available, particularly for interior service, the steam railroad is undoubtedly the most important.

At the termination of Federal control the steam railroads in the United States had an aggregate length of about 260,000 miles. They also owned in addition thereto approximately 145,000 miles of second, third and other tracks. Further, they owned approximately 2,350,000 freight cars, some 65,000 locomotives and about 55,000 cars designed for passenger-train service—the entire property representing a combined investment of approximately \$20,000,000,000. I am now speaking of those roads subject to the jurisdiction of the Interstate Commerce Commission and which are dealt with in the official reports of that body. More than eight hundred separate and independent companies own and operate the mileage which constitutes the Railroad System, so-called, of the United States.

The new Transportation Act provides among other things that in times of emergency the Interstate Commerce Commission shall have authority to treat all of the cars, engines and facilities of all the railroads, regardless of ownership, in such way as to best serve the interests of the public and the commerce of the country.

The law also lays down a definite rule for the guidance of the Interstate Commerce Commission in the matter of fixing rates and in that connection says that rates shall be fixed so as to yield March 1, 1920, rates *shall* be fixed so as to yield $5^1/_2$ per cent, and *may* be fixed to yield 6 per cent upon the value of the property used for transportation purposes; and the Commission in harmony with the law has fixed rates designed to yield an annual return of 6 per cent upon an aggregate valuation which the Commission tentatively fixed for rate-making purposes in this particular case of about \$19,000,000,000.

If this country were fully developed and if we had already reached the peak load which the railroads will be expected to carry, the railroad problem would be a much simpler one than it is under conditions as they actually do exist. Our country has not stopped growing. It is far from being fully developed. Experience of the past demonstrates clearly that at least \$1,000,000,000 per annum must be provided as a minimum for capital expenditures for new equipment and facilities necessary to keep the railroads abreast of the transportation requirements of the country. If the Government owned the railroads, it could, of course, if the people so desired and Congress so determined, raise, by general taxation, the funds necessary to provide in whole or in part the additional transportation facilities required, or it could fix rates sufficient to provide either in whole or in part the large sums of new capital needed on that account each year. However, Congress by virtue of the Transportation Act of 1920 has decided that the policy of private ownership and operation of the railroads shall be continued and has undertaken to provide a plan of regulation to make that policy possible and successful. The owners of the properties, that is, the railroad companies, can only obtain new capital provided that they can satisfy investors of their ability not only to pay the agreed rate of interest, but can also give satisfactory assurances of their ability to repay the principal sum itself when due.

Congress undoubtedly believed when it fixed the rule for rate-making in the Transportation Act that it had provided a plan that would enable the railroads to establish and maintain a firm basis of credit, sufficient in fact to enable them to raise in the aggregate at least \$1,000,000,000 of new capital each year. It was clearly developed during the hearings preliminary to the passing of the Act that unless the railroads were able to raise that amount of new capital each year, they would not be able to provide adequate facilities to take care of the business of the country and in consequence private ownership as an economic policy would fail. The people in this country cannot afford to experiment with or to have any system of ownership or control of the railroads unless such system is able by and of itself to provide, as needed, the additional facilities necessary to move the growing traffic of the country. Personally, I believe the new Act will enable the railroads to do this. But if it should develop that the rate of return permitted under the law is insufficient to accomplish the end desired, it will then be necessary either to amend the law so as to provide a more liberal return or adopt some other method. The only alternative would seem to be ownership and operation by the Government.

The Transportation Act contains one other far-reaching provision, and in my opinion a wise one. It authorizes, as I have already said, the Interstate Commerce Commission in times of emergency to issue such orders concerning the use of the equipment and facilities of all the railroads as may best serve the requirements of the public for transportation. The law also states that the Commission may in the exercise of this power use such agencies as it may select.

The railway managers shortly after the termination of Federal control, and actuated by a desire to coöperate with the Interstate Commerce Commission in an effort to comply with the real spirit of the new Act, formed an Advisory Committee of eleven railway presidents geographically selected. A Car Service Division has also been established in Washington under the direction of an Executive Manager, who reports to the Advisory Committee.

[1] President, Baltimore and Ohio Railroad.

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This Car Service Division has a staff of about 150 persons, and it receives daily reports from all the railroads in the United States concerning transportation conditions, particularly as affected by car supply. This Car Service Division works in close harmony with the Bureau of Service of the Interstate Commerce Commission, and its purpose is to carry out the intent of the law so far as possible by the voluntary coöperation of the separate railroads.

Since the termination of Federal control more than 170,000 empty box cars have been moved on special orders by the Car Service Division from the south and east to the territory west of the Mississippi River, where they were urgently needed. An equal number of open cars have been moved from the western lines into the eastern territory, where they were needed for coal and other shipments requiring equipment of that character. Many other important transportation matters have been handled by the Car Service Division. At all times there has been a full understanding with the Interstate Commerce Commission. In some instances the Commission's support and interest have been supplemented by special service orders which they have issued.

The condition of the carriers' equipment at the termination of Federal control was much below the standard formerly maintained by the railroads under private control. Furthermore, the Government had not been able to, or in any event did not, provide as much new equipment during the twenty-six months of Government control as the railroads had been in the habit of providing during similar periods. The result was that when the railroads were returned to their owners they were inadequately supplied with equipment, and such equipment as they had was in an impaired condition, while there was a larger volume of business offering for movement than at any time before. The situation was further complicated by the switchmen's strike, which began in Chicago early in April and spread to a greater or less extent over the entire eastern region.

The carriers realizing that they were inadequately equipped to handle the unusual volume of business offering, and appreciating that even if the large amount of new capital necessary to purchase new equipment were available, time also was an element to be reckoned with and some months must necessarily elapse before new facilities could be provided, decided that the important thing to do was to make the best use possible of the facilities already available. With that thought in mind they unanimously pledged their best efforts to increase the daily movement of all freight cars to an average minimum of 30 miles per car per day; to increase the average car loading to a minimum of 30 tons per car, and to reduce the number of cars held out of service awaiting repairs to not more than 4 per cent of the total number of cars owned. If these three standards so set up could all be accomplished concurrently, it would in effect be equivalent to adding over 500,000 cars to those available for service. A number of railroads in the United States are already making more than an average of 30 miles per car per day, and on a number of lines the average car load is much in excess of 30 tons per car, and on some lines the number of cars awaiting repairs is not in excess of 4 per cent. But the railroads have not yet been able as a whole to accomplish the standards which they have set up for themselves and it was not expected that the standards would be immediately reached. I am confident, however, that they will ultimately be reached and exceeded. A very marked improvement has already been made. During the month of August the net ton-mileage movement on Class I railroads was in excess of 42,000,000,000 ton-miles, which was a considerably larger performance than ever accomplished before by the railroads in a similar period of time.

In spite, however, of all that the carriers may be able to do with the existing plant, they will not be able to handle all of the business that this country is even now capable of producing. It should be kept in mind that during the war unusual efforts were made to increase productive capacity in all directions. More ground was cultivated than ever before, and larger crops were raised, existing factories were greatly enlarged and new factories of unprecedented size were built. The productive capacity of the country was thereby greatly increased, for war purposes, it is true, but the development is there and can and will be used largely for peace purposes. During the same period the railroad facilities were not increased at all. In fact, it may almost be said that the capacity of the railroads, that is, the carrying capacity, was less at the termination of Federal control than it was at the beginning, for the reason that during the entire twenty-six months of Federal control the Government bought only about 100,000 freight cars, which was approximately the amount that the railroads had been in the habit of buying during each twelve months' period in the past. The number of locomotives bought during the period of Federal control was also considerably less than ordinarily would be purchased during a similar period. No passenger equipment at all was purchased during the period of Government control. It was found that the railroads with their existing plant could take care of the war situation, and properly all men and material available were used in other directions, but in times of peace the people are not willing to accept the character of service which the railroads gave during the war, not is it in the interests of the people as a whole that they should be required to accept such service. In order that the carriers may be able to properly handle the business offered in the future, they must make very large expenditures not only for additional cars and engines, but for additional running tracks and particularly for additional terminals.

So far I have assumed that the commerce of the country would depend largely, if not wholly, upon the railroads for transportation. It seems clear to me, however, that it is in the larger public interest that in developing a transportation system which will be adequate to meet the transportation requirements of our growing commerce, each suitable agency of transportation should be used to the extent that it is economically desirable.

Personally, I believe that the situation should be studied as a whole and along the lines indicated in the recommendation which I submitted to the Council of National Defense in 1917. Each transportation agency should be used to the extent that such use is economically desirable. To make less use than that of each available agency would be wasteful and uneconomic, and if a more expensive agency were used when a less expensive one might be equally available, that practice would also be wasteful and uneconomic. I think in the past there has been a tendency on the part of those who happened to be interested in some particular agency, to try to extend its use in many instances beyond the proper economic limits, and this has resulted in unwise expenditures which in the end proved to be uneconomic and consequently unprofitable. Such mistakes ought to be avoided in the future.

Again, to be specific, I do not believe that the motor truck as now developed and operating on any form of highway can compete in the carriage of long-distance traffic with the steam locomotive running on a steel girder properly supported. I do believe, however, that for short-distance traffic and in sparsely settled communities the motor truck, not only on the improved highway but even on the ordinary dirt highway, may be used in conjunction with the railway and thus afford the cheapest form of transportation. I think the same thing may be said also with reference to some of our inland waterways. I think there should be an intelligent effort to develop all agencies of transportation, each within its own sphere, but all so coördinated with each other as to constitute a nation-wide system which would approximate in its effectiveness the efficiency of the telephone system of which I have already spoken.

Undoubtedly it has happened at different times and places in the past that the railroads have taken business where the out-of-pocket cost, not to mention the cost of capital, has been in excess of the entire revenue. The country as a whole would be better off if such business could be handled in such a way as would give reasonable profits to those engaged in the enterprise. There was a time when railway managers were believed to be opposed to the development of other means of transportation which might become competitors for the business which they were hauling or desired to haul. But whatever may have been the attitude of the railway managers in the past, that is not their attitude at the present time and I am certain that they will be glad collectively or individually to coöperate with all other transportation agencies in such way as will inure to the greatest public good, because in the end all enterprises of an individual character must be tested by that rule. Whatever contributes to the public good is likely to endure, and anything inimical to the public good is certain to fail.

small way. Being private enterprises there was brisk competition and branch lines were constructed to get business which might otherwise go to a competitor. The same thing occurred in the construction of tracks to industries; the railroads assumed all of the expense, but they were able to reimburse themselves by rates charged on the business.

We do not need to follow the history of unrestricted competition on through the period of concessions and rebates as it is past history. Its results were the cause of the beginning of the regulation of railroads and of the gradual evolution of the theory that railroads were not private enterprises but public utilities, and that they should be operated in such a manner as to give everyone the same service.

Early Systems of Regulation

Systems of regulation were inaugurated by the National Government and by the separate states, and like any new power granted it was executed in all manner of ways. Politicians found it a ready excuse to make capital for election to office, and the early practices of railroad managements, while perfectly lawful at the time, were held up as criminal. The result was a wave of popular complaint against the railroads This, as usual, affected the regulatory bodies, and they gave the railroads the worst of every question that came before them.

The ultimate result was that railroads could not raise rates, but on the contrary, rates were continually being lowered, it even going so far that state legislatures undertook to decide what passenger rates should be, with the result that in several states a two-cents-per-mile rate was fixed as the maximum that should be charged on any railroad in these states regardless of whether it was over main lines or branches. The inevitable result was the bankruptcy of many railroads and the cessation of railroad extension and of facilities to take care of the growth of business.

But with the operation of the railroads by the Government it was soon shown that it was lack of facilities and rolling stock rather than private ownership that was handicapping the railroads, and the curtailment of service by the Government, in an effort to operate the railroads and their failure to expend the money necessary to furnish the added facilities, soon brought a demand from the public for a return of the railroads to their owners and an increase in rates that would permit them to furnish the facilities to give the public proper transportation service.

As a result of this the Esch-Cummins Bill was passed, making it incumbent on the Interstate Commerce Commission to permit rates to the railroads that, in addition to paying operating expenses, including a fair amount for depreciation, would yield a return of 6 per cent on a fair value of the property devoted to transportation purposes, either on the railroads as a whole or divided into such groups as the Interstate Commerce Commission might consider advisable.

The Duty of the Interstate Commerce Commission

Now, with a sane and common-sense law by which the railroads are to be permitted to earn a fair return on the money invested in them, and the acknowledgment that the public must pay a rate that will give a fair return on the investment, it becomes the duty of the Interstate Commerce Commission and the railroad managements to make a study of the situation and to see, first, that adequate facilities are provided to give the public the best transportation possible, and, second, to see that this is done at the least cost to the public.

In the past, due to unrestricted competition, many facilities have been duplicated, such as tracks from two or more railroads into the same industry, and branches of two or more railroads tenance and upkeep, the cost of operation and interest on the investment, of duplicate property.

These branch lines were built in the days when there were ordinary dirt wagon roads and all teaming was done with animals. Today, with the advent of the automobile and motor truck have come the so-called "good roads," and where these roads have been built passenger automobiles can travel 25 to 50 miles per hour and motor trucks loaded with produce or goods can travel 15 miles per hour, or, in other words, at practically the same speed as branch-line passenger and freight trains.

It can readily be seen that with the introduction of a class of locomotive that requires no rails and which can be used by the public at large, the use of the railroad, within the limits of the practical use of a single unit of transportation, must become less and less as good roads are constructed. Why, therefore, should the public be obliged to pay in railroad rates the cost of upkeep, operation, and interest on the cost of a branch line of railroad which they do not need, as with a good hard-surfaced road and no branch line of railroad someone would operate a motor bus for passengers and motor express for less-than-truck-load freight? A careful study should be made of branch lines of railroads, and where they are "good roads" of the hard-surfaced class, over which the business now handled by the railroad can be handled by motor trucks and buses, the question of dismantling the branch line of railroad should be given serious consideration.

The Cost of Branch Lines

Branch lines were formerly cheaply built, at from \$12,000 to \$15,000 per mile; they had narrow roadbeds, light rail, light bridges and fewer ties per rail than main lines; and they were equipped with locomotives that had become too light for main-line traffic. With the constant increase in the weight of locomotives on main lines for the past 15 years, there are no light engines to put on branch lines, and the result is that what are now perhaps light main-line engines but are heavy for branch-line service, are sent to the branches. This, and the rapid increase in the size and axle load of cars, has necessitated the strengthening of branch lines with heavier rail and stronger bridges; more ties to the rail; wider banks and cuts; ballast has had to be applied; with the result that the \$12,000 to \$15,000-branch now costs \$20,000 to \$30,000 per mile, with the increased interest charge on the investment and the increased tax on the public to be added to their taxes for good roads.

The cost per ton-mile for transporting freight and the cost per passenger-mile on the short branch lines are far more than the amount received by the railroad, the result being that the revenue from main-line business must be enough to pay for its cost, and in addition must be enough to cover the deficit on the operation of the branch lines. If, therefore, many of these lines that are tributary to a territory within the limits of auto-bus and auto-truck service could be taken up and abandoned, it would mean a reduction in the cost of main-line service.

On the other hand, on such branch lines as cannot be replaced with motor service and do not connect with or cross other railroads, there should be a rate that would yield an amount sufficient to cover cost of upkeep and operation, and to pay the required return on the value of the line, as by this means the main-line rates could be reduced.

Factors to Consider when Abandoning Branch Lines

In considering the question of abandoning a branch line, the first question that comes to the mind of the railroad man is the capital charge. The capital account would have to be credited with the book value of the line abandoned, and operation charged with the same less salvage, but this would be saved in direct outlay in a period of about five years and should be distributed over such a period.

After a careful survey of the situation on each railroad the use-

[1] Chief Engineer, Chicago, Rock Island and Pacific Railroad.

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less branch lines should be listed and a program made up to cover a period of five to seven years, at the end of which period they would all be up and charged to operation, and capital account on which the public must pay a return would be reduced that much, and in addition the public would be relieved of the cost of operation, maintenance and taxes on these lines.

Branch lines are a necessity and it should not be understood that any attempt is being made to belittle their importance, but the transformation that is constantly going on in large cities in connection with the suburban train service, by which stations near the center of the city are abandoned, due to rapid transit on elevated railroads or subways, furnishing as good or better facilities, is also taking place where short branch lines are being operated, where the business can be taken care of as well, if not better, by motor cars on hard-surfaced wagon roads.

The abandonment of short branch lines of railroad and the delivery of freight at main-line stations also means an increased use of cars, as a car sent to a branch-line station means, as a rule, a day going and a day returning to the main line, which is two car-days lost for each car, which will be saved if the car is loaded at a main-line station.

The abandonment of these branch lines will likewise do away with a lot of small mechanical terminals which are expensive to maintain, also with men employed as station agents and helpers on the branch lines, and it will increase the force at many main-line stations, where better supervision can be given to their work.

Tracks built to a single industry should be owned by the industry served and it should pay all cost of upkeep and all cost of operating. Tracks that lead to several industries should be limited to a single industrial track, which should be operated by one railroad, and all expense of upkeep and operation should be paid by the industries served by the line. Also less-than-carload freight should be collected for all railroads at the various stations in the city and should be taken to a central point by one railroad or terminal company, and there made up into carloads and billed over the railroads to which it is assigned. The cost of this service should be kept separate and added to the carload rate from the consolidation point. In short, those getting special services should pay for that service, and those who do not use the special service but perform a part of it themselves should not have to participate in the cost of this special service.

Rate Making as Affecting Branch Lines

In the effort to compel the reduction of rates, both the federal and state regulatory bodies have encouraged the idea that the heavy-traffic main lines were able to handle traffic so cheaply that they should absorb the losses due to rates being too low on the branches, and so in former times a differential rate often existed and branch lines had higher rates than main lines. Now, however, that it has been decided that the railroads shall have rates that will pay the cost of production of transportation, this cost should be allocated as far as possible and paid by those getting service. With the special service paid for separately it will permit of a reduced rate for main-line service from terminal to terminal, or from intermediate stations to terminals, which is what the vast majority of the people use.

A railroad line will, under present conditions, with the advent of the auto and truck, secure all of the business within 50 miles on either side. In the western portion of the country, however, there are large areas that are not within 50 miles of a railroad, where the quality of the land is just as good as that adjacent to the railroad, but which is not cultivated for lack of transportation facilities. The lack of return on investments in railroads during the past ten years has prevented these railroads from securing the money with which to develop the territory that naturally belonged to them, with the result that the cost per ton-mile has been much more over these lines than it would have been with a proper system of feeders. Some of the more prosperous railroads have systematically constructed feeder lines, and their prosperity under the adverse conditions was largely due to this policy having been carried out for a number of years previous to the strenuous years just preceding the war.

With the requirements of the Transportation Bill that the Interstate Commerce Commission shall pass upon all new extensions, railroads that have undeveloped territory adjacent to their lines which will warrant the construction of feeder lines and increase their main-line business, thus reducing the cost per ton-mile of all business over the main line, should apply to the Interstate Commerce Commission for authority to construct such lines and for a freight and passenger rate over the new lines that will pay the proper return on the investment and the cost of maintenance and operation of the line.

The Construction of Branch Lines

These new lines should be located on the best grade line that the country affords, but in the beginning heavy grades and sharp curvatures should be inserted where they will make a decided saving in first cost; second-hand rail and obsolete and non-standard switch stands, frogs, etc., on hand should be used; station buildings of as cheap a class as possible should be constructed, exemption from taxes for five years should be secured from counties through which such lines are to be built, and everything should be done that will decrease the first cost so that the rates can be made as low as possible while business is being developed along the new lines. Later, when the business has developed and earnings will permit, the class of structures can be improved, and should such a line eventually be extended and become a main line the heavy grades and sharp curvature can be taken out at comparatively small expense.

It has been the practice in many cases in the past to charge but a nominal freight rate on material for these lines and to make no charge for general expenses, interest during construction, services of general officers, etc. This should not be done in the future, for if these expenses are not charged to the new line they will have to be absorbed in the operating expenses of the parent line. Each branch line should carry all charges for labor and material used in connection with its construction.

The same methods should apply in the maintenance and operation of the branch lines: all labor, material and freight for use on a branch line should be charged to it. To follow this out properly there should be graduated prices on material so that if a poorer quality of material, such as ties, rail, fastenings, etc., was used on the branch, it would be charged a cheaper price for this material; the whole matter to be handled so that the branch line is charged with what it gets—no more or no less.

The Operation of Branch Lines

No through rates should be made from points on branch lines; the local rate should be applied to the junction with the main line and main-line rates applied to the shipment over the main line. Shipments from points on the branch lines to points beyond the junction will of course get the benefit of the lower main-line rate, and, as the branch-line mileage will usually be but a small percentage of total distance, will probably cost no more in the aggregate than they do under the present system.

In operating a feeder line constructed to develop the country, a mixed train up one day and back the next is all that should be furnished until business enough has developed to warrant additional service. With the regulation of railroads by the Interstate Commerce Commission this can be done but only if the Interstate Commerce Commission has full authority over rates, both interstate and intrastate.

It will also be necessary, in order to permit the Interstate Commerce Commission to handle the question of new lines and abandonment of old lines, to have all railroad charters issued as national rather than state charters, otherwise it will be impossible to abandon useless lines or to make rates over branch lines that will cover the cost of operation and maintenance and yield a proper return on the investment, as state commissions look at the matter from a local standpoint and will object to the abandonment of lines or increases in rates within their state; whereas transportation is a national problem and should be so handled.

Finally, we shall be unable to make these changes in the maintenance and operation of the railroads unless the Interstate Commerce Commission takes a broad view of the transportation situation and handles its regulation along economic lines as a national rather than local matter, and does not let local interests interfere with the carrying out of a broad national policy.

I cost and the most expensive item of cost in railway operation. What proportion of the total cost is represented by terminals and terminal yards is impossible to say, but a high official of one trunk line entering New York recently made the guess that perhaps the reproduction cost of their end and intermediate terminals, together with equipment, would be as much as all the remainder of the road with its equipment. On the average, does it seem unlikely that at least 30 per cent of the physical valuation of the railways in the United States would be represented by terminals and terminal yards? Any figures short of a detailed valuation must be a guess, though a guess based on experience.

To make a similar guess as to the cost of terminal operation would be more difficult and with perhaps a less accurate basis. There is no segregation of cost figures that will give a reliable estimate as to how much of the total expense of transportation is absorbed by the terminals as compared with that absorbed by train transportation on the open track. The ratio will obviously depend on the length of haul, being greater when the haul is between nearby points such as Philadelphia and New York and less when between Chicago and New York; but on the average can it be safely put as less than the estimated constructive cost ratio of 30 per cent?

Again, the writer would like to give figures as to such cost of final delivery, but conditions vary so much in different cities that no reliable statistics can be given. Several investigations have been made in New York and one established the figure of cost of trucking from the railway freight house to the consignee's warehouse as amounting to as much as 80 per cent of the whole railway charge for carriage from Buffalo or Pittsburgh to New York. Place any figures you like within reason as the part of the total railway charge that should be allocated to the cost of passing a car through a New York terminal yard and the unloading of the goods, and it is evident that it costs much more to handle a ton of freight through New York to the point of ultimate destination than it does to haul that same ton some 400 miles, including in the latter expense the cost incurred in handling the goods in the originating and intermediate terminal yards.

Fixing Terminal Charges

There was a time when this question of railway terminal charge was largely one of dispute between shipper and railway companies. At strongly competitive points the companies held rigorously to any special convenience of advantageous location that they might enjoy to the exclusion of other lines. Today we are entering upon a new era of railway economy. To a great extent competition is removed and there is established the base principle that rates must be not only geographically equitable, but should be so fixed by governmental authority as to give a minimum net return which is also substantially a maximum net return on physical valuation.

It is obvious that rates can be raised so high that the resultant gross returns will show declines and not increases. Managers must therefore see that rates are not carried beyond the critical point, or, to put it another way, they must see that business is conducted economically. But that responsibility is also placed on the shipper. If he would avoid further raises in rates he can aid by focusing public attention on the unnecessary burdens placed by legislation on transportation companies, on the failure of the transportation companies to use their properties in the best manner to produce the most economical results for all concerned, or on the failure of public authorities to coöperate with the transportation companies and with each other.

Let us briefly consider terminals and terminal yards from this point of view. The capital invested is probably 30 per cent of all railway capital, and the cost of operation is perhaps as high a terminal operation, therefore, will result in a sensible reduction in operating expense, which reduction inures first to the benefit of the shipper and only to the benefit of the company when an increase in rates no longer produces an increase in gross returns.

How can savings in terminal expense be obtained? In the old competitive days it was necessary for each company to have its own complete terminals and to prevent competitors from obtaining facilities as ample or so well located. There resulted, consequently, as many terminal yards as there were companies, and frequently each terminal yard had its own separate arrangement for the handling of every class of commodity. Under the present law the systems are not actually combined, nevertheless the cutthroat competition has been removed, and the companies are not only free but are encouraged to eliminate wasteful duplication. The Chicago Terminal Commission has already answered this question by saying that "there are decided advantages in coöperative operation."

In 1918 the railways in different parts of the country began to put such coöperative operation in effect and reports show that savings of very measurable proportions resulted. In the northwestern, central-western and southwestern sections covering twenty-eight states, estimated annual savings amounting to $5,750,000 have already been obtained. Would there not be really great savings if all the terminal facilities in all our cities should be pooled and duplication be avoided?

The Cost of Terminal Operation

How can terminals be more economically operated is another question. Many of our terminals, especially passenger, are seriously overburdened, and yet on account of surrounding urban development the facilities cannot be increased. The commuter seeing our great stations crowded morning and evening does not realize that during the remaining twenty hours the efficiency is gradually reduced to zero, giving a very low average load factor. Would electric operation result in simplification and economy? At end terminals with electric equipment, local or suburban trains which constitute the great majority of passenger trains could be handled in and out and do their own switching without calling for shifting engines. Between end terminals the engine runs could be lengthened to any reasonable degree. The electric locomotive, unlike his steam brother, does not have to be taken to a roundhouse after a limited performance.

The question has been put, "What can the railways do to reduce the cost of terminal operation?" The complement question can also be put, "What can the shippers do?" A few years ago shippers used both railway freight houses and cars as places of free storage for long and indefinite periods. High demurrage charges rigorously enforced, however, have greatly reduced this irregular and wasteful proceeding, and in fairness to all parties it should be stopped entirely. There is perhaps only one way in which this can be done and that is by having the railway companies do all the unloading and delivery, either by their own agencies or by some authorized single agent acting for them. To cover the cost of this delivery service, freight rates would have to be raised correspondingly, but the total would be much less than the present cost to shippers, which is a combination of the railway charge and their own trucking expense.

New York Terminals a National Question

At a meeting in New York where terminals are being discussed one cannot refrain from speaking of New York's terminals, nor is it proper to refrain because New York's terminals are really the affair of the whole country. In what can be called the Metropolitan District, embracing a part of New Jersey as well as the City of New York, there is located nearly one-twelfth of the whole population of the United States, and this same district is the greatest manufacturing center of the United States. Forty per cent of the export and import traffic of the whole country passes through the port.

(Continued on page 62)

[1] Consulting Engineer, New York, N. Y.

Abstract of paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

Fuel and Its Conservation

A Group of Papers Dealing with The Fuel Supply of the World, Fuel Conservation, Distillation of Fuels, and Form Value of Energy, with Discussion Thereon, Which Were Presented at the 1920 Annual Meeting of the A.S.M.E.

ONE of the most notable features of the 1920 Annual Meeting of The American Society of Mechanical Engineers was the interest aroused in the sessions devoted to fuel and its conservation. These were held under the auspices of the newly formed Professional Section on Fuels, and in order that all might have an opportunity to express their views concerning this most vital question, two adjourned sessions were necessary. The papers presented were by L. P. Breckenridge who spoke on the Fuel Supply of the World; David Moffat Myers, on Fuel Conservation; O. P. Hood, on Distillation of Fuels as Applied to Coal and Lignite; and Messrs. C. G. Gilbert and J. E. Pogue, on Form Value of Energy in Relation to Its Production, Transportation and Application. Abstracts of all of these papers are presented below, as well as an account of the discussion which they brought forth.

THE FUEL SUPPLY OF THE WORLD

By L. P. BRECKENRIDGE,[1] NEW HAVEN, CONN.

FOOD and fuel are basic necessities of our present-day existence. Here in America as recently as one hundred years ago men were selecting a place to live where food could easily be produced and where wood was nearby for fuel and for the building of the home itself. Up to 1820 fuel was needed primarily for cooking food and for keeping warm. At that time power was produced by wind for the sailing vessels and by falling water for the grist mill, sawmill, cotton mill, woolen mill, and forge. The total amount of coal mined in the United States up to the end of the year 1840 was only 12,000,000 tons, an amount which is now produced in six working days. In fact, the total coal mined up to the end of 1880 was not more than 1,000,000,000 tons, an amount now produced in twenty months.

Fifty years ago the total coal production of the United States was less than one ton per capita (0.96 ton). Today it is slightly over 6 tons. This great increase is accounted for primarily by our growth as a manufacturing nation, involving great increases in the requirements for transportation, but to this must be added the evident fact that we have surrounded ourselves with many comforts, then unknown, as well as luxuries which still are never found in many foreign countries.

We are rich indeed in fuel, but our wealth of fuel resources should not make us wasteful of these resources which are a world need and which, when once used, may never be replaced. It is hoped that a study of the facts presented in Tables 1 to 7 will serve to emphasize the larger problems of fuel as related to their place of production, extent of exhaustion, methods of transportation and especially their methods of use, pointing—as all the facts do—to the great necessity for coöperation for conservation.

The time has come when the fuel problems of the world must be given consideration in a large way. Communication and transportation have made all countries of the world near neighbors. Food and fuel are essential to the world's life and progress. The United States now for the first time has cargo vessels. It will fail in its duty if it does not make wise use of its resources and its facilities to aid the people of the world.

The title of each of the tables given is sufficient to indicate its import. War conditions have made many temporary disturbances in statistics of this character, and for this reason it has seemed wise in some cases to choose prewar conditions where it is simply the trend of progress that it is desired to indicate.

A Plea for Thrift and Conservation

The difficulty of securing a supply of coal coupled with the high price paid for it, has in itself brought about a desire to exercise all possible care in its use. The public at large more and more realizes the need of coöperation to secure conservation in some large way. It is in connection with the last plan, "coöperation for conservation" rather than on "individual thrift" that the writer sees the most promising chance for initial success. Especially is this true as a wise first step. Individual thrift should always be practiced, but the large savings of fuel that could be made by coöperation are way beyond anything that could be expected from individual effort. The suggestions for coal conservation which follow are not new—some of them are already begun—but it is only when all of them are fully realized that we shall be able to feel that we are really making satisfactory progress in preventing waste of fuel, as well as waste in labor and capital, which are required to produce and transport it.

How to Prevent Waste of Coal

1 Extend as rapidly as possible improved methods of mining coal. Under present conditions, one-third the bituminous and one-half the anthracite coal is left in the mine under such conditions that recovery is practically impossible.

2 Extend improved methods of "preparation" of coal at the mines. A premium might well be allowed for well-prepared coal, or a penalty imposed for impure coal.

3 Reduce the hazards of coal mining. For every 1,000,000 tons of coal mined there are between four and five fatalities.

4 Operate the mines a maximum number of days each year. Mines are operated from 200 to 240 days in one year. Lost time is due to three principal causes: shortage of cars, shortage of labor or strikes, and mine disability.

5 Utilize a larger amount of the mine waste. Briquetted fuel, pulverized fuel and electricity from mine waste are all possible of successful development.

6 Increase the use of by-product coke ovens. The by-products wasted by beehive coking are equal to fully 600 lb. of coal per ton of coke produced. Increase the use of domestic coke from the local gas plant.

7 Extend the use of blast-furnace gas for power generation. Much progress has recently been made. It will require coöperative effort to utilize fully the power which might be made from blast-furnace gas.

8 Extend the use of the gas producer, the gas engine and the heavy-oil engine for power generation, more especially where electrical energy is not available. Develop the lignite fields—by power from gas producers—and briquetted fuel for domestic use.

9 Extend water-power development. Hydroelectric power often combined with steam power offers large possibilities for saving coal. It will require comprehensive expert study before any new development can be undertaken, or satisfactory financial returns may not be possible.

10 Extend very generally the best-known performance of locomotives. The better locomotives of 1920 use only two-thirds of the coal required 20 years ago to do the same work. Much saving should be expected in the operation of steam locomotives. Electrification will save coal where water power is conveniently available. Instructions to firemen should be given and followed up even more carefully than in the past.

11 Encourage the tendency of the small industrial plant to purchase its power. The best coal is often sent to the small plant. Small plants, like individuals, should be examined by experts and all reasonable effort made to conserve fuel. Correct equipment and correct methods of operation would save 20 to 25 per cent of the coal used in industrial plants. It is the coal saved by the industries that will set free transportation facilities sorely needed for other purposes than hauling coal. One-third of the railroad tonnage is coal.

[1] Professor of Mechanical Engineering, Sheffield Scientific School, Yale University, New Haven, Conn.

Abstract of a paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision

TABLE 1 ESTIMATED RESERVE COAL AND LIGNITE SUPPLY OF PRINCIPAL COAL-PRODUCING COUNTRIES OF THE WORLD

Countries	Supply in Billion Tons	Source of Information
United States	3,527	United States Geological Survey
China	1,500	Secretary Bituminous Coal Trade Association
Great Britain	180	British Royal Commission
Germany	164	Secretary Bituminous Coal Trade Association
Canada	100	Canadian Authorities
Japan	50	
Austria-Hungary	30	
France	25	Secretary Bituminous Coal Trade Association
Belgium	20	
Chile	2	

TABLE 2 ANNUAL PRODUCTION OF COAL IN THE UNITED STATES (1880–1920)

Millions of Short Tons			Millions of Short Tons		
Year	Anthracite	Bituminous	Year	Anthracite	Bituminous
1880	30	44	1915	86	435
1890	42	110	1916	87	460
1900	60	210	1917	88	500
1905	70	310	1918	87	566
1910	82	420	1919	86	420
1914	84	420	1920	84	(510)?

TABLE 3 THE COAL-PRODUCING AND USING STATES IN 1915

States	Millions of Tons — Bituminous Producing	Bituminous Using	Anthracite Producing	Anthracite Using
Pennsylvania	158	66	89	23
West Virginia	77	6	.	..
Illinois	59	40		3
Ohio	22	22		
Kentucky	21	5		
Indiana	17	16		
Alabama	15	8		
Colorado	9	5		
Virginia	8	4		
Iowa	8	7		
Kansas	7	...		
Wyoming	5	...		
Tennessee	6	...		
New York		17		21
New England		21		14
New Jersey		4		8
Wisconsin		8		2
Minnesota		6		2
Maryland and D.C.		...		2
Michigan		10		..
Missouri	..	8		..
All other states	29	37		5
Railroads	...	122		6
Exported	. .	19		4

TABLE 4 INDUSTRIES USING BITUMINOUS COAL IN THE UNITED STATES (1914)

Industry	Short Tons
Coke	50,467,000
Steel Works	20,343,000
Clay Products	8,566,000
Cement	6,731,000
Paper and Wood Pulp	6,268,000
Gas (Heat and Light)	6,076,000
Railroad Shops	5,486,000
Cotton Goods	3,579,000
Ice Manufacture	3,386,000
Foundry and Machine Shop	2,913,000
Meat Packing	2,786,000
Malt Liquors	2,742,000
Chemicals	2,607,000
Glass	2,252,000
Petroleum Refining	2,045,000
Blast Furnaces	1,892,000
Flour and Grist-Mill Products	1,809,000
Woolen and Worsted Goods	1,544,000
Oil, Cottonseed and Coke	1,232,000
Leather	1,124,000
Zinc Smelting and Refining	1,066,000
Lumber Products	885,000
Sugar Refining	875,000
Copper Smelting and Refining	812,000
Electrical Machinery	769,000
Paving Materials	665,000
Glucose and Starch	648,000
Pottery	577,000
Agricultural Implements	555,000
Wine	523,000
Soap	515,000
Automobiles	464,000
Fertilizers	433,000

TABLE 5 COMPOSITION AND HEATING VALUES OF DIFFERENT RANKS OF COAL COMPUTED ON ASH-FREE BASIS

Rank of Coal	Heating Value, B.t.u.	Fixed Carbon, Per Cent	Volatile, Per Cent	Moisture, Per Cent
Anthracite	14,440	95.6	1.2	3.2
Semi-anthracite	14,880	83.8	10.2	6.0
High-Rank Semi-bituminous	15,360	83.4	11.6	5.0
Low-Rank Semi-bituminous	15,480	75.0	22.0	3.0
High-Rank Bituminous	15,160	64.6	32.2	3.2
Medium Rank Bituminous	13,880	54.2	40.8	5.0
Low-Rank Bituminous	12,880	47.0	41.4	11.6
Sub-bituminous	9,720	42.4	34.2	23.4
Lignite	7,400	37.8	18.8	43.4

[illegible]	[illegible]	[illegible]
Rumania	10,100,000	8,730,235
India	8,200,000	8,000,000
Persia		7,200,000
Galicia	6,400,000	5,591,620
Peru	2,600,000	2,536,102
Japan and Formosa	3,000,000	2,446,069
Egypt		2,079,750
Trinidad	1,000,000	2,000,000
Argentina	870,000	1,321,315
Germany	1,000,000	711,260
Canada	...	304,741
Venezuela	...	190,080
Italy	...	35,953
Total	460,450,000	514,208,715

TABLE 7 ONE YEAR'S FUEL REQUIREMENTS OF THE UNITED STATES AND THEIR COAL EQUIVALENT (13,000 B.t.u.)

Kind of Fuel	One Year's Fuel Consumption	Approx. Coal Equivalent (Tons-2000 lb.)	Conversion factors
(1) Peat	25 thousand tons	12,500	2 tons = 1 ton coal
(2) Natural Gas	800 billion cu. ft.	27,000,000	30,000 cu. ft. = 1 ton coal
(3) Wood	80 million cords	40,000,000	2 cords = 1 ton coal
(4) Water power	7.5 million developed water horsepower	55,000,000	33 per cent load factor, 5 lb. coal per hp.
(5) Petroleum	360 million barrels	100,000,000	3 6 bbl. = 1 ton coal
(6) Coal	650 million tons	650,000,000	....
Total		872,012,500	

13 Extend the custom of coal storage. The facts relating to this important practice are now available. Coal may be safely stored and the load curve on the mining industry may be much improved. The coal should be stored at or near its point of consumption.

14 Extend electrification. The full use of electrical energy offers the most promising means of saving coal. Conservation by coöperation of water power, steam power and electricity opens up large possibilities for saving coal, capital and labor. This is contemplated by the superpower plan now being investigated by the Department of the Interior and a report is in preparation by an engineering staff which will set forth the facts as to: (*a*) Needs for superpower, (*b*) characteristics of an installation, (*c*) location of suitable superpower lines, (*d*) estimated costs, (*e*) estimated economies and other details.

DISTILLATION OF FUELS AS APPLIED TO COAL AND LIGNITE

By O. P. HOOD,[1] WASHINGTON, D. C.

Much has been written on the subject of the distillation of coal, covering the field from the intricate chemical reactions involved to the economic aspects having a bearing on statecraft. The subject is by no means new since men of perception have for many years pointed out the fact that coal is a raw material from which many values other than the heat of direct combustion can be obtained.

The growing appreciation of these values by the layman as a result of present writing is, however, new. There is a widespread feeling that we are not wise in our present methods of using coal. It is well to awaken general interest in this subject, and presenting the matter in exaggerated form to more quickly convey an impression is somewhat justifiable, but it is quite possible to overdo the matter. When coal is used raw for heat generation it should always be with a proper understanding that this material might, under more favorable circumstances, be used for higher purposes. Beside major products of coke, gas, and pitch, an alluring chain of oils, dyes, and medicinals might have been produced.

While all this is possible it does not warrant the conclusion that all coal should be made to yield the last-mentioned products. Because wheat can be made into cake the market for bread is not to disappear. There will always be much use for raw coal, for in this form the individual has the disposition of a maximum amount of energy with the least fixed liability. It must be recognized,

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[1] Chief Mechanical Engineer, U. S. Bureau of Mines, Mem.Am.Soc.M.E.

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therefore, that the distillation of coal is not for universal application, but that it will find its appropriate field of usefulness together with other and cruder methods.

The layman is likely to overlook the fact that processing of coal to obtain more than one or two products is necessarily a large enterprise and not to be entered into with small means or on a limited scale. Even on a large scale the tendency has been to look to a single product to justify the installation; e.g., in the production of metallurgical coke the gas has been wasted, and in the production of city gas the disposal of coke was a problem.

The investment required in large plants for coal processing is so great that it is no reproach to forego this form of ultimate economy so long as our savings are more needed for development in other directions. In other words, conservation of capital is as necessary as conservation of raw material.

There are, however, rapidly developing fields in which the processing of coal is extremely desirable and is practicable. These fields are made apparent by the greatly increased cost of coal, by a general realization that there is a limit to easily won high-grade coal, by the decline of natural-gas supply, the increased cost of transportation, and a growing appreciation of and dependence upon fluid fuels, both gas and oil.

There is a popular hope that if elements of higher value are recovered from coal by distillation, the remaining fixed carbon can be sold at a price lower than the raw fuel; in other words, that coke as a domestic fuel can be sold at a cheap price. Where in any process a chain of products is produced, the actual cost of production of each is largely a matter of bookkeeping and each is priced at what the market will bear. So far, the market has absorbed coke at a price which leaves little hope for cheap fuel from this source and it is not likely that processed coal can yield cheap fuel. It is more likely to produce a fuel whose special qualities of cleanliness and smokelessness will command a good price and supplement our declining store of anthracite coal. There is also the hope that by extensive distillation and other processes manufactured gas may reinforce our rapidly disappearing natural gas. There is little to justify the hope that relative prices for heat units in the form of gas can ever again be as low as they have been in the case of natural gas, for it is now recognized that even natural gas has been sold too cheaply to return the investment at the end of the producing period.

Processes of Distillation

The fact that motor and other oils can be obtained from coal distillates and that there is a market for all that can be produced, strengthens the position of distillation processes. There is a growing appreciation of the fact that the character of coal distillates is quite as much a factor of the process as of the coal used. The amount and quality of the distillates is determined by the heat experience of the primary complex constituents of the coal, so that variation in the engineering structure and mechanism of the apparatus, together with temperature treatment, gives opportunity for a variety of processes and results. These processes can, therefore, within limits, be fitted to the major products desired. A great deal of attention has been given to distillation resulting from temperatures not exceeding about 1400 deg. fahr., which are lower than used in coke-oven or gas-retort distillation. Prof. S. W. Parr states that "in general, it is believed that all the products of decomposition have a higher intrinsic value as delivered under low-temperature conditions chiefly because excessive secondary decompositions are avoided." With the usual methods and lower temperatures there will be considerable difficulty in transmitting heat to coal at a sufficient rate to obtain reasonable capacities from a given investment and in this particular low-temperature distillation is at a great disadvantage, which must be equalized by a greater refinement of its products. It is therefore hard to see how low-temperature distillation can be expected to yield a cheap fuel.

Distillation of coal in by-product coke ovens is already the major process in the production of metallurgical coke, and in a few years probably only the peak load of productive years will be carried by beehive ovens. The gas produced is used in the adjacent industries which determine the location of the plant, and much of the tar is burned instead of fuel oil. An appreciable addition to the supply of motor fuels is made by the benzol which is recovered, and ammonium sulphate for use as fertilizer is recovered in quantity.

A return to distillation methods in the city gas industry is indicated now that gas oil is no longer cheap for the enrichment of water gas and an outlet for coke in domestic heating service becomes more assured. This is the most favorable field for the expansion of distillation processes.

There is great need for a high-class domestic fuel in the lignite areas of the United States where there are large supplies of low-grade fuel. The increased difficulties and cost of transportation of eastern coals into these districts makes the problem a specially urgent one. Experimental work has shown the possibility of applying distillation methods to lignite, obtaining gas, tar, ammonium sulphate and a carbonized residue of excellent heating value. In most regions where this need exists the solid fuel would be the main objective of the process, possibly wasting the others. The char is too fine for domestic use without briquetting, but when put in proper form it makes a fuel comparable with anthracite.

In the southern lignite area there is also a need of developing a distillation process which will make lignite available for the production of city gas. This seems quite possible from the indications of laboratory work, but in both of these fields there is no commercial development. It seems as though the laboratory and small-sized experimental plant had contributed about all that it could and the business awaits that longer step which must be taken to realize these results in full-sized apparatus. In fact, many fuel-distilling processes seem to have reached this interesting stage of expectancy.

FUEL CONSERVATION

By DAVID MOFFAT MYERS,[1] NEW YORK, N. Y.

Seventy-five to one hundred million tons of coal per year could be saved by the adoption in the United States of well-known and well-tried methods of fuel conservation, and this saving would be in addition to a similar reduction in the consumption of other fuels. The writer's experience in the Fuel Engineering Section of the United States Fuel Administration demonstrated without possible doubt that such conservation would involve no experimental features, and that it could be readily accomplished by the simple adoption of sound engineering principles in the use of fuel by consumers. Prevention of waste is merely a matter of the application of well-known engineering principles.

Based upon only 75,000,000 tons, the money saving would be $450,000,000 per year, or enough to pay nearly one-half the interest of our national war debt.

The transportation of coal would be relieved to an extent equivalent to a million and a half 50-ton carloads per year, or 50 per cent more than the coal-carrying capacity of the Pennsylvania Railroad lines east of Pittsburgh. The significance of this will be realized when it is stated that the chief difficulty in securing coal today is due to lack of transportation facilities.

The services of 75,000 miners would be conserved, so that the same force would be able to handle the natural increase in mining production. The additional labor connected with the loading, transportation, and unloading and firing of a million and a half less cars of coal per year would also be eliminated.

Fuel conservation is good for other countries, as it enables us to do our part in supplying their markets. It should be emphasized at this point that the kind of conservation which the writer has in mind is "constructive conservation," which means using fuel efficiently without reduction in the output of our manufactured products and without the slowing down of any of the natural phases of our national and social life. It is necessary to inject this statement owing to the fact that during the war "destructive conservation" was also largely practiced, which simply mean the cutting-off of coal supply to various industries and uses with the consequent impoverishment of our industrial and social life.

All consumers of coal would benefit financially by a program of constructive conservation. During the war, by the adoption of

[1] Consulting Engineer, Griggs and Myers, Mem.Am Soc.M.E.

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It was impossible, at that time, owing to conditions imposed by the war, to adopt measures affecting also the design or equipment connected with the use of fuel. A future program should include such measures. The efficiency of any process that is connected with fuel or any other material is equal to the efficiency of the operation multiplied by the efficiency of the equipment. In other words, the man multiplied by the machine.

The Waste of Fuel in the United States

There is at present a huge and unnecessary waste of fuel in this country. The waste is everywhere. There is not an industrial plant in the country where 10 to 30 per cent saving of fuel might not be effected by common-sense engineering. Some of the items relating to this waste are as follows:

(1) Waste in the boiler plant, including the very large item of inefficient combustion of fuel under stationary and locomotive boilers. Sixty-seven per cent of all the coal mined in this country is consumed for the purpose of making steam on land.

(2) Coal consumed in the old-fashioned, wasteful beehive coke ovens represents 9.3 per cent of the total. Only 4.3 per cent is consumed in the by-product coke ovens.

(3) In domestic heating it is estimated that 12 per cent, of the coal is used. Very large savings were made in this department during the war, and much more can be done by proper conservation methods. The psychological importance of emphasizing fuel economy in this field is evident owing to the fact that it would deal with 20,000,000 people or householders, whereas by comparison fuel conservation in the industries would deal with only 200,000 plant managements and those of the railroads.

(4) Fuel is extravagantly wasted by improper use of steam after its generation. For instance, by the use of:

(*a*) Inefficient types of prime movers
(*b*) Careless maintenance of power-consuming machinery
(*c*) Ill-advised installations unsuited to the purpose they would fulfil
(*d*) Huge volumes of wasted exhaust steam expelled to the atmosphere or to condensers, and live steam used for heating without first developing its quota of energy
(*e*) Unnecessary use of live steam where exhaust steam with proper engineering would fully meet the requirements
(*f*) Badly designed and ill-kept transmission systems.

Of these forms of waste item (*d*) needs the greatest emphasis. Everyone knows steam is being wasted when they see clouds of exhaust blowing out into the air, but how many people (not engineers) realize that our modern and highly efficient central stations are guilty of wasting some 80 per cent of the heat of the steam into the condenser, while at the same time, particularly during the heating season, hundreds of buildings and factories in the vicinity are burning thousands upon thousands of tons of coal for heating purposes, and that the owners of these would gladly dispense with their expensive heating plants if the central station would sell them heat as well as power.

Fuel Savings in Industrial and Private Plants

The other side of the problem relates to the private plants, each of which must be diagnosed according to the merits of the case. Many industrial plants can utilize all of the exhaust steam from their own power plants all the year round, and in such cases their power is merely a by-product of their heating fuel. If they were to shut down their engines or turbines they would still have to burn about 90 per cent of their former coal consumption, so that only 10 per cent of their engine water rate is chargeable to power. Such a plant of course produces its own power so cheaply that no central-station condensing power plant will ever be able to compete with it. Frequently it would easily be able to generate more power than it can use without wasting any exhaust steam, under which circumstances it should be enabled to sell its surplus power to a central-station system.

The other extreme exists when the private plant has no use for heat and wastes all of its exhaust to the atmosphere. Coal, and ments were sufficiently large, could afford to install modern equipment and make its own power more cheaply than it could buy it. Coal might not be saved over the plan of buying power from the central station, but money would. A very common case is that of the private plant that can utilize all of its exhaust heat during the heating months but wastes it through the non-heating months. Such a plant should make its own power in cold weather and buy it in warm weather. What we need to develop is a flexible plan of coöperation between the central power stations and the privately owned plants.

The superpower system advocated by W. S. Murray, apparently fails to consider the vital factor of industrial and building heating, and unless this factor is interwoven in the system in the manner the writer has indicated above, the waste of steam and fuel (to the condenser) in large central stations would be augmented rather than reduced. If power alone were the only consideration necessary, Mr. Murray's plan would avoid this important fault. As applied to the railroads alone, which consume 28 per cent of all the coal we produce, the plan would appear to have many important advantages.

Our Failing Supply of Fuel

The need of a definite policy of fuel conservation is urgent. Natural gas, the most nearly ideal of all our natural fuels, today is practically gone. Inside of three years there will be no more available for industrial uses, and all owing to our failure to demand a definite policy of conservation. We permitted instead a definite policy of waste.

The next natural fuel to go will be oil. The supply in the United States it is estimated will be used and wasted out of existence in 20 to 30 years. Our production is stated at one million barrels of crude oil a day, which is more than 60 per cent of the world's total output, but this is not enough for our present domestic consumption. The peak of production will be reached in a very few years, whereas the consumption is increasing steadily. The demand for motor fuels is the greatest of all the items of consumption, and fuel oils is said to be the next largest. A bill has been introduced for an appropriation of $250,000 to enable the Department of Agriculture to conduct experiments looking toward the discovery of a new motor fuel. Coal-tar products including benzol are under consideration as well as alcohol. That the expensive method of producing oil from the shale beds of Utah, Colorado, Wyoming, and Nevada is being more and more brought to the attention of investors, is an indication of the urgency of the oil situation. All this is occurring years earlier than should have been, owing once more to our lack of a definite policy of fuel conservation.

We formerly had no policy whatever in regard to utilization of the vast water powers of this country. The economic waste that existed under these conditions was such that we were eventually forced to adopt a definite policy, as illustrated in the recent Water Power Bill. This aims to protect the rights of future generations in this great natural resource.

Government Aid in Conservation

It is now the time to consider how the Government can assist in the conservation of coal and oil. It is the writer's personal opinion that coal and other natural fuels present a problem that so intimately concerns the welfare of all the people that it must equally concern the Government which represents the people, and that therefore until the general public through its Government takes action in the matter there can never be any truly adequate answer to this problem. The mere financial incentive to stop the unnecessary waste of fuel is not strong enough to do the job, for the reason that the great bulk of coal and other fuels is consumed in industrial undertakings, wherein substantial profits are readily available without the trouble of economizing in the application of fuel. This fact may be strikingly realized through the statement of an authority that of the total cost of all the manufactured products of the country only 2 per cent is fuel cost.

The public at large does not yet fully realize the importance of fuel as a national issue, but the writer believes that even now it is coming slowly into such a realization. Therefore, although the time is not yet ripe for any radical step in this direction, yet we may and must look forward ultimately to a solution along these lines.

The public must be made to see how adversely it is affected by this great and uncontrolled waste of fuel so that Government coöperation and assistance will be demanded. This means that time will be necessary in which to educate the public as to the importance of fuel conservation as a national issue in order to secure the necessary interest by Congress and Government bureaus.

Finally, the writer wishes to offer for consideration and constructive criticism the following policy of fuel conservation to be adopted with the coöperation of the Government:

(1) Regulation of quality of fuel.

(2) Measures for prevention of flagrant waste of all fuels.

(3) In the matter of transportation, zoning is productive of large economies.

(4) Better means of coal storage are urgently needed to flatten out load curves at the mines, which are now overcapitalized and overequipped 40 per cent.

(5) Possibilities of conservation by the United States Bureau of Mines.

(6) Great advantages to be secured by appointment of a resident engineer in each state, to keep in close touch with local industries and with a clearing house of information in Washington.

(7) A body of citizens advisory to Bureau of Mines should assist in the planning and development of the conservation program. It should be representative of business men, engineers, and citizens from various parts of the country.

(8) Correct design of new power plants, and perhaps changing of power equipment in existing power plants.

(9) Government should encourage new inventions and investigation, leading to the economical use of fuel.

(10) Better educational measures. Every technical school should have lecture courses on fuel conservation, more for the purpose of emphasizing its importance rather than from intensified and specific instruction. Educational courses for chief engineers and firemen. Examination for license in this profession. Provide throughout the country uniform examinations with corresponding certificates for operating engineers and firemen thus educated in steam and fuel and economics.

(11) Measures looking toward the development of low-temperature distillation of coal (and lignite) for the conservation of the immensely valuable by-products which at present are wasted when raw coal is burned for steam making. The resulting smokeless carbonized coal would then become the boiler fuel of the future in proportion to the extent to which this by-product industry could be economically developed.

FORM VALUE OF ENERGY IN RELATION TO ITS PRODUCTION, TRANSPORTATION, AND APPLICATION

By CHESTER G. GILBERT,[1] WASHINGTON, D. C., and JOSEPH E. POGUE,[2] NEW YORK, N. Y.

Coal, oil,[3] and water power are the principal sources of energy in the United States. Although commonly regarded separately, they really constitute a single resource group which provides the energy essential to modern conditions and contributes commodities of growing importance besides. Two-thirds of the energy extracted is consumed as power in doing the work of industry and transportation, while the remainder is devoted to the production of heat and light, and the furtherance of chemical work. The commodity values held in coal and oil, while having an important and growing bearing upon modern needs, are largely ignored. Not only is the civic and industrial life of this country utterly dependent upon the energy materials, but the production, transportation, and distribution of these essentials constitute a prominent aspect of the country's activities.

Can this country continue to rely almost exclusively upon the railways for its supply of energy? Coal alone now engages nearly half the freight capacity of the railways. Can the cities and homes of the country afford to turn to bituminous coal with its smoke and dirt for their fuel dependency? Anthracite is fast becoming a luxury and metallurgical coke is not a satisfactory substitute. Is the public ready to curtail the use of automobiles and motor transport within the next few years because of an inadequacy of gasoline? The petroleum resource is already showing signs of strain. Is it wise for this country to ignore its water-power resources? Under present conditions water-power sites, with choice exceptions, cannot be developed. If we are prepared to answer these questions in the affirmative the whole matter may be dismissed. Otherwise, the present situation must come up for revision.

These are the most immediate points of practical contact with the energy problem. They all involve issues of the day: transportation, domestic fuel, motor fuel, water power. But these are not all. What of the congestion in our terminals and cities because of coal distribution and ash removal? What are the civic losses due to smoke? What of the values going to waste when raw coal is burned? Can these be saved and made to contribute to a lowered fuel cost? What are the chances of building up a large coal-products industry in this country? Has chemistry as yet wrested its full count from coal tar? What shall we miss by not cultivating this field? Can coal solve our nitrogen problem? What are the by-product possibilities in petroleum?

These questions are pressing forward for attention. They involve the foundations upon which our industrial stability, our domestic comfort, and our national welfare are based. With bountiful resource wealth and with mastery of technology we have proved ourselves to be lacking in adequate economic procedure to take advantage of our endowment. The conditions under which energy is brought into play in the United States are mainly an inheritance from a period when the character of energy resources was imperfectly known and the technology of energy employment was crudely developed.

The employment of our available resource in energy involves three progressive stages: production, transportation, and utilization. It may be of interest to examine coal, oil, and water power in turn with respect to their status under these headings.

Coal

The production of coal is scattered, uncoördinated, and wasteful. The coal mines of the country carry a variable but large idle capacity, accompanied by an uncertainty of operations, that is at once a menace to the stability of the labor supply and to the maintenance of an adequate output; the technique and practice of storing coal is imperfectly developed; the seasonal fluctuations in the demand for coal remain uncompensated. These conditions are essentially the product of past circumstances—excessive competition, overdevelopment of the resource, and inadequate prices at the mine mouth, which led to poor engineering and low recoveries of values.

Transportation is the weakest link in our coal supply. Coal forms over a third of the country's freight; the mining of coal is dependent upon an unbroken movement of coal cars past the mine mouths; the number of coal cars has never been equal to the full capacity of the developed coal mines. With every period of industrial prosperity, a car shortage is bound to result. Moreover, as a result of the size and industrial status of this country, the railways have a sufficient responsibility without the carriage of coal.

Present utilization of coal involves a very low recovery of the energy content and an almost total loss of the commodity values present. This of course necessitates the production, transportation, and distribution of a much larger quantity than would otherwise be required; concentrates the whole cost, in respect to the consumer, upon the modicum of energy extracted; requires the imports of materials which might be manufactured from the non-energy components; holds back the development of latent possibilities

[1] Consulting Engineer, Arthur D. Little, Inc.

[2] Industrial Economist and Engineer, Sinclair Consolidated Oil Corporation.

[3] In an economic sense, natural gas may be regarded as a variant of oil and needs no separate consideration in this summary paper, since the principles governing the production, transportation and utilization of both oil and natural gas are similar.

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waste than is found in the mining of coal, with far more serious consequences because the domestic supply is altogether inadequate for meeting the present requirements of the country and the domestic resource is rapidly suffering depletion. Less than half of the oil underground is raised to the surface; there has long been an overproduction in respect to the higher types of uses, prompting the surplus to be used for crude purposes in the place of coal and water power.

The transportation of petroleum makes use of an extensive system of pipe lines, thousands of miles in length, spread over half of the country, connecting points of production with refineries, markets, and seaports. The efficiency attained in the transportation of petroleum energy is in marked contrast to that characteristic of coal energy, and should point the way to the reconstruction of the latter, whose faults are now throttling the commodity transportation of the country as well as contributing to unhealthy urbanization and sectionalization.

The utilization of petroleum is far in advance of coal in that the bulk of crude petroleum now produced is separated into its chief components—gasoline, kerosene, fuel oil, and lubricants—whereas coal is employed dominantly in the raw state. Here again the oil industry points to the analogous need for a coal-refining industry to separate coal into mobile forms of energy and commodities. The utilization of the various petroleum products displays various degrees of efficiency, with the greatest discount applying to the low-use products such as fuel oil. The by-product actualities held in petroleum are not yet adequately utilized, nor are the by-product potentialities sufficiently developed.

Water Power

Only a small fraction of the water-power resources of the country is developed. This is due to the abundance of coal and oil, on the one hand, and the high rate of interest demanded by capital in respect to hydroelectric developments, on the other, with complications growing out of public sentiment and legal restrictions regarding water-power rights under Federal control.

The transportation of hydroelectric power, so far as it is produced, is technically satisfactory. The lack of a common-carrier system for the transmission of electrical energy, however, contributes to the undevelopment of water-power sites by making it necessary for the generating project to provide its own transportation.

The utilization of electricity for power production and lighting has been more highly perfected than that of any other form of energy; the application of electricity has also been more efficiently developed than the production and transportation of this energy form, viewed in an economic sense. The status of electric application is a cause for congratulation in an energy situation fraught with shortcomings, but at the same time this development has exaggerated the lack of balance obtaining in the present state of development of the energy industry and invites further neglect of the other energy forms.

Technique of Energy Analysis

This brief review is sufficient to indicate that the various components of the energy situation have developed to different degrees of attainment, and with little relation of one to another. In an industrial age, energy, the basis of industry, has failed to become an integrated industry itself. The production of energy is still individualistic, corresponding to economic conditions of the past; industrial activities in general have evolved to an interlocking and coördinated whole; not so energy. With minor qualifications the field of energy has merely grown in size and the system of energy supply is now modern in proportions but ancient in structure.

The reconstruction of an economically and socially competent supply of energy is an issue of profound importance, which cannot be met by discordant attentions to its component parts. The greatest weakness in the present situation is the dissociated character of its growth; little can be accomplished by merely perfecting

short of the mark.

The technique of conducting an adequate survey of the problem of energy supply involves a fundamental consideration of "form value" and "resource value." Form value is an intangible quality denoting the broad applicability of the energy form in contrast to its theoretical thermal value as ordinarily expressed in B.t.u., and involving the consideration of transportation as well as of utilization. Resource value is an intangible quality expressing the availability of energy in terms of location and chemical character of its source, and involving the potentiality of chemical control for purposes of multiple production.

Form Value

The concept of form value is of sufficient importance to warrant further attention. The significance of form value has been admirably illustrated by a series of valuable charts prepared by the W. S. Rockwell Company, covering industrial heating operations. The complete paper reproduces a member of this series, showing the factors governing the selection of fuel for industrial heating

Comparative costs of the most commonly used forms of energy in terms of thermal value are also given in the complete paper and they clearly illustrate the fact that form value is of greater importance than thermal value as a decisive factor in energy selection, for otherwise no other form of energy could compete with bituminous coal and the chief elements of progress in energy supply thus far attained would be nullified. The importance of form value is so obvious that it is difficult to understand why it has been so universally neglected as a broad economic concept.

Form Value in Respect to Application

The applicability of energy involves not merely the utilization of energy, but the transportation of it as well; both considerations necessitate a coördinate view of the value of the energy form in respect to what the demand for energy requires. This concept leads to a study of form value relative to application as the initial step in the development of an energy supply.

As is well known, energy may be brought to the points of application in solid, liquid, gaseous, or non-substantial (electrical) form. Under each form there are varying degrees of energy concentration. The market for energy, as developed by the innumerable natural and artificial factors that have contributed to building the present range of requirements, demands all four forms in their numerous varieties.

Before we are in a position to consider adequately the transportation phase of the energy problem, therefore, we must first determine what will best serve the needs, having regard for the potentialities as well as the actualities, afforded not merely by one system of supply, such as the electrical, but by all other types as well. To impart a special impetus in any one direction is to retard developments in all others. We should bear in mind that expansion in any one form of energy automatically follows the development of appliances for transforming that energy into useful service and that electricity has outdistanced gas more by virtue of this fact than because of inherent superiorities.

The demand for energy is a composite of requirements varying regionally according to the prevailing industrial type, and locally according to the details of the application. Both regionally and locally considerable possibilities of correlation are present, especially as between the needs for industrial power, on the one hand, and the requirements for industrial and domestic heating, on the other; since the two types of demand are to a large degree complementary. On the whole, a difficult compromise will have to be reached between what the market at the moment desires, and what it may be educated to take.

Energy application in this country in point of development thus far is the composite result of promotion and advertising. We have electrical experts; powdered-coal enthusiasts; fuel-oil advocates; mechanical-stoker adherents; but no recognized court of appeal for an unbiased consideration of a given item. Detail

after detail of power or heating installation has been added to the country's total as a result of the particular hands to which the item happened to be assigned. The character of this development renders the quality of the demand singularly difficult of economic appraisal, since the point of view of the analysis itself is apt to be colored by the same historical precedence.

Form Value in Respect to Transportation

While the market is under appraisal, the transportation of energy will require consideration, since the form value with respect to application is not wholly independent of form value with respect to transportation, although the reverse relation is to a partial degree true. The energy market has thus far been dominated by the transportation facilities available, whereas there should be a give-and-take relation between the two.

The means for transporting energy, are, of course, cars for the solid and liquid forms, pipes for the liquid and gaseous forms, and wires for the electrical form. With these facilities in mind, an appraisal of energy transportation must have an eye both to the application of the energy at the points of use and the resource value at the points of origin. The prevalence of energy haulage in the solid form has not only reduced the efficiency of energy utilization but has lowered the resource value of the energy as well, not to mention the loss arising from competition with commodities in a congested railroad system. The means of transportation which have naturally developed, or which may be arbitrarily provided, should be studied not only with relation to the effect upon transportation itself, but with respect to their influence upon the efficiency which may be derived from the energy and the values which may be won from the resource. The transportation of energy by either pipes or wires tends to stimulate the enlargement of resource value through by-product recoveries, and the increase of form value through added efficiency in application. The proper balance between a system involving the use of cars, pipes, and wires is an ideal upon which sufficient information is lacking even to speculate, and chiefly because transportation has not been studied with due regard to form value and resource value.

Resource Value

Of the three major elements entering into the energy situation, resource value has suffered the greatest neglect, both by the circumstances of development as well as by current plans for reconstruction. One element of resource value—location—it is true has been overemphasized in the course of industrial development, with the result that we now have an unhealthy centralization and urbanization with an aggravation of sectional and class differences. The major element of resource value—chemical character—is only just now coming in for some degree of attention, although the interest in it is not usually carried through to the point where the interdependence of resource value, transportation, and form value becomes clearly illuminated. The chemical character of the resource raises the problem of chemical control for purposes of multiple production, in order that valuable materials occurring with the energy, as well as much of the energy itself, may be kept from going to waste. In other industries the only way in which advancing costs have been effectively met has been through multiple production and its better-known partner, mass production.[1] The main reason why energy prices have advanced so strongly is that in the absence of an energy industry there has been no chance for savings in these directions while producing costs have steadily increased. Energy will lose much in social potentiality if its resource value is not enhanced over that obtaining at the present time.

In fine, energy needs to be placed upon a sound industrial basis, and this requires that due consideration be given to all these factors that are studied as a matter of course in connection with the establishment and nature of a new industry. The need is for adjustments in energy form to the end that greater efficiency in utilization and transporation shall be obtained, and a full measure of resource value received.

[1] In an economic sense, mass production and multiple production are the same. Mass production is the mechanical equivalent of multiple production which involves the element of chemical control; in many industries the two become actually identical.

DISCUSSION AT FUEL SESSION

The oral discussion which followed the presentation of the papers on fuel was entered into by a large number, and that all might have an opportunity to express their views two adjourned sessions were necessary. One of these was held on Wednesday morning, the other on Thursday evening.

At the first session discussion was largely confined to Professor Breckenridge's paper on the Fuel Supply of the World, and that by David Moffat Myers on Fuel Conservation. The use of peat, oil shale, and coke as aids in fuel conservation was touched upon by many. George Otis Smith stated that in one area in western Colorado and in eastern Utah it has been estimated that there are about ten times as much shale as fluid petroleum. He also pointed out that the oil-shale industry could not be expected to develop as rapidly as the petroleum had done, as it involved a much larger expenditure per heat unit for human labor.

Edwin DeLany referred to a process of making fertilizer from peat and expressed the fear that the supply of peat would be used up long before it was in great demand as a fuel.

In connection with the coke industry, Frank H. Kneeland stated that while it requires the greatest coal consumption of any of the industries, it was possible, through the processes of distillation, to create a coal containing 35 per cent volatile and producing a residue of solid fuel containing 8 per cent volatile, which is practically the same as Pocahontas coal.

R. P. Bolton was the first to discuss the question from the standpoint of conservation. He referred to the saving made by shutting down small electric plants and using electrical energy from central stations. In one case, he stated, such procedure had resulted in a direct saving of 25,000 tons, and allowing for the coal used in the central station, a net saving of 15,100 tons.

H. M. Crane spoke at some length regarding the use of fuels in the automotive industry. He stated that the petroleum industry is attempting to obtain fuels suitable for small isolated plants and for use in automobiles. The conservation of such fuels, he declared, is dependent upon their proper use by the public.

Harrington Emerson confined his discussion to the saving to be effected by a study of locomotive fuels. The locomotives of the country, he stated, burn 140,000,000 tons of coal per year, and looking at railroads as concerns buying coal at wholesale and retailing it by the ton-mile and passenger-mile, they had lost, as a whole, during the year 1919 nearly $15 for every ton of fuel burned.

Horace C. Gardner called attention to the conservation to be effected by coöperation with the Government. The trouble, he said, was that we really have 49 governments and we must get the coöperation of all of them. He suggested that this was a problem for consideration by the newly created American Engineering Council.

Joseph Harrington was of the opinion that fuel conservation was a problem of applying the knowledge that we already have rather than attempting to develop new knowledge on the subject. He also stressed the importance of publicity and education.

W. C. Buell called attention to the fact that in the steel districts a great deal of work has been done on fuel conservation and that in one case of which he had knowledge a billet-heating furnace producing 70 tons per hr. was operated at a thermal efficiency of 60 to 63 per cent.

Gardner T. Voorhees discussed the question from the viewpoint of the large public-service and electric plants. He stated that a device might shortly be expected on the market which would take the heat from the steam which is now exhausted into the condenser and by using one pound of steam from the boiler furnish several pounds of steam at moderate pressure for heating purposes.

Prior to the adjournment of the morning session the chair announced that at a conference between the chairmen of the Professional Section on Power and the Professional Section on Fuel, it was decided that the activities of the Fuel Section should end in the steam pipes between the boiler and engine.

Discussion at the First Adjourned Session

At the first adjourned session discussion was opened by E. H. De Lany, who spoke of conservation and the possibilities of coöperation with the Government. Referring specifically to the con-

people and he also has rights which he enjoys in common with them.

C. S. Blake stated that conservation rested very largely with the owners of power plants and that it had been his experience since the war that many owners did not care to practice fuel economy. The country does not lack engineering skill to give advice in the economical use of fuel, he said, but the ratio of fuel cost to value of production was such a small percentage that it was hard to interest manufacturers in this much-needed economy. In order to bring about this conservation he urged that a system of education be carried on between The American Society of Mechanical Engineers and the fuel users and without Government force.

D. T. McLeod discussed the same question and at considerable length. Conservation, he said, should start at the mines, for present mining methods do not recover anything like the amount of coal that is possible. He also stressed the importance of conserving by-product coals. He concluded by relating some of his experiences with regard to operations at the mines, especially as to labor conditions and their effect upon production.

R. H. Kuss commented upon the need of information as to fuel economy. The Federal Government, he declared, was not prepared to give such assistance. A. G. Bailey also spoke of Government aid. We should have, he declared, every chamber of commerce helping to bring public opinion to bear on both city governments and public-service commissions.

R. P. Bolton referred to the great saving that could be made by conservation of the domestic supply. The heating of New York City, he said, involved the burning of 7,000,000 tons of coal a year. As a means of saving in the transportation of this coal he suggested that a system might be created by which the coal would be brought to the city through pipe lines similar to those in use in the oil industry. Two 14-in. pipes, he declared, should be sufficient.

H. H. Kimber spoke at some length regarding pulverized fuel and the many uses to which it has recently been put.

D. C. Buell offered two recommendations as to procedure for future meetings. The first of these was that the Society work out a form giving the proper value of the different items which an engineer must consider in studying the waste of fuel, and the second that the Society send a delegate to the annual meeting of the International Railway Fuel Association.

G. T. Pogue closed the discussion of the second session with the suggestion that the Fuel Section devote some attention to the economics of energy service.

Discussion at the Last Session

At the final adjourned session on Thursday evening E. H. De Lany opened the discussion by referring to the great need of educational work in fuel conservation, and said that in his opinion lectures on fuel conservation would be of great value. Loring Freed referred to the low-temperature carbonization of coal and suggested that the Society go on record as advocating a campaign of education to encourage the use of low-candle-power gas and low-B.t.u. gas.

George H. Sharpe, in discussing the division of work among the sub-committees that had been proposed to handle the question of fuel conservation, suggested that an engineering representative from the coal operators be placed on one of the sub-committees. If this were done, he said, he believed it might lead to the creation of plans whereby it would be possible to work the miners 250 or 275 days a year, with a resulting reduction in the cost of coal of somewhere between 30 and 35 per cent.

A. D. White suggested that a committee be appointed to formulate rules for the use of coal, similar to those now in use for the building of boilers. David Moffat Myers also commented upon what he termed " the code of conservation," and stated that while excellent results had been secured during the war by the use of plant, Government engineers should look over the plans and pass upon them so that they may conform to proper engineering economics and will not result in wasteful operation. The French Government, he stated, is doing this very thing.

George A. Orrok was of the opinion that the greatest offenders in the waste of coal are the householders who, he stated, waste 40 to 50 per cent of the coal they buy. The city of New York alone, he said, uses about seven million tons of coal annually for domestic purposes, and if some method could therefore be devised to educate the ordinary man in the use of coal, it would probably result in the saving of 30 to 40 million tons of coal every year.

Joseph F. Shadgen, speaking of conservation, stated that while education was exceedingly desirable, it was his experience that an appeal could best be made to a man by showing him that he was losing money. A. A. Adler said it was his belief that it would be impossible to educate the public into saving fuel by means of laws. He also spoke of the savings to be made by having houses properly designed and suggested that the architects be interested in the question of fuel economy.

E. Kilburn Scott referred to present methods of mining, and stated that he believed some commission should determine as to whether in the interest of economy the long-wall system could not be employed in this country much more than it is. In reference to Government coöperation for fuel economy, he urged that consideration be given to a closer coöperation with municipalities. In England, he stated, there is a conservation officer just as there is a health officer, and his job is to see that there is no waste and to issue printed matter to educate the public in the proper use of coal.

R. P. Bolton differed from the previous speaker and gave it as his opinion that the first class to be educated were Government officials and municipal authorities. He also referred to the question of economy in the individual homes of the people and stated that if the tenants in our large apartments had to pay for the steam they used, a very great difference in the amount of fuel burned would be seen.

M. S. Hutton suggested that if the newly formed Fuel Section should create a committee upon conservation, it should coöperate with the Federated American Engineering Societies, as under this larger organization any work that might be done would carry great prestige and weight.

F. R. Low told of the objections that were offered to the Boiler Code when it was first presented by the Society, and how little by little, as states began to adopt it, the owners of boilers had accepted it as a standard. This was so because boiler explosions were communal disasters. Similarly, he declared, the wilful and unnecessary waste of fuel is a communal loss. Fuel conservation, he asserted, is a question of educating the individual and not of the passage of laws. "Cannot we impress these things upon the public," he said, "to an extent which will be fully as effective as a law which says 'Thou shalt not?'"

Elias Schlank closed the oral discussion by suggesting possible ways in which this education might be accomplished. Among other things he urged that the engineer take a larger part in civic affairs and that the children in the schools be taught the need and necessity of conservation.

Written Discussion

John W. Lieb, Jr., presented an extended discussion on the fuel problem in connection with the operation of public utilities, which use approximately ten to twelve per cent of the total bituminous production in this country. He said that whereas in 1916 the average price of good quality bituminous was roughly three dollars per ton f.o.b. tidewater, New York, of which about one-half was the charge for freight, at the present time the freight alone amounts to more than three dollars a ton. Apart from the price, however, it had been impossible during the past two or three years to obtain from coal operators a contract which, from a legal or commercial standpoint, is either reasonable or equitable. In fact, the "terms

and conditions" of the contracts, examples of which Mr. Lieb submitted, were such that they become at the pleasure of an unscrupulous operator practically a "scrap of paper," of little binding value.

Before the World War, said Mr. Lieb, there was sharp competition in the bituminous market and it is probably true that the competitive prices were too low and did not afford sufficient return on the investment. It was then possible to buy coal under a specification which assured its quality and would guarantee a certain number of B.t.u.'s per lb. within commercial limits, and a specified percentage of volatile matter, ash, degree of fusibility, etc. It was thus possible to gage boiler performance accurately and to obtain good boiler-room efficiency. All this has gone by the board. No specifications of any kind are obtainable at present. The boiler-room engineer cannot tell from one hour to the next what kind of coal is coming down on to the boiler-room floor or into the stoker hoppers. It has been a not infrequent experience to receive coal so deficient in quality that only 75 or 80 per cent of the maximum capacity of the boilers has been obtainable and station operators have been seriously concerned to meet the demands made upon them by their customers. Under these conditions, the speaker contended, the economic efficiency of utility plants (lb. of coal per kw-hr.) during the past two years cannot be taken as a fair or correct index of their normal and real economic efficiency.

Mr. Lieb then reviewed the history of the coal situation during the period of the war and subsequent to it, referring to the establishment of the Tidewater Coal Exchange, the restrictive orders under the Garfield Fuel Administration, the strike of bituminous coal miners in 1919, provisions for priority shipments, etc. He said that while the New York Edison Company had withdrawn from the New York Tidewater Exchange because it was unable through the Exchange to receive the specific coal which it had bought, the Exchange had been effective as a war measure. It had simplified railroad operation at the ports by having separate tracks for each pool classification and cars could be unloaded continuously without "drilling" out the cars of each individual shipper. But for the priority orders to the public utilities during August, September and until October 15, they would have met inevitable disaster and the country would have faced a national calamity.

Mr. Lieb then gave the following figures obtaining under the conditions prevailing during the period 1916–1920:

	1st 6 Mos. 1916	1st 6 Mos. 1920	Increase, per cent
Kilowatt-hours generated	322,750,850	422,070,915	30.8
Coal consumed, tons	289,289	438,834	51.7
Cost of coal (in bunkers) used	$921,331	$3,195,984	247.0

The pounds of coal per kilowatt-hour generated rose from about 2 lb. in the first six months of 1916 to $2^1/_3$ lb. the first six months of 1920, reaching as high a figure as 2.5 lb. for the second half of 1919, a decrease in efficiency of 25 per cent.

In the meanwhile the price had risen from approximately $3.20 per ton in the first half of 1916 to $7.30 per ton average for the first half of 1920; or, as expressed in cost of coal per kw-hr. at the generating-station switchboard, from 0.29 cent per kw-hr. to 0.76 cent per kw-hr., with a present cost of coal in the bunker of approximately $8.80 per ton and a coal cost of 0.9 cent per kw-hr. generated.

The question of storage of coal, Mr. Lieb said, might be regarded from two viewpoints: first, the endeavor to stabilize the output of the mines, make production more regular and uniform, and provide more continuous employment to the labor at the mines; and second, to protect the user against irregular deliveries due to unfavorable weather conditions, interference and delays in transportation, congestion at port terminals and harbor and switching difficulties. The former would call for storage at the mines, the latter, at the point of consumption.

The amount of storage necessary would depend on the size of a mine and the scarcity of cars, and car shortage had undoubtedly been the most serious of the difficulties encountered during the past year or two. Roughly, the average output of the mines is not over 50 per cent of their capacity, and, considering this caused entirely by lack of cars, it would appear that as the car shortages are rather daily than weekly or monthly, a bin storage capacity of 40 cars or approximately 2000 tons would be ample to take care of a 1000-ton mine. Taking the mean between the cost of wooden and concrete construction, the fixed charges on a 2000-ton pocket and machinery would amount to 7.5 cents per ton, which would be quite lost in consideration of the added output of 80,000 tons per year, and the more constant employment of labor with its enhanced efficiency.

The problem of storage at the point of consumption presented greater difficulties. It had been the experience of public utilities over many years that even in normal times it was necessary to provide for a reserve supply of fuel in storage to last from 45 to 60 days, dependent upon the proximity of the utility to its base of supply, its location on rail or water routes, dependency on one or more alternate transportation routes, rail or harbor terminal facilities, labor, barging, etc. On the limited areas usually available near large power plants this required the massing in piles of considerable height, introducing the difficult problems of protection against spontaneous combustion and the necessity of moving the coal in case of trouble. These contingencies, however, had to be met and the expense faced in order to safeguard continuity of operation.

It had been proposed that in order to stimulate the accumulation and storage of coal during the summer months when its transportation can be more easily accomplished, a lower freight rate be established during the season of favorable transportation conditions and a higher rate for the remainder of the year.

In conclusion, Mr. Lieb said that it would be seen that the problem of an adequate and regular supply of fuel to the public utilities was an important factor in our national economy, and that such a measure of practicable supervision and regulation of the production and distribution of the fuel supply to the railroads, army and navy, public utilities and public institutions should be assured as would secure to the public the guarantee of continuity of operation of these essential factors of modern civilization in the paramount public interest.

J. H. McNally. Since it is the intention of the Fuel Section to obtain, through coöperation, an exchange of ideas on the subject of fuels it is my theory that this coöperation should begin with the coal operator and not at the power plant. In seeking to coöperate with the various engineers in the power-plant field, we have great difficulty in ascertaining the kind and quality of coal that they desire, the usual saying being any low-ash, low-sulphur steam coal. As you know, this grade of coal is being very rapidly acquired by the metallurgical industries, so that in a short time none will be available for steam purposes, and it is my belief that a general educational campaign along the lines of utilizing our lower-grade coals, where fusion temperature and not sulphur is the index of the quality, would be very much in order.

Horace C. Porter. There is a confusion of statement and possibly of ideas as to the economic practicability of expansion in the industry of converting coal into coke, gas, and by-products. It is often assumed that this expansion would necessarily mean the displacing of raw coal for boiler fuel. As a matter of fact, however, coke and gas cannot compete with raw coal as a boiler fuel, even with the credit from the by-product ammonia, unless it be in large superpower stations, which sell the highest-grade coke and part of the by-products at prices well in excess of their relative B.t.u. values.

The abandonment in some measure of raw coal as boiler fuel may result from increasing use of centrally developed electric power from super-stations. Gas-fired boilers also may sometime prove to have lower overall costs than coal-fired, but the great field for expansion of coal carbonization lies in the other 35 to 40 per cent of our coal consumption not applied to steam raising. Beehive coking can and should be practically all displaced by recovery coking. The coal used in metal-heating and other industrial heating furnaces is probably 10 to 15 per cent of our total consumption. Gas and coke, or semi-coke, in the domestic field can be largely extended with profit, if the regulatory commissions will generally permit a B.t.u. standard for gas low enough so that manufacturing methods of highest thermal efficiency and therefore lowest costs can be used.

But for boiler firing, a much larger field, the problem is more

order to pay for themselves, must have a practical value in application equal to 160 per cent of that of the coal, and this they do not have as boiler fuels in the present state of the art.

O. P. Hood. Mr. Myers points out many places where there is evident waste of coal and suggests that Government interest itself in the matter. Our machinery of government has developed through an effort to minimize these wastes of human imperfection, but comparatively little governmental machinery touches the waste of natural resources and the production of energy. In fact, it has been considered wisest to leave such matters as largely as possible to the interaction of individual effort. When, however, one realizes the national significance of serious waste, it is a natural thought to invoke the power of the state to police the situation. That the Government must help in the matter of energy conservation in order to protect its own life will sometime become evident to all the people and at that time many governmental agencies can be effectively employed to save coal. At the present time it is a question as to what extent the Government can interest itself effectively in this basic question. However, one perfectly safe method with which most everyone will agree is the use of educational methods which contain no element of compulsion.

It has been the opinion in the Bureau of Mines that perhaps the greatest need and the one on which attention should first be focused is that of providing machinery whereby the coal industry may be helped to maintain a reasonable standard of quality. The Bureau of Mines proposes a fuel-inspection system which contemplates as a salient feature advice to the public as to the quality of coal as shipped. The only force depended upon to produce results is a public statement of the facts, rather than the arbitrary police power needed in time of war. For this purpose the machinery for accurate sampling of full carload lots by an impartial organization is necessary. The Government now possesses facilities for analyses and publication.

It is proposed that each mining company set its own standard of quality, consistent with the particular vein, preparation, and market which the business affords, and that the government shall publish such standard and certify as to whether such standard is being maintained by the mining companies. Such work would not replace inspection by the mining companies. It would not certify as to the quality of each and every shipment, but it would inspect and sample at irregular intervals a sufficient number of cars of coal as shipped to indicate whether the declared standard of the mining company was being maintained.

It is believed that some measure of this kind, akin to our meat and wheat inspection system, fits the public temper at the present time and would be a real help in fuel conservation without going too far in governmental contact with business.

Walter N. Polakov. We have created public-service commissions and other governmental and official bodies to supervise the functioning of our public utilities. But so far as fuel consumption goes our gas works are using only about 1 per cent and our public-utility companies about 7 per cent of the coal, which is less than that annually destroyed by beehive coke ovens alone. Also the industrial steam trade consuming 33 per cent and the railroads, who are the greatest wasters, are allowed to continue to do so quite unmolested by public opinion.

During the war we created the Fuel Administration, but we were not consistent enough to carry out the good intentions to a true, logical conclusion by denying to the reckless and incompetent plants the privilege of wasting fuel. But even half-hearted measures to meet temporary expedients taught us a bitter lesson. We all have learned how easy it is for those who know to show how to prevent a goodly part of coal which we throw away and to secure which we keep thousands of men in mining and railroad industries doing utterly useless work. Patriotic motives being rapidly forgotten, the half-billion-dollar loss in fuel is cheerfully included in the cost of production of various commodities and now we have come to repent. Of course I do not mean to say that waste of coal by manufactur rs is alone responsible for high prices and dull

Referring now to the paper by Messrs. Gilbert and Pogue, its exceptional value is due, in my estimation, to the fact that the authors clearly conceived and successfully applied to the solution of their problem all three forms of modern engineering: (1) technological, (2) economic and (3) social. Every industrial, creative problem must necessarily be studied from all these aspects, for otherwise the "abstract" engineering of a technician may prove to be either economically unsound or socially worthless.

The relative importance of form values in practice is usually obscured if not altogether disregarded because of wide divergence in economic advantages depending upon managerial ability of users of energy. Charts as prepared by Rockwell are theoretically interesting but practically misleading. Under poor management of the best-fitting and theoretically advantageous form energy it does often appear as wasteful. The electrical form of heating is inferior to gas or steam, but when management cares little as to methods of operation, electricity gives ultimately higher economy. Likewise fuel oil used under boilers is wrong from a broader economic aspect, but in practice coal is used so recklessly under either incompetent or disinterested management that fuel oil gains in popularity. In other words, the problem that must be solved in parallel with that pointed out by the authors is one of the immediate elimination of such wastes in power generation, distribution and utilization as now obscure the true significance of "form value" and stand in the way of both "integration of industry" and establishment of an "unbiased court of appeal," for otherwise its consideration will be distorted by wide variations in the degree of managerial efficiency in employing different sources of power.

G. H. Sharpe. Before the war, coal organizations, confining myself particularly to the Eastern bituminous field, started their selling organizations about April 1st, the recognized beginning of the coal year, and vigorously solicited contracts for the delivery of coal over the twelve future months. Purchasing agents for industries and railroads, however, studiously refused to enter into contracts providing for a regular flow of coal during the months of April, May, June and July, and in many cases, August, thus crowding the major portion of their demands into the months of September to March, inclusive, with all the attendant handicaps of difficulties in transportation and lowered output per miner during the winter season.

The coal operator found no reasonable market for his output during these dull months and knowing the expenses of a shutdown, turned to the middleman or broker, and he in turn drove a hard bargain for the delivery of a fixed tonnage per month over the year.

This practice has built up a brokerage class who are much wiser than the purchasing class in coal distribution and much stronger financially than the larger percentage of operators, and they have simply seized the opportunity that has been afforded them during the past year.

As engineers it is our duty to aid in the education of the coal consumers. They must buy and store coal every month in the year and they must buy and store a greater tonnage from April to September, inclusive, than during the remainder of the coal year. The larger public utilities are, as a rule, consistent in their coal purchases, but the greater number of small public-utility plants are dilatory, so that in the end all must suffer equally for the Fabian tactics of the majority. Some of the public utilities, however, are able to pass the additional cost along to the public, who, after all, are in a great measure responsible for the conditions.

Charles C. Phelps. Many engineers have no opportunity for saving fuel except in the particular plants with which they are connected. Hence it is of interest to have data for comparing results obtained in different plants. An article by David Brownlie published recently in the *Chemical Trade Journal and Chemical Engineer* gives interesting figures representative of British boiler plants. In an investigation of 250 miscellaneous plants and of 60 chemical plants, tests representative of everyday operation and

(Continued on page 38)

Power Test Codes

A.S.M.E. Committee Appointed to Formulate a Test Code for Reciprocating Steam Engines, Submits the Preliminary Draft Given Below

IN 1918 the Power Test Committee of the A.S.M.E. was reorganized to devise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, under the chairmanship of Fred R. Low, and under its direction are 19 individual committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the second of these codes to be completed, namely, the Test Code on Reciprocating Steam Engines. This Code was prepared by a committee consisting of William C. Brown, Chairman, Alexander G. Christie, Secretary, George H. Barrus, Harte Cooke, Herman Diederichs, J. F. Max Patitz, and Fred H. Vose.

This Committee will, of course, welcome suggestions for corrections or additions. These should be mailed before February 1 to the Chairman, care of The American Society of Mechanical Engineers.

Test Code on Reciprocating Steam Engines

Introduction

1 The code for steam-engine tests applies to tests for determining the performance of the engine alone (including reheaters and jackets, if any), apart from that of the independently driven auxiliaries which are necessary for its operation, and apart from that of feedwater heaters or other apparatus for reclaiming heat. For tests of an engine and independently driven auxiliaries combined with means for reclaiming heat (for example, a multiple-expansion engine from the receiver of which steam is withdrawn for heating feedwater or other purposes), the rules given in the Code for Complete Steam Power Plants should be followed.

Object

2 In accordance with the "General Instructions" the object of the test should be determined and recorded. If the object relates to the fulfillment of a contract-guarantee, an agreement should be made before the test between the interested parties concerning all matters about which dispute may arise, as noted in Par. 3 of the "General Instructions," and the points agreed upon should be stated in the Report of the Test.

Measurements

3 The measurements that must be made in a performance test of a reciprocating engine will consist of some or all of the following quantities:

(a) The cylinder diameters and stroke
(b) The volumetric clearance in per cent of the piston displacement
(c) The diameters of piston rods and tail rods
(d) The indicated horsepower
(e) The brake horsepower or shaft horsepower output
(f) The kilowatt output if engine is connected to a generator
(g) The speed in revolutions per minute
(h) The pressure in the steam pipe before the throttle
(i) The barometric pressure
(j) The percentage of moisture or number of degrees of superheat in the steam just before the throttle
(k) The back pressure in the exhaust pipe near the engine cylinder
(l) The receiver pressure
(m) The temperature of the exhaust steam leaving all cylinders
(n) The temperature of the drips if any, from jackets, reheaters and receivers.
(o) The temperature of steam leaving receivers, cylinder jackets, reheaters and similar parts
(p) The weight of return drips from jackets, reheaters and receivers
(q) The weight of the condensed steam in pounds or the weight of the water fed to boilers, less drips and leakage if the test is based on feedwater fed to boilers, less drips and leakage if the test is based on feedwater measurement
(r) The temperature of the condensed steam
(s) Engine-room temperature and outside air temperature
(t) The variation in steam pressure in the steam chest.

Instruments and Apparatus

4 The instruments and apparatus required for a performance test of a reciprocating steam engine are:

(a) Tanks and platform scales for weighing water (or water meters calibrated in place)
(b) Graduated scales attached to the water glasses of the boilers if the feedwater is measured
(c) Pressure gages, vacuum gages or mercury columns and thermometers
(d) Steam calorimeters
(e) Barometer
(f) Steam-engine indicators
(g) Planimeter
(h) Tachometer, revolution counter or other speed-measuring apparatus
(i) Friction brake or dynamometer, if available
(j) Appropriate electrical instruments if engine is connected to an electric generator.

Directions regarding the application, use, and calibration of these instruments and apparatus and statements as to their accuracy are given in Pars. Nos. ——— of the Code on Instruments and Apparatus.

Preparations

5 Before proceeding with an engine test Pars. 4 to 8 of the "General Instructions" should be carefully studied. The dimensions and the physical condition not only of the engine but of all associated parts of the plant essential to the object of the tests, should be determined and carefully recorded. The following paragraphs suggest methods by which this information may be secured if required.

Dimensions

5a The dimensions of engine cylinders should be taken when they are cold. If extreme accuracy is desired as in scientific investigations, corrections should be applied to the cold dimensions to conform to the mean working temperature. If the cylinders are much worn, the average diameter should be found. The clearance of the cylinders may be determined approximately from working drawings of the engine. For accurate work, when practicable, the clearance should be determined by the water-measurement method. To carry out this method, set the engine exactly on the center, with the piston at the end of the cylinder where the clearance is to be determined. From a quantity of water previously weighed pour enough into the clearance space by means of a funnel through some available opening, such as may be obtained by removing a steam valve in a horizontal four-valve cylinder, or through indicator cocks, until the clearance space is completely filled. By weighing the water remaining the amount necessary to fill the clearance space can be obtained, and by making the proper allowance for temperature the clearance volume may be calculated. The percentage of clearance is found by dividing the clearance volume thus found in cubic inches by the volume displaced by the piston in one stroke, also in cubic inches. Care should be taken to see whether the clearance space is so arranged that no air is retained when it is filled with water. If such pockets cannot be properly vented, this method will not give accurate results. When full, the gradual lowering of the water will show leakage by the valves or piston. Allow leakage to go on for a certain time, then from a quantity of water previously weighed pour enough into the clearance space to fill it up again, note the time it takes to do this and weigh the water remaining after filling up the clearance space. Then the weight of water from which clearance space is to be calculated (W_1) can be determined as follows:

$$W_1 = W - \frac{wT}{t - t_1}$$

Where W = weight of water filled into clearance space.
T = time to fill clearance space
t = time allowed for leakage
w = weight of water for filling space up again
t_1 = time required to fill clearance space again.

This method will give the proper correction to be subtracted if the leakage is not very great. If the leakage is too great, and the object of the test will allow it, the valves and piston rings must be put in proper condition.

The area of interior steam surfaces is all of that part of the interior of the steam cylinder, the piston head and the parts back to the valves that are exposed to the steam at the time that the exhaust valve is opened. If desired, the clearance surfaces can be calculated by subtracting from this interior steam surface the area of the circumferential walls of the cylinder from the location of the piston at the dead-end center to the location of the piston when the exhaust valve first opens.

the circulating water, steam is allowed to pass into condenser until the condensate flows out of the opening in the bottom. Then the steam is turned off the engine and careful note is taken whether or not the flow of water stops, thereby testing the tightness of the condenser. (See Par. 6a for method of testing condensers for tightness when measuring condensate.) The engine should then be blocked just beyond the head-end center, with the valves in mid-position with full steam lap, the throttle opened and the leakage weighed for each minute for fifteen minutes or a half-hour, thereby determining the rate. This operation should be repeated with the engine just beyond the crank-end center. Each of these tests gives the leakage by one steam valve, one exhaust valve and the piston. If the leakage is only nominal no further leakage tests need be made, but if the leakage is excessive its source should be determined. In any case it cannot be assumed that such tests give an exact measurement of the leakage under operating conditions. They merely indicate the degree of leakage.

5c In testing for the degree of leakage in the high-pressure cylinder of a compound engine the exhaust valves of the low-pressure cylinder, or the relief valves if they are connected to the condenser, should be opened to allow the leakage to pass. The low-pressure cylinder may be tested like that of a single-cylinder engine by admitting steam to it through the receiver and by-pass valve. Care should be taken when thus testing a compound engine that the pressure differences applied in both cylinders are approximately the same as the working pressure differences.

5d If the engine has no surface condenser, a small one can be fitted up, or the leakage condensed by letting it flow into a barrel of cold water. If the engine is reasonably tight it may be assumed that the leakage should not exceed one-tenth of a pound per rated horsepower per hour, or one per cent of full-load steam consumption, so that the capacity of the small condenser or barrel of cold water need not exceed this amount.

5e A method of testing for the degree of leakage of valves and pistons by observation in a four-valve engine, or an engine in which the admission valves can be worked by hand independently of the exhaust valves, is as follows: The engine is turned until the piston is about mid-stroke. The two steam valves are closed, the two indicator cocks are opened, and the full pressure of steam is admitted into the chest by opening the throttle valve. The starting bar is then moved first one way and then the other, closing first one and then the other exhaust valve, and the degree of leakage by the steam valves can be roughly judged by the force of the steam coming out of the indicator cocks. To test the exhaust valves and piston, the flywheel is blocked so that the piston will be at a short distance from the end of the stroke, and the steam is turned on. The leakage then escapes to the exhaust pipe, and can be observed at the open atmosphere outlet. If the outlet is not visible and there is a valve in the exhaust pipe, this can be shut and the indicator cock on the opposite end of the cylinder opened, thereby diverting the steam which leaks and causing it to appear at the indicator cock. In a condensing engine where no atmospheric exhaust is provided, and where there is no opening that can be made in the exhaust pipe between the engine and the condenser, some idea can be obtained in regard to the amount of leakage by observing how rapidly the condenser is heated. It is well to make these tests with the piston in different positions, so as to cover the whole range of the length of the stroke.

5f Another method of testing for the degree of leakage is called the "time method." Instead of observing the steam that actually blows past the valves or piston to be tested, they are subjected to full steam pressure, and when the parts are thoroughly heated, the throttle valve is shut and the length of time which is required for the pressure to disappear is observed. In testing the piston and exhaust valves, the flywheel is blocked as before, and, preferably, an indicator is attached, and lines drawn on a blank card at intervals of, say, one-quarter of a minute after the valve is shut, thereby making a record of the fall of the pressure. In a tight engine the fall of the pressure is slow, whereas in a leaky engine it is sometimes very rapid. The relative condition of the engine under test as compared with a tight engine must be judged by the observer, who must, of course, have had experience in tests of this kind on engines in various conditions. The leakage of a piston may be determined by removing the cylinder head, after first blocking the engine, and observing what blows through the open end with the pressure of steam behind it. The advantage of the time-method is that it saves the labor and time required in removing the cylinder head and replacing it, which, in the case of large engines, is considerable.

5g Leakage tests of single-valve engines cannot be made as satisfactorily as those of the four-valve type. The best that can be done as regards the valve is to place it at or near the center of its travel, covering both ports, and then make the test under full pressure. The valve and piston can be tested as a whole by blocking the flywheel and opening the throttle valve in the same way as in the other engines.

5h In testing compound engines for the degree of leakage the work is somewhat simplified, as compared with a simple engine. For example, leakage of the high-pressure cylinder can be revealed by opening the indicator cock on the proper end of the low-pressure cylinder, the steam valve of that cylinder being open. The test of leakage of the low-pressure exhaust valve and piston when the time method is used may be based on the indication of the receiver gage, instead of using an indicator. In that case the fall of the pressure due to leakage is read directly from the gage.

5i In four-valve engines the degree of leakage of the piston with the there is no chance for leakage, this is sufficient. For example, where a straight-way valve is used for cutting off a connecting pipe, and this valve has double seats with a hole in the bottom between them, this being provided with a plug or pet cock, assurance of the tightness of the valve when closed can be had by removing the plug or opening the cock. Likewise, if there is an open drip pipe attached to an unused or empty section of pipe beyond the valve, the fact that no water escapes here is sufficient evidence of the tightness of the valve. The main thing is to have positive evidence in regard to the tightness of the connections, such as may be obtained by the means suggested above. But where no positive evidence can be obtained, or where the leakage that occurs cannot be measured, it is of the utmost importance that the connections should be broken and blanked off. Leakage of relief valves which are not tight, drips from traps, separators, etc., and leakage of tubes in the feedwater heater must all be guarded against or measured and allowed for. It is well as an additional precaution to test the tightness of the feedwater pipes and apparatus concerned in the measurement of the water by shutting the feed valves at the boilers, making sure that they are tight, and turning steam on to the feed pump. If there is no leak the pump can run only as fast as is permitted by its own slippage. Leakage will be revealed by disappearance of water from the supply tank. A gage should be placed on the pump discharge to guard against undue or dangerous pressure.

5k To determine the leakage of steam and water from boiler, steam pipes, etc., up to engine throttle valve, the water-glass method may be satisfactorily employed. This consists of shutting off all the feed valves (which must be known to be tight), including the main feed valve, thereby stopping absolutely the entrance or exit of water through the feed pipes to or from the boiler; then maintaining the steam pressure in boiler and steam lines (by means of a very slow fire) up to a fixed point, which is approximately that of the working pressure, and observing the rate at which the water falls in the gage glasses. It is well, in this test, as in other work of this character, to make observations every ten minutes, and to continue them for such length of time that the differences between successive readings become constant. In many cases the conditions will have become constant at the expiration of fifteen minutes from the time of shutting the valves. In boilers with much brickwork, especially if run at a high rate, it will be several hours before pressure conditions become constant and safety valves stop popping. Thereafter the fall of the water level due to leakage of steam and water becomes approximately constant. It is usually sufficient, after this time, to continue the test for two hours, thereby obtaining a number of half-hourly periods. When this test is finished, the quantity of leakage is ascertained by calculating the volume of water which has disappeared, using the area at the water level and the depth shown on the glass, and multiplying by the weight of one cubic foot of water at the temperature observed. The water columns should not be blown down during the time a water-glass test is going on, nor for a period of at least one hour before it begins. If there is opportunity for condensation to occur and collect in the steam pipe during the leakage test, the quantity should be determined as closely as possible and properly allowed for.

6 *Steam Consumption.* The steam consumption of an engine equipped with a surface condenser should be determined by measuring the condensate from the condenser, assurance being obtained that all the steam entering the cylinders passes into the condenser. If the condenser leaks, the defects causing the leaks should be remedied or suitable corrections should be made. The water of condensation from jackets and heaters, if not included in the condensate, should be weighed separately and added thereto. If a surface condenser is not available, the steam consumption should be determined by feedwater tests, which require the measurement of the various supplies of water fed to the boiler, of the water wasted by separators and drips on the main steam line, of the steam used for other purposes than the main engine cylinders, and of water and steam which escape by leakage from the boiler and piping. All of these last quantities must be determined and be deducted from the total measured feedwater supplied to the boiler. The heat consumption is determined from the steam consumption as pointed out in Par. 12.

6a In making an engine test where the steam consumption is determined from the amount of water discharged from a surface condenser, leakage of the piston rods and valve rods should be guarded against; for if this is excessive, the test is of little use, as the leakage consists partly of steam that has already done work in the cylinder and partly of water condensed from the steam in contact with the cylinder. Leakage of the condenser itself may be determined by operating the condenser under vacuum when all steam from the engine is shut off, and observing the rate at which the water, if any, is discharged by the condensate pump. When salt water is used for circulating water, leakage may be determined by testing the condensate with silver nitrate or by some other suitable method such as the conductivity bridge or the Dionic tester. If a few drops of solution of silver nitrate added to a sample of condensate produce a white precipitate, the presence of salt water is indicated.

6b When no other method is available, the steam consumption may be determined approximately by the use of a steam meter calibrated under the conditions of use.

6c The steam consumed by independently driven auxiliaries which are required for the operation of the engines should not be included in the total steam from which the steam consumption is calculated. These should be supplied from a separate boiler, if possible, if the steam consumption is determined by the measurement of feedwater.

6d The steam consumption of auxiliaries may be determined approximately by the water-glass test, as described in Par. 5k.

Operating Conditions

7 The operating conditions conforming to the object in view should prevail throughout the trial, as pointed out in Par. 19, of the "General Instructions."

Starting and Stopping

8 The engine and appurtenances should first be thoroughly heated and run under the prescribed conditions until uniformity is secured. If the period to be covered by the test includes the time employed in warming up a cold engine, as in the practice of many industrial plants, the preliminary heating should be omitted, and the conditions should all conform to the usual operations.

8a When a surface condenser is used, the test should start by commencing to weigh or measure the condensate and any other quantities of steam consumption involved, at the same time beginning the regular observations and other necessary test work. At the end of the allotted time the test is stopped by discontinuing the measurements and observations. When feedwater measurements are employed, the test should be started by carefully observing the steam pressure and water level in the boiler, and the level in the feed tank, if measuring tanks are used, at the same time beginning the water measurements and taking up the regular work of the test. At the end of the prescribed time, the water levels and steam pressure should be brought as near as practicable to the same points as at the start, and the observations discontinued. If there are differences in the water levels or pressure, proper corrections must be applied to the water measurements.

8b When feedwater measurements are employed care should be taken in cases where the activity of combustion affects the height of water, that the same conditions of fire and draft are secured at the end as at the beginning. Care should also be observed to note the average height of water in the glass when the water line fluctuates.

Duration

9 When surface-condenser measurement is employed and the load is substantially constant, the test should be continued for such time as may be necessary to obtain a number (not less than three) of successive half-hourly records during which the results are reasonably uniform. When the steam consumption is determined by measuring the feedwater supplied to the boiler, the run should be as long as the operating conditions permit. For accurate results the duration of such a test should be at least five hours.

9a When the conditions determined upon are such that the load varies widely at different times, the duration should be such as to cover at least the entire period of variation.

Records

10 The general data should be recorded as pointed out in Pars. 20 to 30 of the "General Instructions." Instruments should be read and indicator cards taken from each end of each cylinder at least quarter-hourly when the conditions are uniform and oftener when there is much variation. If there are wide fluctuations in readings they should be shown by recording instruments. Each indicator card should be marked with the number, date, time, scale of spring and end of cylinder, and on one card of each set the readings of the steam gages should be recorded. The log should contain the record of the readings of steam and vacuum gages, thermometers, calorimeters, speed indicator, load-measuring devices, and all other instruments, and these readings should be obtained at practically the same time the indicator cards are taken. The areas, lengths, mean effective pressures, and cut-offs shown by the indicator cards, should also be entered in the log. If complete test data are desired, representative steam-pipe diagrams should be taken with an indicator applied near the throttle-valve gage and operated by connection to the reducing motion of the cylinder indicators.

10b A set of specimen indicator diagrams should be carefully selected from the whole number taken, and these should be embodied in the record. The specimen cards selected should be such as to show the average conditions of pressure and cut-off. If steam-pipe diagrams are obtained, specimens of these should also be placed in the record.

Calculation of Results

11 *Steam Consumption.* Whether the engine is supplied with wet, dry and saturated, or superheated steam, the actual steam consumption is stated in the report of the test. When the engine is supplied with wet steam, the quantity of dry and saturated steam comprised in the wet steam is found by deducting from the total weight of steam as measured the moisture as shown by a calorimeter near the throttle. Superheated steam requires no correction. The "equivalent steam" consumed corresponding to any desired or specified set of conditions as to moisture, superheat, pressure, and vacuum which differ from the conditions of the test —such, for example, as those required by a contract guarantee or acceptance test—should be determined in the manner previously agreed upon by the interested parties in accordance with Par. 3 of the "General Instructions." (See Code on Definitions and Values, Par. 93.)

11a In view of the fact that "dry saturated steam" is practically unobtainable commercially and that the presence of moisture is detrimental to the economy of the engine to a greater degree than the amount present in the steam would indicate, arbitrary corrections (referred to in Par. 11 above) for correcting the actual steam consumption for quality are to be used in arriving at a value of "Equivalent Steam."

12 *Heat Consumption.* The number of heat units consumed by an engine per hour is found by multiplying the consumption, as measured in pounds of steam per hour, by the difference between the total heat in one pound of steam at the average pressure and of the average quality found in the steam pipe near the throttle and the heat in one pound of water at the temperature of saturated steam at the average pressure existing in the exhaust pipe near the cylinder.

13 *Indicated Horsepower.* The indicated horsepower for each end of the cylinder is found by using the formula

$$\text{I.hp.} = \frac{P\,L\,A\,N}{33{,}000}$$

where P represents the mean effective pressure in pounds per square inch, L the length of the stroke in feet, A the area in square inches of the piston less the area of the piston rod, if any, and N the number of revolutions per minute. The total horsepower of the cylinder is the sum of the horsepower developed in the two ends.

13a The mean effective pressure should be found by dividing the area of the diagram in square inches as determined with a correct planimeter, by the length of the diagram in inches, and multiplying the quotient by the average corrected scale of the indicator spring. If a planimeter is not available, the approximate mean effective pressure may be determined by finding the average height of the diagram in inches as obtained by averaging a suitable number of ordinates, at least ten, measured between the lines of the forward and return strokes, and then multiplying this average by the scale of the spring.

14 *Brake Horsepower.* The brake horsepower is found by multiplying the net pressure or force W in pounds on the brake arm —that is, the gross pressure minus the weight when the brake is entirely free from the pulley—by the circumference of the circle whose radius is the horizontal distance L in feet between the center of the shaft and the bearing point at the end of the brake arm, and by N the number of revolutions of the brake shaft per minute, and dividing the final product by 33,000.

$$\text{B.hp.} = \frac{2\,\pi\,LWN}{33{,}000}$$

See Code on Instruments and Apparatus for descriptions and methods of applying brakes.

15 *Electrical Horsepower.* The electrical horsepower of a generator is found by dividing the output at the terminals expressed in kilowatts by the constant 0.7457. In the case of an alternating-current generator the quantity of output determined, whether expressed in electrical horsepower or kilowatts, should be the net output. When the power for excitation or ventilation is taken directly from the engine shaft, the net output is that indicated at the a.c. generator terminals. When this power is taken from the a.c. generator through a motor or from some outside source, the net output is found by deducting the current furnished as excitation from that indicated at the terminals.

16 *Thermal Efficiency.* The proportion of the total heat consumption which is converted into work is called the "thermal

efficiency in per cent. The formula is

$$\text{Thermal Efficiency} = \frac{2547}{w\ (H_1 - q_2)}$$

where w = pounds of steam as supplied per i.hp-hr.

H_1 = total heat above 32 deg. per pound of steam at the initial conditions prevailing before throttle valve.

q_2 = heat of liquid above 32 deg. in one pound of water at the temperature of saturated steam at exhaust pressure.

17 *Engine Efficiency.* The engine efficiency is the ratio obtained by dividing the heat equivalent of the actual work done by the heat available for an ideal engine. The accepted standard for the ideal steam engine is the Rankine cycle (Code on Definitions and Values, Par. 89). The engine efficiency is obtained by the following equation:

$$\text{Engine Efficiency (referred to i.hp.)} = \frac{2547}{w\ (H_1 - H_2)}$$

where w = pounds of steam per i.hp-hr.

H_1 = total heat above 32 deg. per pound of steam at the initial conditions prevailing before the throttle valve

H_2 = total heat above 32 deg. per pound of steam after adiabatic expansion from initial conditions to the final pressure.

H_1 and H_2 can be found from any Total Heat-Entropy diagram. $(H_1 - H_2)$ is the heat available for work.

18 *Nominal Cut-Off.* The nominal cut-off can be found in the following manner from an indicator card: Through the point of maximum pressure during admission a line is drawn parallel to the atmosphere line. Then through a point near the top of the expansion line where the cut-off is complete, a hyperbolic curve is drawn. The intersection of these two lines is the point of nominal cut-off, and the proportion of cut-off is found by dividing the length measured on the diagram up to this point by the total length, as shown in Fig. 1.

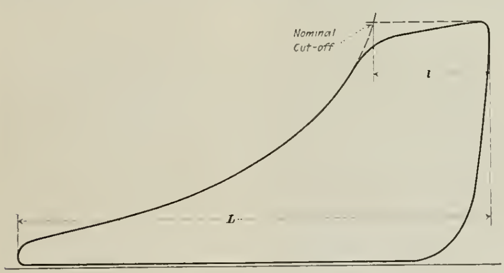

Fig. 1

Note.—The method of calculating the steam accounted for by the indicator card has been omitted for the following reasons:

(*a*) It is not essential to a performance test of an engine;

(*b*) As this method does not even approximate the actual steam consumption of an engine, it is liable to be misleading unless thoroughly understood.

19 *Throttle Pressure.* The throttle pressure, or the average pressure in the steam pipe just before the throttle, is that shown by a corrected steam gage attached at the desired point, the fluctuations of which are reduced so far as may be by choking the gage cock. When extreme accuracy is desired or when the fluctuations are large the average pressure may be found by working up the steam-pipe diagram taken at or near the same point and finding the mean pressure for the entire stroke, during the periods of admission. The superheat or quality of the steam supplied should be measured in the steam supply pipe before the throttle valve.

19a In the case of guarantee tests of capacity, if so agreed upon, the throttle pressure may be taken as the minimum pressure shown on an indicator diagram taken from the steam pipe near the throttle.

the form (Table 1) given herewith, adding lines for data not provided for, or omitting those not required, as may conform to the object in view. If the principal data and results pertaining to steam consumption only are desired, the subjoined abbreviated table (Table 2) may be used. Unless otherwise indicated, the items should be the averages of all observations.

See Note 1 of Table 1 for references to engines driving electric generators and other machinery.

TABLE 1 DATA AND RESULTS OF RECIPROCATING STEAM-ENGINE TEST

(*A.S.M.E. Code of 1920; Long Test*)

General Information

(1) Date of test ....
(2) Location ....
(3) Owner ....
(4) Builder ....
(5) Test conducted by ....
(6) Object of test ....

Description, Dimensions, etc.

(7) Type of engine (simple or multiple expansion) ....
(8) Class of service (mill, marine, electric, etc.) ....
(9) Auxiliaries (steam or electric drive) ....
(10) Type and make of condenser equipment ....
(11) Rated capacity of condenser equipment ....
(12) Type of oil pump, jacket pump, and reheater pump (direct or independently driven) ....
(13) Rated power of engine ....
(14) Kind of valves ....
(15) Type of governor ....

		First	Second	Third
(16)	Diameter of cylinders	in.	in.	in.
	(*a*) Diameter of piston and tail rods	in.	in.	in.
(17)	Stroke of pistons	in.	in.	in.
(18)	Clearance volume in per cent of piston displacement			
	(*a*) Clearance head end	in.	in.	in.
	(*b*) " crank end	in.	in.	in.
	(*c*) " average	in.	in.	in.

(19) Head end hp. constant (stroke × net piston area ÷ 33000) ....
(20) Crank end hp. constant (stroke × net piston area ÷ 33000) ....
(21) Cylinder ratio (based on net piston displacement), 1 to ....
(22) Area of interior steam surface .... sq. ft.
(23) Area of jacketed surfaces .... sq. ft.
(24) Capacity of generator or other apparatus consuming power of engine .... hp. or kw.

Test Data and Results

(25) Duration of test .... hr.

Average pressures

(26) Barometric pressure .... in. of mercury .... lb. per sq. in.
(27) Pressure in steam pipe near throttle by gage .... lb. per sq. in.
(*a*) Corresponding absolute pressure .... lb. per sq. in.
(*b*) Minimum pressure above atmosphere, steam-pipe diagram near throttle .... lb. per sq. in.
(*c*) Minimum pressure above atmosphere, steam-pipe diagram near throttle .... lb. per sq. in.
(28) Pressure in 1st receiver, by gage .... lb. per sq. in.
Corresponding absolute pressure .... lb. per sq. in.
(29) Pressure in 2nd receiver, by gage .... lb. per sq. in.
Corresponding absolute pressure .... lb. per sq. in.
(30) Pressure or vacuum in exhaust pipe near engine by mercury column .... in of mercury
(*a*) Corresponding absolute pressure .... lb. per sq. in.
(31) Pressure in jackets and reheaters .... lb. per sq. in.

Temperatures

(32) Engine-room temperature .... deg. fahr.
(33) Temperature of steam near throttle .... deg. fahr.
(34) Temperature of saturated steam at throttle pressure .. deg. fahr.
(35) Temperature of steam if superheated:
(*a*) Entering 1st receiver .... deg. fahr.
(*b*) Leaving 1st receiver .... deg. fahr.
(36) Temperature of steam if superheated:
(*a*) Entering 2nd receiver .... deg. fahr.
(*b*) Leaving 2nd receiver .... deg. fahr
(37) Temperature of saturated steam corresponding to pressure in exhaust pipe near engine .... deg. fahr.
(38) Temperature of steam in exhaust pipe, as observed ... deg. fahr.

Quality of Steam at Throttle

(39) Number of degrees of superheat .... deg. fahr.
(40) Percentage of moisture in steam .... per cent

Total Quantities

(41) Total steam consumed by engine, as measured (see Par. 6)...lb.
(42) Total dry and saturated steam or superheated steam consumed (Par. 11)...lb.
(43) Correction factor conforming to conditions agreed upon (See Pars. 11 and 11a)...
(44) Equivalent total steam consumed, conforming to conditions agreed upon (Item 41 × Item 43)...lb.

Hourly Quantities

(45) Steam consumed per hour as measured (Item 41 ÷ Item 25...lb.
(46) Dry and saturated steam or superheated steam consumed per hour (Item 42 ÷ Item 25)...lb.
(47) Equivalent steam consumed per hour conforming to conditions agreed upon (Item 44 ÷ Item 25)...lb.

Heat Consumption

(48) Total heat above water at 32 deg. fahr. per lb. of steam at throttle...B.t.u.
 (a) Heat of liquid at temperature of steam at exhaust pressure...B.t.u.
 (b) Heat supplied per pound of steam...B.t.u.
(49) Heat consumed per hour (See Par. 12)...B.t.u.
(50) Heat available for work per lb. of steam, from adiabatic expansion between initial conditions and final pressure according to Rankine cycle (See Par. 17)...B.t.u.

Indicator Diagrams 1st Cyl. 2d Cyl. 3d Cyl.

(51) Nominal cut-off...per cent
(52) Mean effective pressure (avgr.)...lb. per sq. in.
(53) Maximum pressure above atmosphere...lb. per sq. in.
(54) Absolute back pressure at lowest point...lb. per sq. in.

Speed

(55) Revolutions per minute...r.p.m.
 (a) Variation of speed between no load and full load...per cent
 (b) Momentary fluctuation of speed on suddenly changing from full load to half load...per cent
(56) Piston speed...ft.p.m.

Power

(57) Indicated horsepower developed by whole engine...i.hp.
(58) 1st cylinder, crank end...i.hp.
 head end...i.hp.
(59) 2d cylinder, crank end...i.hp.
 head end...i.hp.
(60) 3d cylinder, crank end...i.hp.
 head end...i.hp.
(61) Brake horsepower developed by whole engine...b.hp.
(62) Friction of engine Item 57 — Item 61...hp.
(63) Percentage of friction (Item 62 ÷ Item 57) × 100...per cent
(64) Indicated horsepower with no load at normal speed...i.hp.
(65) Mechanical efficiency (Item 61 ÷ Item 57) × 100...per cent

Economy Results

(66) Steam consumed per i.hp-hr. as measured (Item 45 ÷ Item 57)...lb.
(67) Dry saturated or superheated steam consumed per i.hp-hr. (Item 46 ÷ Item 57)...lb.
(68) Equivalent steam consumed per i.hp-hr. conforming to conditions agreed upon (Item 47 ÷ Item 57)...lb.
(69) Steam consumed per b.hp-hr. as measured (Item 45 ÷ Item 61)...lb.
(70) Dry and saturated steam or superheated steam consumed per b.hp-hr. (Item 46 ÷ Item 61)...lb.
(71) Equivalent steam consumed per b.hp-hr. conforming to conditions agreed upon (Item 47 ÷ Item 61)...lb.
(72) Heat consumed per i.hp-hr. (Item 49 ÷ Item 57)...B.t.u.
(73) Heat available according to Rankine cycle per i.hp-hr. (Item 50 × Item 66)...B.t.u.
(74) Heat consumed per b.hp-hr. (Item 49 ÷ Item 61)...B.t.u.
(75) Heat available according to Rankine cycle per b.hp-hr. (Item 50 × Item 70)...B.t.u.

Efficiency Results

(76) Thermal efficiency referred to i.hp. (2547 ÷ Item 72) × 100...per cent
(77) Thermal efficiency referred to b.hp. (2547 ÷ Item 74) × 100...per cent
(78) Engine efficiency (referred to Rankine cycle) based on i.hp. (2547 ÷ Item 73) × 100...per cent
(79) Engine efficiency (referred to Rankine cycle) based on b.hp. (2547 ÷ Item 75) × 100...per cent

Specimen Diagrams

(80) Sample diagram from each cylinder...
(81) Sample steam-pipe diagram...

Note 1: When the engine drives an electric generator the following additional data and results applicable especially to a.c. generators should be entered in the table.

Electrical Data

(82) Average volts each phase...volts
(83) Average amperes each phase...amp.
(84) Power factor...per cent
(85) Total output in kilowatts...kw.
(86) Net output in kilowatts (See Par. 15)...kw.
 (a) Field volts...
 (b) Field amperes...

Power and Economy

(87) Electrical horsepower developed (Item 86 ÷ 0.7457)...
(88) Steam consumed per net kw-hr. (Item 45 ÷ Item 86)...lb.
(89) Dry and saturated steam or superheated steam consumed per net kw-hr. (Item 46 ÷ Item 86)...lb.
(90) Equivalent steam consumed per net kw-hr. (Item 47 ÷ Item 86)...lb.
(91) Heat consumed per net kw-hr. (Item 49 ÷ Item 86)...B.t.u.

Note 2: When testing a marine engine having a shaft dynamometer, the form should include the data obtained from this instrument, in which case the brake horsepower becomes the shaft horsepower.

TABLE 2 DATA AND RESULTS OF RECIPROCATING STEAM-ENGINE TEST

(*Short Test*)

(1) Dimensions of cylinders...
 (a) Diameter of piston and tail rods...
(2) Date...
(3) Duration...hr.
(4) Pressure in steam pipe near throttle by gage...lb. per sq. in.
(5) Pressure in receivers by gage...lb. per sq. in.
(6) Vacuum in condenser...in. mercury
(7) Percentage of moisture in steam near throttle or number of degrees of superheat...per cent or deg. fahr.
(8) Total steam consumed per hour...lb.
(9) Total dry and saturated steam of superheated steam consumed per hour...lb.
(10) Equivalent steam consumed conforming to conditions agreed upon per hour...lb.
(11) Average mean effective pressure in each cylinder..lb. per sq. in.
(12) Revolutions per minute...r.p.m.
(13) Indicated horsepower developed...i.hp.
(14) Steam actually consumed per i.hp-hr...lb.
(15) Dry and saturated steam or superheated steam consumed per i.hp-hr...lb.
(16) Equivalent steam consumed per i.hp-hr. conforming to conditions agreed upon...lb.
(17) Engine efficiency (referred to Rankine cycle based on i.hp.) ...per cent

New Process of Steel Manufacture

A company has been incorporated at Etamps, 50 miles south of Paris, for the commercial exploitation of a patented process for manufacturing steel directly from the ore using an inclined rotating furnace similar to that employed in the manufacture of cement.

In this process—the Basset—the ore is charged at the upper end and works its way toward the lower end as the furnace slowly revolves—at the rate of one revolution in three minutes. Pulverized coal is used for fuel. The air which supports the combustion is previously heated about 1000 deg. cent. in a regenerator similar to that connected with an open-hearth furnace. The temperature of the gases as they leave the furnace is said to be 300 deg. cent. and by the nature of the process these gases contain 44 per cent carbon monoxide. This gas of course may be used for heating purposes. The slag is tapped off the top of the metal which is poured into the ingot molds.

It is claimed that three qualities of metal have been produced, including pig iron of a grade between gray and white, hard steel, and malleable iron. These results are obtained by varying the ore charge and the temperature of the process.

It is stated that since the first experiments at the Lavocat Usine at Dennemont, 2000 tons of iron have been produced by this process at Longwy. It also is stated that the Hauts Fourneaux de Caen has produced 500 tons. In the latter district it is now planned to erect a battery of furnaces with a capacity of 2000 tons per 24 hr.

American engineers, says *The Iron Trade Review* of November 11, 1920, will be struck with the similarity between this process and the Jones step process which was the subject of extensive trials at Marquette, Mich., over a decade ago. In view of the utter commercial failure of the Jones process, the progress of the French experiments will be watched with interest.

Notable Session on Transportation—Professional Sessions Interested Large Numbers of Membership—Brashear Memorial Meeting—Record Attendance

THE Forty-first Annual Meeting of The American Society of Mechanical Engineers had the distinction of being the richest in professional program of any meeting held by the Society. To this the newly formed Professional Sections contributed greatly. Their coöperation with the Committee on Meetings and Program in the carrying out of their several sessions prophesies a great future for the professional and technical activities of the Society. In fact, the organization of Professional Sections and the consequent quickening of the technical life of the Society is a step that well accompanies the formation of The Federated American Engineering Societies with its avowed purpose of dedicating the organization to service. To be of service the technical society must be intensively organized technically, and the Professional Sections fill this requirement in The American Society of Mechanical Engineers.

In the arrangement of general Professional Sessions this year no more than three papers were assigned to any session. This arrangement coupled with the adoption of limiting times for the presentation and discussion of these papers, insured more completely the carrying on of the meeting according to schedule and still permitted adequate time for the discussion of each paper. This arrangement, however, is subject to change and members are requested to send in to the Secretary any comments or criticisms of the new rules or the new arrangement of sessions.

The meeting formally opened on Tuesday, December 7, and contrary to the usual procedure, three sessions were held Tuesday afternoon. On Monday, however, the Local Sections' delegates gathered for their annual conference, which proved of great value as a meeting place for the discussion of Local Sections' problems and for the advancement of new ideas in Society policy. A more complete account of the Local Sections' Conference will be given in Part Two of the February issue.

The social functions consisted of the Presidential Reception on Tuesday evening, and the Ladies' Reception, Tea and Dance on Thursday afternoon. Thursday evening being left open for other than Society activities, a number of technical schools availed themselves of the opportunity for Reunion Meetings. The most notable of these was the meeting of the New York Alumni of Worcester Polytechnic Institute in honor of Governor-Elect Lake of Connecticut.

Wednesday evening was devoted to a memorial meeting in honor of the late Dr. John A. Brashear, Past-President of the Society. Mr. Worcester R. Warner, after a few words bearing on his intimate connection with Doctor Brashear, introduced the orator of the evening, Dr. Henry S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching. An abstract of Dr. Pritchett's address, entitled John Alfred Brashear, Humanitarian and Man of Science, is printed on page 39 of this issue.

Only one formal excursion was organized, the studio of the Metro Picture Corporation being visited. Small groups of members, however, were conducted to points of interest throughout New York City.

Registration totaled 2171, of whom 1368 were members and 803 guests—from twenty-nine states, Canada and France. This number exceeded last year's attendance, which was the largest previously recorded.

EDWIN S. CARMAN PRESIDENT, 1921
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Presidential Address and Reception

The meeting was formally opened on Tuesday evening with President Miller's address on The Engineer's Service to Society, which appears as the first article in this issue. Following the presidential address, honorary memberships were conferred upon the following men:

Captain Robert Woolston Hunt, of Chicago, Ill., Past-President of the Society and John Fritz Medallist, for his life-long and eminent achievements in the field of engineering, and particularly in connection with the steel industry;

Rear-Admiral Robert Stanislaus Griffin, of Washington, D. C., for his signal contributions to the engineering work of the naval forces of the United States during the World War;

Dr. Samuel Matthews Vauclain, of Philadelphia, Pa., Past-Vice-President of the Society, for his many important contributions to the mechanical engineering of the steam locomotive;

Honorable Sir Charles Algernon Parsons, of London, England, for his valuable contributions to the development and construction of the steam turbine which has now become an essential prime mover;

Lord William Weir, of Glasgow, Scotland, for his energy and genius in the organization of war work in the British Isles, and particularly as Director-General of Aircraft Production in the Ministry of Munitions; and

Grande Ufficiale Ingegnere Pio Perrone, of Genoa, Italy, for the unselfish devotion of his engineering and manufacturing skill to the cause of his country in the World War.

The first three recipients were present; official documents of honorary membership will be conveyed to the others through the American ambassadors in their respective countries.

The report of the tellers of election was presented by Dr. H. G. Tyler, who announced the election of officers for the ensuing year as follows: *President*, Edwin S. Carman, Cleveland, Ohio; *Vice-Presidents*, Leon P. Alford, Montclair, N. J., J. L. Harrington, Kansas City, Mo., and Robert B. Wolf, New York, N. Y.; *Managers*, Henry M. Norris, Cincinnati, Ohio, Louis C. Nordmeyer, St. Louis, Mo., and C. C. Thomas, Los Angeles, Cal.

President-Elect Edwin S. Carman was escorted to the platform by James Hartness, Governor-Elect of Vermont and Past-President of the Society, and Ira N. Hollis, Past-President of the Society. President Miller was welcomed to the past-presidency and back to

the membership of the Society by Governor Hartness and the new president was welcomed by Major Miller, who spoke of the services rendered by Mr. Carman as president of the Cleveland Engineering Society and as Chairman of the Local Sections Committee.

In acknowledging his election, Mr. Carman spoke briefly of the manner in which engineers should deal with professional matters, pointing out and emphasizing the fact that engineers, more than any other body of men, cannot attain satisfactory results without getting at the truth of every problem. The same accuracy which he must observe in designing a machine, Mr. Carman said, should be applied to every problem which the engineer undertakes.

Following these ceremonies the Presidential Reception was held and the remainder of the evening was devoted to dancing.

Business Meeting

President Fred J. Miller opened the Business Meeting on Wednesday morning with a few remarks on the growth of the Society, its participation in matters affecting the public welfare, especially its support of The Federated American Engineering Societies, and restrictions necessitated by increased costs. Reports of the various Standing and Special Committees of the Society were then presented by title by Secretary Rice. An abstract of these reports will be found in Section Two of this issue of Mechanical Engineering. The importance of the work of these committees was brought out by Secretary Rice.

The first report to be discussed was that of the Code of Ethics Committee. Prof. A. G. Christie, chairman of this committee, read the report and moved its adoption. The discussion which followed centered around the phraseology of the code, its purpose, and whether it should be the product of one man, a committee, or such an organization as The Federated American Engineering Societies. It was felt by many that the wording and style of the code should be changed so that it would be free from any possible criticism as to its English. A code so important, it was pointed out, should be couched in the purest possible language. There seemed to be considerable discussion, also, as to whether or not the purpose of the code was clearly understood. Several expressed the opinion that the code was not necessary as a guide for engineers, but should be a declaration of principles or a guide to the public as to what might be expected from the engineers in this and other societies. It was further suggested that the code should be an Engineers' Code, applicable to all engineers, rather than to mechanical engineers alone. It would thus become a creed for all engineers, a statement of their ideals, a standard for them in their work and at the same time a pledge to the public.

It was thought by some that a better code could be formed by one person, and the names of Felix Adler, an expert on the subject of ethics, Herbert Hoover and General Wood, for their knowledge of engineering, and President Wilson, for his mastery of the English language, were suggested as men to whom the code might be submitted for revision. Others felt that if the code were to apply to all engineers it might best be framed by the newly organized Federated American Engineering Societies, but it was argued that it might be some time before this body would be ready to consider codes and that in the meantime, both as a matter of courtesy to the committee which had drafted the code and as a means of keeping the work alive, the code should be referred back to the committee.

The motion which was finally carried was that the report be referred back to the committee for such action as they might deem wise, either for the modification of the code itself, for conference with other societies, or for the purpose of submitting the recommendations of the committee to The Federated American Engineering Societies. Professor Christie closed the discussion with the hope that further criticisms of the code would be sent to the committee.

Secretary Rice stated that the reports read by title should be discussed by correspondence. Among these he named the reports of the special committee on Standard Tonnage Basis for Refrigeration, Fluid Meters, and Bearing Metals; the special committee on Industrial Engineering; committee on Power Test Codes (General Instructions); special committee on Weights and Measures; special committee on Feedwater Heater Standardization; committee on Education and Training; and the committee on Awards and Prizes.

Professor H. S. Philbrick, secretary of the Sections Conference, read the report of that Conference, at which it was voted that junior members shall not be given the voting privilege in Society affairs, and the following names for the 1921 Nominating Committee were presented: Elmer Smith, Boston, Mass.; G. K. Parsons, New York; W. W. Varney, Baltimore, Md.; B. S. Hughes, Buffalo, N. Y.; W. M. White, Milwaukee, Wis.; F. E. Bausch, St. Louis, Mo.; and E. O. Eastwood, Seattle, Wash. The report was adopted.

F. E. Matthews, president of the American Society of Refrigerating Engineers, read the report on the Standard Tonnage Basis for Refrigeration. This report has been adopted by the joint committee of the Mechanical Engineers and Refrigerating Engineers, and by the American Society of Refrigerating Engineers itself. The report was referred back to the committee, to be presented at the next Council Meeting and brought up again at the Spring Meeting of the Society.

The meeting closed with the award of the Student Prize, details of which will be found elsewhere in this issue.

The meeting was adjourned until Friday afternoon for the presentation of two amendments to the Constitution, the report of the delegates to the American Engineering Council, and a statement on Appraisal and Valuation by Mr. James R. Bibbins, but unfortunately, when Friday afternoon came, no quorum could be obtained and no meeting was held.

DISCUSSION AT FUEL SESSION

(Continued from page 31)

not ideal conditions showed that over 60 per cent of the miscellaneous plants and 50 per cent of the chemical plants had an efficiency of less than 60 per cent. Analyses of the flue gases in these same plants showed that over 40 per cent of the chemical plants and over 65 per cent of the miscellaneous industrial plants had a very poor combustion efficiency, with less than 8 per cent of carbon dioxide present in the gas.

An estimate of efficiency and heat losses in the average boiler plant in the United States, reproduced in Technical Paper No. 205 of the Bureau of Mines, showed only a 57 per cent efficiency. A study of the situation shows that the efficiency should be increased to at least 67 per cent. Many authorities agree that the average efficiency may safely be considered as not over 60 per cent, leaving a large margin for possible saving in the average plant.

Willis Lawrence. The operator of the modern power house, even if he is familiar with the technical features of conservation, has little time to devote to experiments and tests to develop and maintain an efficient system of firing, so that the burning of fuel is not, as a rule, conducted on the highest plane of efficiency. Under such conditions the logical relief lies in supervision by a permanent outside organization which is in touch with the entire field of engineering, and has abundant research and test data, together with the practical experience which the individual plants can contribute. Such a source of help, whether federal, state or community, would be welcomed by the operators of fuel-burning plants, as it would relieve them from the burden and responsibility which they now carry. At the same time it would assist in a wonderful conservation of fuel.

Charles R. Schmidt. The first point in Mr. Myers' paper on fuel conservation, namely, the regulation of the quality of fuel, is perhaps the most important because it is "the foundation in the economical use of bituminous coal." The writer advocates the crushing and washing of all bituminous coal at the mines and suggests that the Federal Government furnish the crushers and washers to the operators, charging them 6 per cent on the investments plus the upkeep charges of the equipment, which would remain the property of the Government and in charge of the engineers from the Bureau of Mines. Also, as soon as enough mines are equipped with crushers and washers it should be made unlawful for anyone to sell or transport any but crushed and washed bituminous coal. We have a pure-food law; why cannot we have a pure-fuel law?

Oration in Memory of the Late Dr. John A. Brashear, Past-President of The American Society of Mechanical Engineers, by Dr. Henry S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching[1]

Adhuc scholasticus tantum est; quo genere hominum, nihil aut est simplicius aut sincerius aut melius.

I AM asked to speak before this body of trained engineers touching the scientific work of John Alfred Brashear. For nearly forty years I had the pleasure of his friendship and companionship. It is not easy under such circumstances to differentiate between those qualities in a man's life that pertain to his science or to his profession and those deeper and simpler relations that belong to friendship.

My purpose in speaking before this body of scientific men is not so much to tell the story of his life as to call attention to his contributions to optical science and research and his relation to some of those great forces in our social order which went to the making of a character like Brashear.

He was born almost exactly eighty years ago in what was then the little village of Brownsville, about thirty miles south of Pittsburgh. His father was a mechanic and the boy grew up under surroundings that intensified his natural aptitude for machinery. His mother's father was a watchmaker. From him the boy acquired not only his taste for technique of fine tools but he also imbibed from him early in life that love of astronomy which was perhaps his ruling passion.

Brashear's formal education was obtained in the public school of Brownsville which he attended until he was about thirteen years old, when it became necessary for him to earn his own living. Accordingly he went to Pittsburgh, learned the patternmaker's trade, and sought employment in one of the steel mills where he remained for twenty years, developing into an expert mechanic and becoming, toward the end of this period, the superintendent of a rolling mill.

During this period of his life as a practical mill mechanic he was under two strong influences, the one appealing to the spiritual side of his nature, the other to his intellectual side. He was a devout member of the Methodist Church and having a facility in public speaking he came to take an increasing part in the religious exercises of his denomination, until finally he came to believe that his path of duty lay in the ministry.

Side by side with this absorbing and insistent motive there grew up in his life another equally insistent and equally influential source of action. Early in his mill days Brashear had acquired a small refracting telescope. With this modest instrument he observed the moon and the principal planets, some of the star clusters and nebulæ. These views merely whetted his thirst and he began to long for something better than this small and inferior objective. Having no money there was but one way to get it and that was to make it himself; and so in the little shop at the back of his house, he and his wife began the grinding of a five-inch refractor. The story of this refractor has often been told.

These two motives, a deep and fervent humanitarianism and a passionate devotion to science were to be the dominant influences of his life. He never gave himself wholly to either the one or the other. Always he was the humanitarian, and always he was the man of science. Doubtless the impulse toward both of these lines of action arose from the same thing—the possession of a keen and ardent imagination. We do not always realize that the vision of human destiny and human progress that brings men with complete devotion into the service of their fellow-men is closely akin to that other vision of the forces and operations of nature, whether exercised upon the molecule or upon the stars, which also brings men irresistibly into the service of knowledge. Imagination, keen, far-sighted, sympathetic, may equally well lead its possessor into the one path as into the other. With Brashear it was a question hard to decide whether he should travel his life journey by the one way or by the other.

[1] Delivered December 8, 1920, at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York.

It seemed at one time of his life that he had definitely turned toward the ministry. His intention to be a Methodist minister was publicly announced. On one or two occasions he undertook to conduct formal service, but in the end he convinced himself that he was a better mechanic than he was a preacher, that he could serve God better as a layman than as a minister. In the meantime the lure of the telescope was drawing him more surely into the service of science. It needed only the association with Langley to make him a lifelong worshipper at the altar of science, equally inspired by the beauty of the planets and the perfection of a prism.

Encouraged by Langley's praise of the five-inch lens, Brashear immediately began in 1875 a twelve-inch reflecting telescope which he completed in 1877 and which he used for some three years afterward in a study of the lunar crater Plato. During these years also Brashear became more and more the mechanical and optical assistant of Langley in his reseaches on radiant heat.

It was a fortunate chance that brought Langley, the astronomer, and Brashear, the mechanician, to the solution of a common problem, a process that also knit two great souls in a lasting and devoted friendship. To the men of our day, living amid the engrossing and insistent demands of civilization as it has developed in the last fifty years, it is not easy to picture the scientific enthusiasms that made possible in that day an astronomical observatory in the City of Pittsburgh, and which furnished at the same time the inspiration of a technician like Brashear and of an astronomer like Langley. The rise of the Allegheny Observatory is a part of the romance of the astronomy of the middle half of the nineteenth century.

Between 1840 and 1860 there was a popular passion for astronomy that was widespread, which took hold upon the imagination of the people of the United States as perhaps no other science has ever done. This enthusiasm had its origin in two things. The improvement of the telescope and of the optical means for the manufacture of telescopic lenses and mirrors had resulted in the interesting discoveries of Herschel, in the invention of the spectroscope and had aroused the general expectation that the telescope would soon reveal new wonders of the heavens to the eyes of men. Furthermore, in that day most of the information in regard to science was disseminated through the medium of public lectures. The all-pervading newspaper had not come to dull the thirst for knowledge and to satiate the curiosity for news.

This popular interest in the science of astronomy was greatly quickened by the appearance of Donati's comet in 1858. This was one of the most glorious heavenly visitors that have ever come within human ken. At its brightest the comet reached from the zenith to the horizon and the nations of the world gazed at it with awe and admiration.

The establishment of the Allegheny Observatory was a part of the romance of this movement. In February, 1859, in the glow of the enthusiasm created by Donati's comet, a few citizens came together to consider the purchase of a telescope which in their own language "should have the magnifying power which would bring the heavenly bodies near enough to be viewed with greater interest and satisfaction." The association was called in its earlier days the Allegheny Telescope Association, but it did not attain its object until after the expiration of ten years when it found itself in the possession of a telescope of thirteen inches aperture, at that time an instrument of extraordinary power.

I have dwelt with some length on the astronomical enthusiasm of the period between 1840 and 1860 and of the founding of the Allegheny Observatory because in this movement and in the founding of this observatory lay the forces which transformed John Brashear from a skilled mechanic into a maker of great lenses and the perfecter of the most delicate instruments of spectrum analysis.

When Brashear brought to Langley in 1875 his little five-inch

lens, Langley was engaged in a research into the problem of the selective absorption of radiant heat. Astronomy at that day was just beginning to turn from the old astronomy, which concerned itself with a right ascension and declination of stars, their proper motion, and their distances, to the study of the physical nature of the sun and of the stars made possible by the invention of the spectroscope and the gradual advance of photographic art. To carry on such researches as Langley was engaged in, there was needed not only a telescopic lens but also the most refined and delicate mechanical instruments. When Langley gave his kindly welcome to the mechanician Brashear with his imperfect lens, he had little reason to suspect that he was to find in him a coadjutor whose coöperation was to make his work glorious in the annals of astrophysics. Brashear became his indispensable aid.

Between 1875 and 1880 he had made a number of pieces of apparatus for Professor Langley to be used in connection with his study of radiant heat. By that time he had become so interested in these problems that he gave up his work in the steel mill and began making telescopic lenses and mirrors as well as other optical apparatus in his own shop established in 1880.

His first great success was attained in the silvering of the mirrors for Professor Langley's Mount Whitney expedition in 1881. His next achievement in Langley's researches was the invention of a method for polishing rock-salt prisms. Rock salt crystallizes in cubes. It has the remarkable property of transmitting heat rays and was therefore specially adapted for Langley's researches in radiant heat. On account, however, of its softness and its dull color it is difficult to obtain prisms or lenses that will take a high polish. Brashear overcame all these difficulties and produced rock-salt prisms and lenses which were not only used in Langley's researches but were immediately adopted by European astrophysicists.

About this time also he became much interested in the work of Professor Rowland of Johns Hopkins. The spectrum studied in the spectroscope is produced by a dispersion of rays of light in passing through a series of prisms due to the varying refraction of light of different wave lengths. Soon after the discovery of the spectroscope and the adoption of the undulatory theory of light, it was found that a spectrum resembling the prismatic spectrum could be produced by the diffraction of light waves from a ruled surface, the difference in the light phase being proportional to the number of rulings. Professor Rowland in the effort to perfect a machine capable of making a great number of lines on a hard surface so as to obtain gratings suitable for determination of the lengths of the light waves invoked Brashear's assistance. After a year of hard work he succeeded in overcoming the mechanical difficulties and Professor Rowland was able to rule gratings containing many thousands of lines to the inch.

In 1885 Brashear completed his first large spectroscope and in 1887 he completed what was then the greatest spectroscope of the world for the Lick Observatory, with which Professor Keeler made his famous investigations on the motion of the nebulæ in the line of sight. Other great spectroscopes followed in the years immediately succeeding. About this time also Brashear became interested in the work of Professor Michelson on the determination of the velocity of light and also on the measurement of velocities as existing between long and short waves. His aid was enlisted in the first refractometer which was used to measure the meter of the International Bureau in terms of light waves. He succeeded in reducing the limiting error of the optical surface to less than 5/100 of the wave length, a marvelous achievement in optical construction.

In the early nineties Brashear constructed for Prof. George Hale the first spectroheliograph for the automatic photography of the surface and surroundings of the sun. This work has been epoch-making in the realm of solar photography.

Meantime in his optical works Brashear was constructing objectives and mirrors for reflecting telescopes and for refractors of larger and larger aperture. Among the largest of these are the 16-in. refractor of the Carleton Observatory, the 18-in. refractor for the Lowell Observatory, and finally the 30-in. Cassegrain for the Allegheny Observatory, completed some ten or twelve years ago, and the 72-in. reflector for the Dominion Observatory at Victoria. He succeeded the Clarks as the great lens maker of America, but unlike them his marvelous mechanical knowledge and skill extended to almost every field of solar investigation. As the Clarks were the representatives of the old astronomy in the manufacture of great refractors, so Brashear became the representative of the new astronomy in the realm of mechanical and technical advancement. There have been in America three manufacturing firms who have had a notable part in the advancement of astronomy and stellar physics—Alvan Clark and Sons of Cambridgeport, the makers of the great refractors; Brashear and McDowell of Pittsburgh, also makers of lenses and of mirrors, but preëminent in the making of delicate prisms and tools needed in the new astronomy; and, finally, Warner and Swasey of Cleveland, the engineers of both the old and the new astronomy, whose designs and constructions have made possible the telescope tubes and the great installations necessary to operate the modern telescope with its spectroscope and photographic attachments.

Among Brashear's many achievements in aid of astronomy was the manufacture of photographic doublets designed to photograph in a single exposure a wide field. Among the most ingenious of these instruments were the great cameras made for Dr. Max Wolf of Heidelberg which were used for the photographic discovery of asteroids.

In the days between 1840 and 1860 when Brashear received those deep impressions which centered his interest upon astronomy, asteroid hunting was a favorite sport of the astronomer, and the discovery of an asteroid brought fame to the finder. In that day the discovery and the pursuit of these little planetoids was purely the work of the mathematical astronomer working with the ordinary refractor. It would have been a bold prophet who could have foretold fifty years ago that a highly trained mechanician and technologist like Brashear would have anything to do in the discovery of these little planets between Mars and Jupiter, but the wonderful photographic cameras which he made for Dr. Wolf were so effective that they quickly superseded all other means of asteroid hunting.

Brashear as a scientist, therefore, stands as the great technician of the new astronomy. His lenses, his mirrors, and his prisms, his gratings and his stellar cameras made possible those refined observations which have opened a new chapter in our knowledge of the physical conditions of the stellar universe. Astrophysics is not different from other physics except that it studies the physical properties of highly heated bodies millions of miles away. The lens of the telescope is only an incidental part of the apparatus used and the great results are gained by the perfection of those delicate instruments which are able to recognize a small displacement of an absorption line in the spectrum of the sun, of the stars and of the nebulæ. Brashear's scientific fame rests on these great achievements. He stands in the history of science as the master mechanic of the new astronomy.

The last fifteen years of Brashear's life saw him turn once more to the passion of his earlier years. With him the humanitarian and the scientific imagination had lived side by side and in his last years, and particularly after the death of his faithful wife, the old passion for human brotherhood once more became the dominant factor in his life. His work as Chancellor of the University of Pittsburgh, as administrator of Mr. Frick's gift for the teachers of Pittsburgh, and his untiring service to the Carnegie Institute and the educational interests of Pittsburgh was the expression of the devotion which had always been a part of his life and which became in his last years the moving force of his existence. Into all this work he threw a devotion and a sweetness of personality which made him a power in increasing and deepening those forces in education that made for good will and right living and earnest devotion. He did not pretend to be an expert in the organization or direction of formal education, but he was a missionary of kindliness and human service to those who wrought in formal education. After one of his astronomical lectures to the West Point cadets a very discriminating listener, himself an astronomer, said to Brashear, "Those boys will soon forget what you have said to them about astronomy but they will never forget you." It was a true word. Brashear's service to education was the gift of his own personality alive with the twin passions for science and for humanity.

Recent Papers Relating to Marine Engineering

PROGRESS IN OIL-BURNING PRACTICE IN THE NAVY AND MERCHANT MARINE

Recent Advance in Oil Burning, Ernest H. Peabody, Mem. Am.Soc.M.E. In the field of oil burning, as in many others, it is the U. S. Navy that is pointing the way to future developments. While oil burning has been and is extensively used in the merchant marine, it is carried out by means of comparatively small units both at the boiler end and at the oil-burner end. In fact, the author states that there is probably no single oil burner in the merchant marine capable of atomizing over 600 lb. of oil per hour, while the oil burned per hour per square foot of heating surface under forced-draft conditions is under one-half pound. This means that the full value of the use of oil fuel has not yet been approached and while savings and advantages in the use of oil fuel have been realized, all the possibilities of it have not yet been reached. For this there are good reasons, one of the most important being the fact that oil fuel has been applied to Scotch boilers and the above figures marked practically the limit to which such boilers may be forced with safety. Furthermore, certain limitations in the design used in the merchant marine are imposed by the existing types of condensers and evaporators.

In marked contrast to this the Navy Department is making rapid advances of an important character. In fighting ships it is now using water-tube boilers entirely, with improved condensers and evaporators, and the oil burners have been brought to a point where in recent tests it proved possible to atomize more than one ton of oil per hour per burner.

This apparently sounds the doom of the Scotch boiler. In the near future instead we shall have large economical water-tube boilers installed in closed firerooms, burning oil and operating under forced draft with a few large-unit mechanical atomizers.

A series of interesting tests were recently carried out at the Navy Fuel Oil Testing Plant using a small-tube express-type water-tube boiler of the White-Forster design, built by the Babcock and Wilcox Company and containing 7565 sq. ft. of heating surface and 753 sq. ft. of superheating surface, the furnace volume being 751 cu. ft. Three different types of air registers were used, two of the Bureau of Engineering with forced-draft and natural-draft design, and one Peabody register of the Babcock and Wilcox Company on which either forced or natural draft could be used.

The data of these tests are given in Fig. 1. In the tests of June 10 there were 11 boilers in operation, each atomizing 1032 lb. of Navy standard oil (25.5 deg. B.) per hr., giving a consumption of 1.5 lb. of oil per sq. ft. of heating surface per hr. The evaporation of water per pound of oil from and at 212 deg. fahr. was 15.14 lb., giving an evaporation of water per sq. ft. of heating surface per hr. of 22.73 lb. from and at 212 deg. with an efficiency of 76.15 per cent. The air pressure in the closed fireroom was 9.5 in. and the rate of combustion per cubic foot of furnace volume reached the very high figure of 15.12 lb. of oil per hr. It is believed that this test stands as a world's record for efficiency at high boiler and furnace capacity.

The record of 1032 lb. of oil per burner per hr., however, has been already outstripped in tests made on an enlarged type of the Babcock and Wilcox air register with mechanical atomizers which proved actually capable of atomizing over 1500 lb. of oil per hr. under conditions similar to those in the U. S. scout cruisers now under construction; and even this record was exceeded when, in a test of a Normand boiler at the Fuel Oil Testing Plant, Peabody-Fisher wide-range mechanical burners atomized over 1800 lb. of oil (crude Mexican of 13.3 deg. B.) per burner per hr., without smoke, carbon or other objectionable conditions. In these tests the oil burned per sq. ft. of heating surface was 1.2 lb. per hr., and per cu. ft. of furnace volume, 11.15 lb. per hr. It is claimed, however, that a record of atomization at the rate of 2287 lb. per burner per hr. has been attained for a short time.

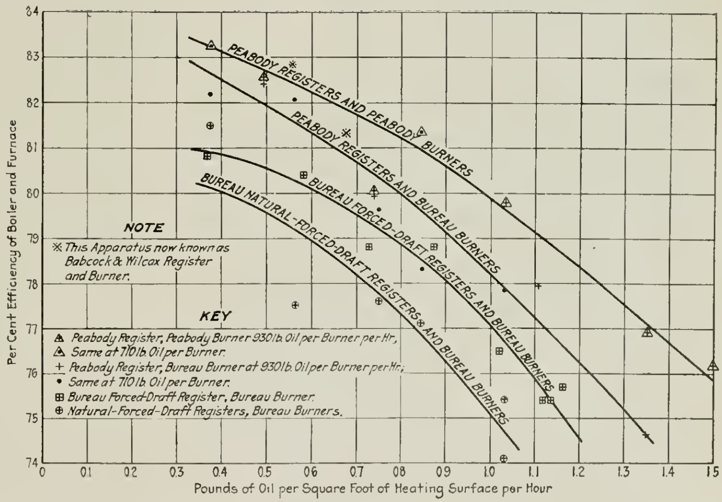

Fig. 1 Data of the White-Forster Boiler Tests Carried out at League Island Navy Yard Fuel-Oil Testing Plant

In this connection attention is also called to Fig. 3 giving data of one of the tests on a White-Forster boiler in which efficiency for boiler and furnace, in per cent, is plotted against boiler output.

These tests are too recent to make it possible to foretell their precise significance, but they point to important possibilities such as the use of a few very large boilers to obtain great outputs of power. Mr. Peabody expresses the conviction that the large unit both in boilers and oil burners has come to stay and that the trend of modern development is certainly in the direction of larger units and the higher capacities made possible by the use of fuel oil.

An important development in the design of oil burners has been that of making their operation more flexible. The mechanical atomizer of the usual design has a decided limitation in range, as it cannot be operated at low capacity if it is designed for a high one. The lower limit with the oil pressures ordinarily used is approximately one-half the upper. The reason for this is that the burner depends for its atomizing effect on the centrifugal force induced by giving the oil a rapid whirling motion in the central chamber of the tip. This whirling motion, in turn, is produced by delivering the oil to the central chamber through eccentric passages or

small channels substantially tangential to the walls of the chamber. As the capacity of the burner is reduced by reducing the oil pressure, the velocity through the channels decreases and friction losses grow until finally the spraying effect is reduced to the point where the oil issues from the tip in a solid stream or in a spray too coarse and excessive to give the desired results.

In the Thornycroft atomizer the size of the tangential channels may be reduced by an adjustment in the burner. This gives a greater flexibility to the burner, but it has been found difficult in practice to make individual adjustments under service conditions. The only other procedure, namely, to shut off some of the burners at low powers, or to change the size of the tips, or to do both, can be followed, but is open to objections.

Another and radically new plan, however, has been devised, which promises very satisfactory results. This consists in maintaining the whirling motion in the central chamber of the tip undiminished, whatever may be the capacity desired of the burner

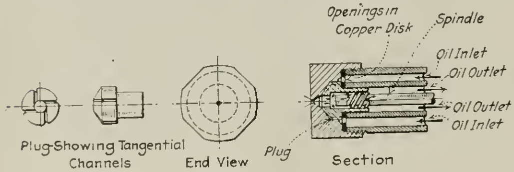

Fig. 2 Fisher Burner Used in U. S. Navy

in other words, instead of delivering through the orifice all the oil which enters the burner chamber, as is invariably done in all other mechanical atomizers, a part of the oil supply is diverted or bypassed from the central chamber and returned to the pump suction, and the actual effective capacity or amount of oil which is sprayed into the furnace depends merely on the proportion of the oil that is bypassed to the total amount entering the burner. Thus, as the amount of oil entering the central chamber through the tangential

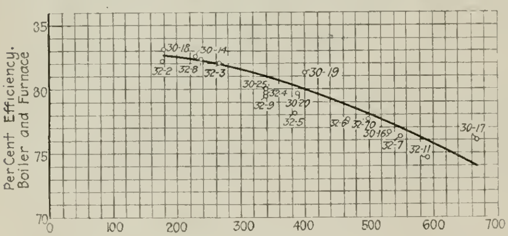

Fig. 3 Efficiency vs. Boiler Output, White-Forster Boiler

slots remains at all times at the maximum, the whirling of the oil and the atomizing effect remain also at a maximum, so that a perfect spray is secured whatever the capacity, at low powers as well as at the highest rate. By this method the range of the atomizer is very greatly increased, and, instead of being limited at the low powers to 50 per cent of the maximum, a good spray can be secured all the way down to about 10 per cent of the total.

This method of spraying is the invention of Commander J. O. Fisher, U. S. N., now fleet engineer of the U. S. Atlantic fleet. He first applied it in an attempt to spray oil into the cylinders of an internal-combustion engine, where, owing to the intermittent action required, the ordinary mechanical atomizer was an entire failure. By introducing the bypass a continuous flow was secured, even when the regular outlet orifice was closed. The application of the principle to atomizers for boiler work followed, with the result that a single burner without change of tip could be used over a greatly extended capacity range. The Navy Department has applied the Fisher burner with great success to small boilers of the launch type, where its wide range enables them to operate the boiler with only one burner. The author shows the navy design of this burner in Fig. 2. The company with which he is at present connected has developed a modified form of the Fisher burner with which some interesting experiments have been carried out with the coöperation of the Navy Department. It is believed that the wide range in capacity will make the burner especially useful for fluctuating loads or in any installation where it is now necessary to change the tips or close off a portion of the burners.

It may be of interest to state that the burners having a maximum hourly output of 1820 lb. which were tested at the Fuel Oil Testing Plant were successfully operated at 250 lb., while smaller tips designed for a maximum of 800 lb. were operated at a minimum of 80 lb. per hr. In the design described by the author the spindle shown in Fig. 2 has been dispensed with and the capacity is controlled entirely by an external valve in the bypass return line, so that by the manipulation of this valve any number of burners can be simultaneously increased or decreased in capacity over the entire range. Also, the tangential channels and the outler orifice are in a single piece. (Abstract of paper read at the 28th general meeting of the Society of Naval Architect and Marine Engineers, New York, Nov. 11–12, 1920.)

TESTS ON METHODS OF INJECTING FUEL OIL IN DIESEL ENGINES

Some Experiments in Connection with the Injection and Combustion of Fuel Oil in Diesel Engines, Prof. C. J. Hawkes. Data of experiments carried out with solid-injection and air-injection systems.

The solid-injection tests were carried out on a single-cylinder four-stroke engine in the Admiralty Engineering Laboratory. The engine is fitted with the piston of an aluminum alloy, has a cylinder diameter of $14^1/_2$ in., a stroke of 15 in. and develops 100 b.hp. at 380 r.p.m. The solid-injection fuel valve used during most of the experiments was of the direct-lift type, that is, the fuel-valve spindle which passed through a gland was operated directly by the fuel-valve lever.

The fuel used was shale fuel oil having a viscosity of 43 sec. at 70 deg. fahr. (Redwood No. 1). Because of the use of very small holes in the sprayer the oil was carefully strained through strainers fitted both on the suction side and on the discharge side of the fuel pump, the latter between the pressure gage and the fuel valve.

One of the objects of the experiments was to ascertain the effect of varying the bore and size of the holes in the solid-injection sprayer.

The first sprayer used was provided with five holes 0.019 in. in diameter and was similar in design to the sprayers fitted in submarine engines in 1914.

Next, the sprayer shown in Fig. 1 was tested. Here the fuel sprays were passed over the heated surface and each of the five holes was surrounded by a steel trumpet expanding from 1/16 in. to 3/16 in. in three-quarters of an inch. As the fuel valve in the experimental engine was inclined to the axis of the cylinder, a large portion of some of the trumpets had to be cut to allow the fuel valve to enter the cover. This modified sprayer did not prove successful and gave only 65 b.hp. When the valve was removed and examined, it was found that the interior of each trumpet was quite clean and bright, but there was a considerable carbon deposit on the external surface. Apparently the jets of oil had been striking the inner surface of the trumpets and it was decided to ascertain the effect of increasing the size of each trumpet so that it expanded from 1/8 in. to 5/16 in. in three-quarters of an inch. This alteration resulted in increasing the power to 95 b.hp. at 380 r.p.m., but after 40 min. running the power dropped to 90 b.hp. An examination of the trumpets showed that the jets had again been striking the sides and dribbling had occurred. The color of the trumpets also indicated that they had been comparatively cool and had not reached the red heat. The design was therefore abandoned.

Several tests were then made with sprayers provided with holes smaller than the standard 0.019 in. With 0.016-in. holes good results were obtained with an appreciable decrease in fuel as compared with the larger holes. Tests were then made with fitting steel plates to the top of the aluminum-alloy piston.

It did not appear, however, that the plates assisted combustion

either. The unsatisfactory results with the use of plates on top of the aluminum-alloy piston were apparently due to delayed combustion and possibly to some of the particles of fuel oil assuming the spheroidal state on striking the hot piston, thus delaying vaporization and combustion. On the other hand, however, in tests where heavy petroleum oil was allowed to flow in drops through a distance of about 6 in. on a heated steel plate, it did not show a clear spheroidal state. In tests, however, with shale fuel oil at about 250 deg. fahr. the drop of oil on reaching the plate broke into a number of smaller drops and assumed the spheroidal state. The occurrence of this state was observable until the plate reached a temperature of 600 deg. fahr. which was the highest temperature required in the tests.

If any portion of the injected oil assumed a spheroidal state on reaching the piston there would be a slight delay in combustion and the question of what proportion of the fuel oil which reached the piston remained in contact with it is discussed in detail by the author, who comes to the conclusion that both increased fuel consumption and delayed combustion with the hot plates may have been due either to the oil globules which assumed a spheroidal state on reaching the piston or to very rapid vaporization. This latter would appear to be an ideal condition so long as it is accompanied by good distribution.

Tests of variable fuel-injection pressures have shown that up to a certain point increase of pressure slightly reduced fuel consumption, but increase in fuel-valve roller clearance beyond a certain point did not give any better results and it was also noticed that the fuel-valve roller did not follow the contour of the cam.

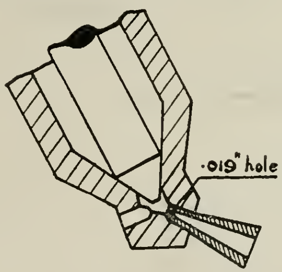

Fig. 1 Experimental Nozzle for Solid-Injection Marine Diesel Engine

Because of the lack of space the various valve-lift diagrams reproduced and discussed in the original article cannot be used here. Attention is directed, however, to Fig. 3, which presents the data of tests on fuel valve, cam, spring, etc., showing, among other things, under what conditions jumping of the fuel valve was likely to occur. Curve *a* represents the curve of velocity of opening and closing of the fuel valve; curve *b* the forces necessary to accelerate and decelerate the valve, etc.; curve *c* the load due to a 618-lb. spring; and curve *d* the spring load available after deducting the force necessary to accelerate or decelerate the valve and its operating gear.

Curve *e* represents the unbalanced oil pressure on the valve on the assumptions that the full pressure is acting during the opening and closing periods of the valve, and that the pressure drops uniformly in the system from 4500 to 3500 lb. per sq. in. The former is not of course correct for all positions of the fuel valve, but the latter is approximately correct. Curve *f* shows a similar curve, but its assumes that the pressure in the system drops uniformly from 3000 to 2000 lb. per sq. in.—which was the pressure for which the system was originally designed.

The critical period is undoubtedly when the valve begins to close, and if the full pressure acts on the underside of the valve during this period—and it probably does during the early portion of the closing period—it will be seen that the balance of spring load available to overcome gland friction is practically negligible with the higher fuel pressures assumed. Gland friction is acting

Fuel-valve gland friction is difficult to estimate in an engine running on service. In the case of the experimental engine it was ascertained that with the fuel-valve gland carefully packed (and tight) a force of 8.5 lb. was required to overcome gland friction (diameter of valve spindle, 7/16 in.). This should be regarded as being about the minimum figure. It will be seen that the 618-lb. spring provides only a small margin to overcome an increase in gland friction, or an increased fuel-oil pressure beyond that for which the system was originally designed. So far as spindle friction is concerned, the use of a "ground" fuel-valve spindle is an advantage—as a gland is then unnecessary. Difficulties following the adoption of higher pressures can be surmounted by fitting stronger springs or by a further modification of the design.

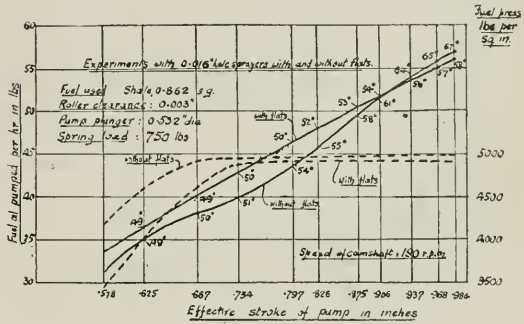

Fig. 2 Experiments with Sprayers of Different Lengths

Some interesting experiments were carried out with the object of ascertaining the effect of reducing the lengths of the holes in the sprayer on the quantity of fuel oil pumped and also on the pressures reached in the system. For this purpose a special apparatus briefly illustrated in the original article has been prepared. The tests were made and two sprayers drilled with five 0.016-in.-diameter holes, one fitted with flats in the vicinity of each hole, and the other without flats. The length of each hole in the sprayer with the flats is about $^1/_{32}$ in., or about half the length of the holes in the sprayer without flats.

The data of these tests are shown and plotted in Fig. 2, where the quantity of fuel oil pumped per hour (full lines) and the pressure in the system for each sprayer (chain-dotted lines) are plotted against the *effective* pump stroke—the fuel-valve spring being loaded to 750 lb. in each case. Against each recorded point is a number which represents the total period of opening of the fuel valve in degrees, obtained from fuel-valve lift diagrams. It will be seen that for the same effective pump stroke the quantity of fuel pumped is greater in the case of the sprayer *with* flats than in the case of the sprayer *without* flats, until the "jumping" of the fuel valve with the latter becomes excessive. It will also be seen that the fuel valve begins to "jump" when the pressure in the system exceeds about 4300 lb. per sq. in.

Similar experiments were carried out with these sprayers with a spring loaded to 900 lb. The effect of the stronger spring was to reduce the "jumping" of the valve with each sprayer, but the fuel pressures throughout were generally higher and the value of flats was more marked.

A large number of experiments were made with the sprayers under varying conditions, and the results may be summarized as follows:

1 It was noticed that the valve-lift diagrams obtained when the apparatus was barred round was shorter with a 900-lb. spring than with a 750-lb. spring—due to a slight deflection of the fuel shaft and lever at the increased spring load.

2 The difference between the quantity of fuel oil pumped when spraying into a cylinder filled with compressed air at 430 lb. pressure and when spraying, with the same sprayer, into the atmosphere was inappreciable.

3 When pumping the same *weight* of fuel oil, other conditions remaining the same, the pressure in the system when using Broxburn oil of 0.816 sp. gr. was slightly less than when using shale oil of 0.862 sp. gr.

4 It was thought that there might be a slight difference in the results with sprayers drilled with twist drills and similar sprayers drilled with flat drills. Two sprayers were therefore made similar in all respects, but the holes in one were drilled with flat drills 0.155 in. in diameter, and in the other with twist drills 0.01575 in. in diameter. The sprayers when tried in the spraying apparatus did not indicate any difference in the amount of fuel oil pumped, nor was there any difference found in the fuel pressure in the system.

5 The spindle friction of the valve used in these experiments was 15 lb., i.e., the valve required a force of 15 lb. to draw it through the packing with the spring removed. (The previous figure mentioned was $8^1/_2$ lb.)

SURFACE CONDENSERS FOR NAVAL VESSELS

Surface Condensers, Luther D. Lovekin, Mem.Am.Soc.M.E. There was a time when condensers were designed on a basis of so many square feet of surface per horsepower and this practice is still followed in some cases, though it is undoubtedly an unsatisfactory basis of design.

Tests made by the author of this paper have shown that other factors have a very vital influence on the performance of condensers, in particular, velocities of water and the steam space surrounding the tubes.

Thus, in tests made with a $^5/_8$-in. tube placed inside of other tubes of varying inside diameter, heat transfers with varying velocities of water and different tube layouts were obtained varying from 1000 to as high as 2750, this latter having been obtained when ample steam space was provided between the tubes.

These experiments also showed that it was a serious mistake to

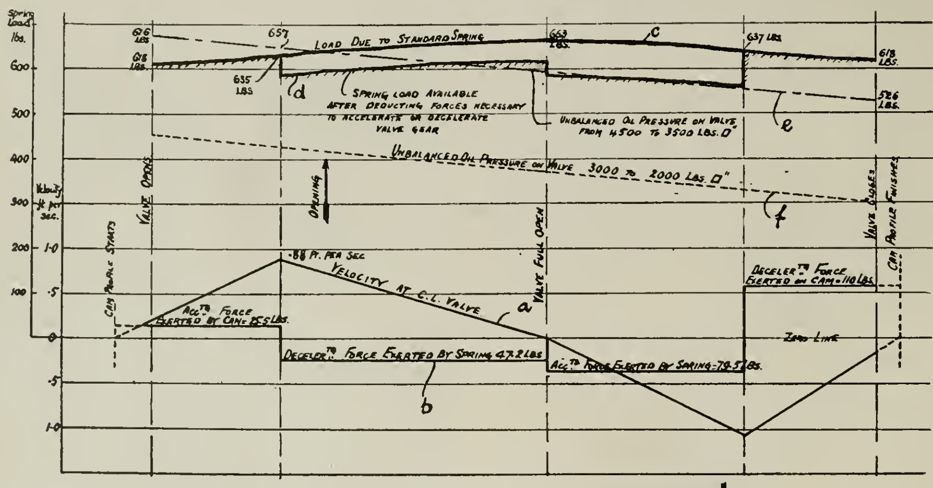

Fig. 3 Data of Tests on Fuel Valves in Solid-Injection Marine Diesel Engines

Closing

6 When the fuel pump was pumping with an effective stroke of $^{15}/_{16}$ in. against atmospheric pressure only its volumetric efficiency was about 95 per cent. The volumetric efficiency when pumping against the maximum pressure averaged about 75 per cent.

The conclusion to which the author arrives is that the success of the solid injection in service from the point of view of smokeless combustion depends very largely on the fuel-valve and fuel-pump design, correct settings, clean sprayers, and tight joints in the system. The best all-around results were obtained with a sprayer provided with five holes 0.016 in. in diameter. In general, however, the number and size of the holes in a sprayer depend on the mean pressure in the fuel-injection system; on the viscosity of the fuel oil; on the mean indicated pressure aimed at; on the distance the jets have to penetrate into the combustion chamber and also on the speed of the engine. The angle of the holes, i. e., the angle of the cone on which the holes are drilled, is dependent on the shape of the combustion chamber. So far as the author is aware, there are at present no formulas which can be used to determine the number, size and angle of holes necessary in a sprayer for a given engine to insure the best results—it is largely a question of trial and error.

The second part of this extensive and interesting paper cannot be presented here owing to lack of space, but it will be abstracted in an early issue of Mechanical Engineering. (Paper read before the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-on-Tyne, Nov. 26, 1920, abstracted through an advance publication, 44 pp., 28 figs., *eA*)

fill up the condenser enclosure with an excessively large amount of tubes. Nothing could be gained by having the steam or condensed vapors traverse a mass of tubes after it had been condensed. Instead, the author recommended a design whereby a maximum inlet area between the tubes could be obtained so that with a volume of steam corresponding to a vacuum of $28^1/_2$ in., the velocity would be about 100 ft. per sec. or less. To do this, it was decided to reduce the depth of the bank of tubes to about half of that ordinarily used and to permit the condensate to be drained from said bank of tubes o its maximum temperature, approximately that of the temperature corresponding to the temperature of the vacuum.

An additional cooling chamber of liberal size was added to the condenser, the purpose of this being to condense any vapors that remained, the condensate from this area going into the common condensate space where it would be removed at the bottom of the shell. When used for battleships or the like, this air-cooling space was enlarged, providing about 40 per cent of the local tube surface. This enabled the outer portion of the condenser to serve as a primary condenser and the so-called air-cooling space as a secondary condenser. When the turbines are operating at less than full load, the primary condenser can do all the work and retain its heat in the condensate.

The design of the Lovekin condenser may be seen from Fig. 1. The air channel way is formed of two plates running the entire length of the space between the tube sheets, these plates being spaced apart and having their sides perforated with small holes over the entire plate. This is done so as to prevent any air pockets

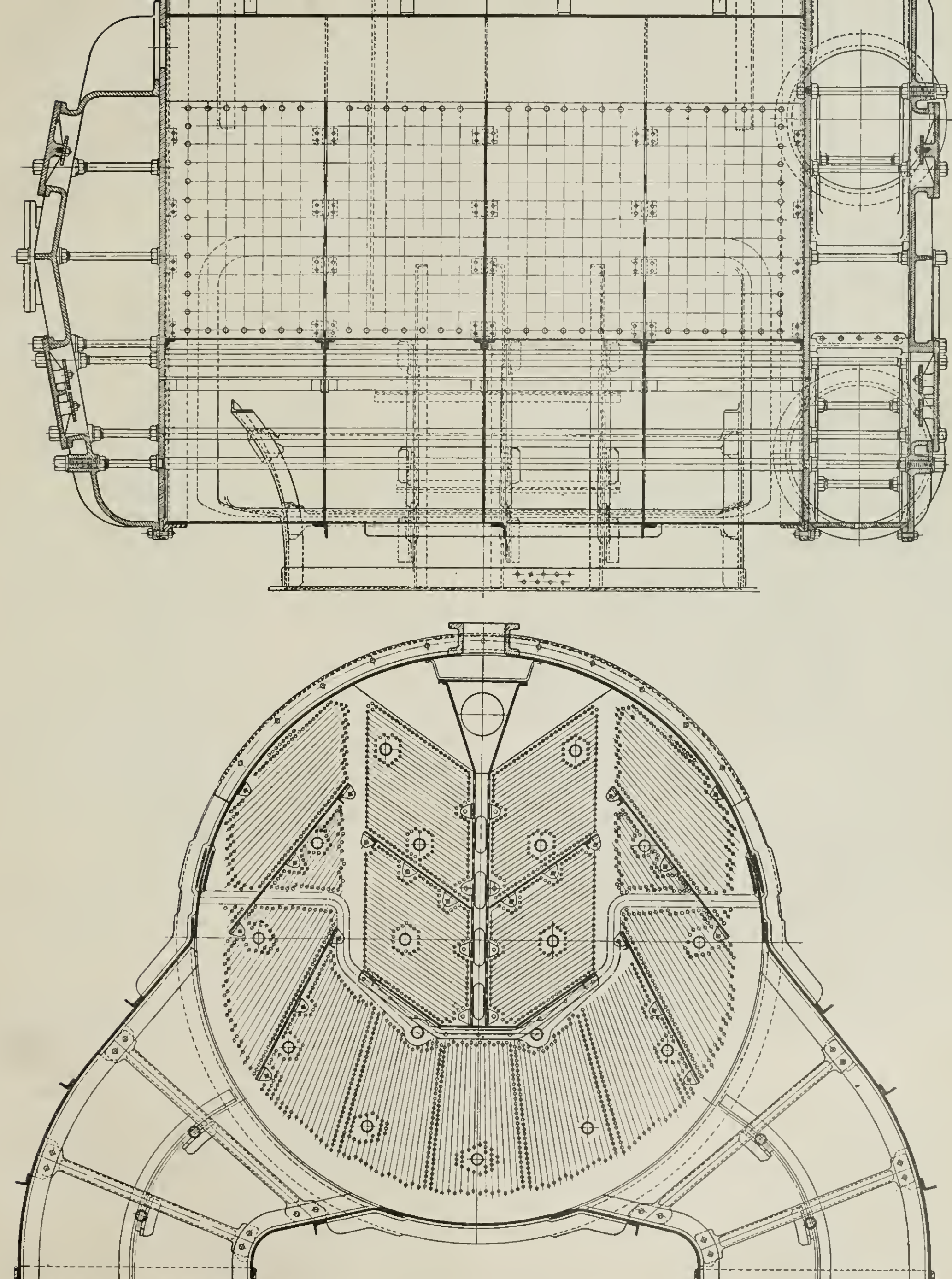

Fig. 1 Lovekin Surface Condenser

being formed in any part of the condenser. Where the condensate pump and air ejectors are used, the condenser head is cut away so as to clear the air-ejector connection. This makes a very simple connection and yet prevents the air pipe being flooded with water.

Small angle bars are placed in the lower edges of all the drain plates. These angle bars are not continuous but simply consist of short spaces with clear spaces of equal length between them so as to prevent the formation of a continuous sheet of water the entire length of the condenser running into the condensate space, which might interfere with the vapor and air entering the secondary zone.

In connection with the design of the Lovekin condenser, tests were made on the employment of coatings on the condenser shell as a means of preventing infiltration of air. These tests were made without any coating on the shell, then with one coat of bitumastic enamel, and finally with two coats of enamel. The effect of the final coat was an improvement of nearly 1 in. of vacuum under the same conditions. (Abstract of paper read at the 28th general meeting of the Society of Naval Architects and Marine Engineers, New York, Nov. 11–12, 1920.)

RIVETING FOR OIL-TIGHT WORK ON SHIPS

Notes on Rivets and Spacing of Rivets for Oil-Tight Work, Hugo P. Frear. The subject of proper riveting of oil tankers is a comparatively new one, as tankers themselves have scarcely been in existence fifty years. In fact, it is claimed that the first bulk oil-carrying steamer was built n 1872 in England.

Up to 1894 there were no definite rules laid for tanker construction by any of the national classification societies. In that year, however, Mr. B. Martell, chief surveyor to Lloyd's Register read a paper before the Institution of Naval Architects wherein he outlined his views on the details of construction and of riveting for bulk oil carriers. While not official, this paper served for a number of years as a guide to shipbuilders in the design and construction of tankers intended to be classed at Lloyd's. It is of interest to note, however, that the first rules of Lloyd's did not appear for general use until 1909, even though two other classification societies, the Bureau Veritas and the American Bureau of Shipping, had published their rules several years before. This is a good illustrat on of the slowness and care with which the great classification societies are accustomed to lay down their standards of construction.

In fact, judging from data presented in Mr. Frear's paper, it is doubtful if any standards of construction may be considered as having been definitely adopted even today. Thus, it would appear hat while double riveting is the general requirement for oil-tight work, single riveting is permitted in the seams of double bottoms intended for carrying fue oil. It is still uncertain, however, whether single-riveted seams are tight enough for gasoline, or whether, as some claim, they are even more suitable for gasoline than for crude oil, because of their tendency to rust up with gasoline.

In this connection the writer recommends as well worth considering the use of single riveting in the longitudinal seams of centerline bulkheads, with the exception of the lower seam. The cargo is sometimes made up of more than one kind of oil and it is therefore important that the transverse bulkheads be absolutely tight, but different kinds of oil have seldom been carried on opposite sides of the center line and it would appear that a single-riveted longitudinal bulkhead would fulfill every function that the trade demands

As regards spacing, a considerable latitude still exists. At first, Lloyd's recommended three diameters for all oil-tight spacing, but a spacing of five diameters is now allowed in connecting bulkhead bounding bars to shell.

In both the types of bounding bars and the methods of riveting a variation is still permitted, the builder having an option of using either single double-riveted bars or double single-riveted bars. Furthermore, the rivets sometimes are calked before testing and sometimes are left free from calking. A good pan-head rivet should not require calking before testing. It would appear that countersunk-head rivets may require it.

Coming back to the subject of spacing, it would appear that while in his time Mr. Martell was justified in recommending a spacing of three diameters for satisfactory oil-tight work improvements in design, construction and workmanship have demonstrated that stanch ships can be built with wider spacing. In merchant vessels converted to carry oil the spacing is generally $4^1/_2$ diameters in the shell. In determining spacing it is well to bear in mind that work which might be tight under a static head might work loose on parts subject to the working stresses of a vessel in a seaway. Any design, spacing or workmanship which will not permanently prevent the joints from slipping will not remain oil tight.

In naval vessels using oil for fuel special problems of design came up. In these, in some cases, longitudinal bulkheadsare used as strength members and the riveting should be such as to obtain maximum strength, which means that the spacing cannot be made too close, especially where the bulkheads form boundaries of oil tanks. Because of this, if the strength bulkhead is designed for a spacing of six diameters for rivets in stiffeners and oil-tightness demands five diameters at the transverse bulkhead, it becomes necessary to introduce compensating liners which add to the weight and also increase the difficulty of making the structure tight. At the same time, tests carried out at the Philadelphia and New York Navy Yards appear to indicate that in fairly heavy plating where the members are not under the influence of other stresses than those due to head, six diameters is suitable. The thickness of angle bars, it was suggested, should preferably be not less than $^3/_8$ in. The Navy has under contemplation the revision of its rules for oil-tight riveting, due to the very considerable increase in amount of oil-tight work involved by new construc ion.

So far in naval work a c oser spacing is demanded for oil-tight work than for water-tight work, though experience in the construction of oil tanks in double bottoms seems to indicate that with ordinary good workmanship water-tight spacing will be satisfactory for oil.

The following spacing has been proposed as meeting both leakage conditions and the stresses imposed by deflections caused by calking and water pressure:

Plate	15-lb.	20-lb.	25-lb.	30-lb.	35-lb.
Spacing in diameters	4	4.5	5	5.3	5 6

These values, however, have been deduced without reference to strength of joint.

From the general data presented by Mr. Frear in his paper it would appear that any riveting for oil-tight work is really a compromise between the desire to produce an oil-tight joint and the very important consideration that every unnecessary rivet is a possible source of leakage and also a source of weakness of the plates. (Abstract of paper read at the 28th general meeting of the Society of Naval Architects and Marine Engineers, New York, Nov. 11–12, 1920.)

Short Abstracts of the Month

BUREAU OF STANDARDS

The Carbonization of Lubricating Oils. The principal reason for writing this circular was to give detailed descriptions of the methods used for the determination of the "Conradson carbon residue" and the "Waters carbon" of oils used to lubricate internal-combustion engines.

After brief accounts of the nature and effects of "carbon" deposits in the engine, and of the chemical nature of petroleum oils, the theories concerning the causes of the deposition of this material are discussed in connection with somewhat detailed accounts of the oxidation and cracking of petroleum oils.

The Waters and Conradson tests are described in detail, together with the apparatus employed, and brief accounts are given of a few other methods, including those in which the oil is distilled.

The circular closes with a condensed summary of several more or less controversial papers that have been published elsewhere. (Abstract of Circular No. 99 of the Bureau of Standards, *e*)

the Institution of Mechanical Engineers covering experimental research on wire ropes for use over pulleys.

It does not appear that the Committee carried out any special experimental work of its own, but it very carefully collated all the available information and presented it in a clear form.

The conclusions arrived at are that there is no reliable information available as regards the factor of safety when used over pulleys. No sufficient data are available to establish a general method for the design of ropes, especially as entirely different problems present themselves in various installations. Thus, the outside wear is most important for a rope working on a large pulley, whereas bending fatigue and internal wear do most damage when a small sheave is used.

The calculation of the bending stress for design does not at present appear to be satisfactory. There is a lack of agreement on the factor to be used with the Reuleaux formula. There is no rational formula which covers the actual conditions and it has not yet been shown that the bending stress is the determining factor in the destruction of a rope. It is suggested that an attempt should be made at an analysis which will separate the three destructive effects: namely, outside wear, wear between the wires, and bending fatigue.

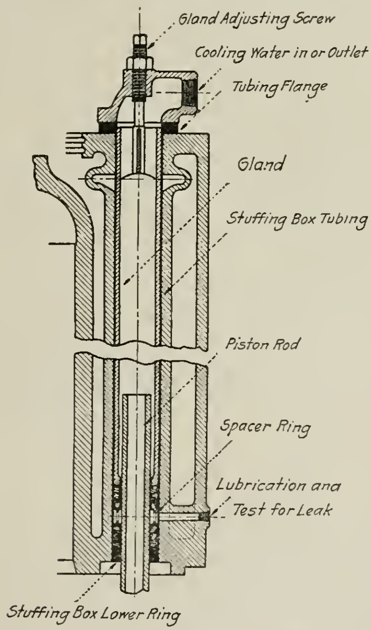

Fig. 1 Section through Power Cylinder of the Manning, Maxwell & Moore Marine Diesel Engine

Distinction should be drawn between hardness and tensile strength, which are generally regarded as increasing together.

The information concerning the wire diameter indicates a difference of opinion which was not expected. As regards the adjustment of the lays to suit the diameter of the pulley, some writers have asked for it, but there is no exact information which bears on this point. The balance of opinion favors Lang's lay, where it can be used, but the preference is not shown so clearly by American engineers.

The effect of different angles of bending of the cable over the pulley appears to be explained very clearly by Leffler, although some opinions are at variance with his conclusion. The formula he gives to calculate the true radius of curvature of the rope does not agree with that of the Trenton Iron Company.

pulleys there is scarcely a single element of design on which sufficient information is available and an agreement exists between engineers. To say the least, this is a very surprising state of things, considering the extensive and long use of such wire ropes. (*The Journal of the Institution of Mechanical Engineers*, no. 7, Nov. 1920, pp. 835–868, 1 fig., *gpA*)

INTERNAL-COMBUSTION ENGINEERING

Marine Diesel Engine with Peculiar Arrangement of Scavenging Pump and Piston Rods

Goldberg Double-Acting Two-Cycle Marine Diesel Engine. Description of an engine in which the scavenging pump is in two stages, the first stage serving for scavenging proper and the second stage for supercharging the working cylinder and also as the first stage for the injection-air compressor. With this arrangement the low-pressure injection cylinder requires not over 70 per cent over its displacement when using air at atmospheric pressure. The air-pump piston closes the scavenging ports ahead of its dead center for a distance, preventing the pump on its return stroke from filling again from the working cylinder.

This means that the scavenging port of the pump cylinder is not uncovered again until the working piston has covered the the scavenging ports of the power cylinder.

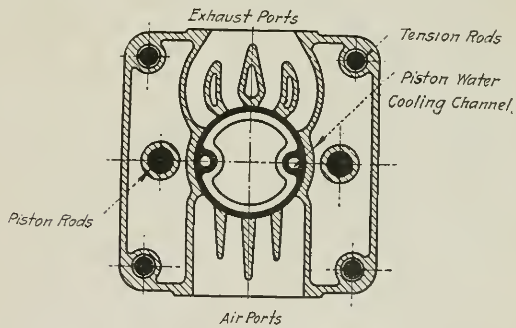

Fig. 2 A Large Section of Stuffing Box for Piston-Cooling Arrangement, Manning, Maxwell & Moore Marine Diesel Engine

To provide a better cooling of the pistons, the piston rods are extended into the upper cylinders and are drilled as shown in Fig. 1, one rod serving for water intake and the other for water outlet. The stuffing boxes proper for these sliding pipes (Fig. 2) consist of a light tubing with a collar at the bottom extending to the lower end of the cylinder casting. The packing is held between the lower collar and the gland in the form of a tube.

It is claimed that the double-piston-rod arrangement besides other advantages accomplishes also a great saving in the construction of the connecting rods. With this, the crosshead proper consists of a simple steel forging to which the crosshead shoes are fastened in a conventional way, but the forked type of marine rod is not used any more.

The four-cylinder 3000-shaft-hp. engine of this type has the following dimensions:

Bore	22 in.
Stroke	33 in.
Speed	120 r.p.m.
Piston speed	660 ft. per min.
Shaft mean effective pressure (m.e.p.)	66 lb. per sq. in.
Overall length, including flywheel, thrust block and air compressor	40 ft.
Overall height from center line of shaft	26 ft.

A shaft m.e.p. of 66 lb. per sq. in. is a very conservative figure. The low piston speed of 600 ft. per min. was selected with propeller efficiency in view. A shaft m.e.p. of 66 lb. per sq. in. can be obtained without surcharging the cylinders and the great over-

load capacity of this type of engine for forced runs of vessels may well be of great value. With surcharging and increasing the speed of the engine, say, to about 160 r.p.m., we can obtain 3000 shaft hp. for short periods, though it may not be advisable to carry this load through continuous days of service. (*Motorship*, vol. 5, no. 11, Nov. 1920, pp. 993–994, 3 figs., *d*)

FUELS AND FIRING

Initial Air Temperature and Economy of Furnaces

Influence of the Initial Air Temperature on Combustion Processes in Furnaces, J. Hudler. The question of the importance of higher initial temperatures of air supplied to furnaces is discussed and it is pointed out that this importance is much greater than is generally realized. Particular attention is paid to the relation between the entering temperature of air and the temperature of exhaust gases and rate of firing of the unit. In general, the problem of firing consists in the transmission of heat from rapidly moving gases of combustion to stationary solid or liquid bodies. The author claims that the processes taking place during this heat exchange are not always fully understood, and proves mathematically that to each initial temperature of air T_0 there corresponds a definite temperature of the exhaust gases T_1, providing the amount of heat generated per hour remains constant.

To show the bearing of this fact he compares two cases of combustion of pure carbon with a 6 per cent carbon dioxide content in one case and 12 per cent in the other, which corresponds to the change that occurs in passing from hand firing to automatic stoking with the better control of stack gases, and shows that if the rate of firing in the case of the 12 per cent CO_2 content be reduced to such an extent that the temperature of exhaust gases falls to 185 deg. cent., there will be a saving of 28.3 per cent in fuel, with undiminished output. Should, however, the gain in the CO_2 content be obtained by the usual method of decreasing the volume of exhaust gases, that is, maintaining the temperature of the smokestack constant, there will be a fuel saving of only 21.3 per cent. From this it would appear that the importance of higher content of carbon dioxide in the smokestack gases accompanied by a higher initial air temperature is greater than generally realized.

As to the means for securing a higher initial air temperature, the author points out that the heat contained in a cubic meter of exhaust gases must be considered as the basis for the initial temperature of the air and is fairly well proportional thereto, and therefore economically it is important to make the ratio W/V of heat in the air to heat in the exhaust gases as large as possible.

While such a requirement, however, is very simple theoretically, it is very difficult to solve the practical problems involved therein. In hand-fired grates immediately after the coal has been thrown upon the grate there is a development of gases with very high heat content which require large amounts of air for their combustion. As soon, however, as the process of volatilization is ended, and from that point on to the next firing, the air demand falls off. This difficulty is largely eliminated by modern automatic methods of firing in which coal is delivered on to the plate uniformly, and the air delivery may be maintained in a balanced manner proportional thereto. It is this that makes it possible to raise the content of carbon dioxide in the exhaust gases to 12 and even 14 per cent, which is so largely in excess of what could be done with hand firing. A still further opportunity to increase the content of carbon dioxide or to reduce the volume of exhaust gases is offered by producer-gas firing. While this method of firing has not proved hitherto entirely successful for boiler-operation purposes, this was mainly due to the fact that gas producers have considerable radiation losses which are further increased during the transit of the gases from the producer to the firing chamber, so that the reduction of V is offset by a simultaneous decrease in W. Furthermore, the usual addition of steam to the gas-producer air supply also increases V. It is therefore not correct to say that in view of fuel conservation our fuels should be utilized always in a gaseous state.

On the other hand, where producer-gas firing is used for purposes making necessary the employment of high smokestack temperatures, it is possible to raise the initial air temperature to a very high degree by preheating it, and therefore to increase the numerator in the expression W/V while maintaining the denominator unaltered.

The author asks the following question:

What gain is secured in preheating the air to 800 deg. cent. as compared with combustion carried on with air at zero deg. cent., maintaining the smokestack temperature at 1000 deg. cent. and operating with a 20 per cent excess of air?

The answer obtained is so surprising that it appears to be worth while to reproduce the calculation given in the article.

As during the combustion of one cubic meter of carbon monoxide 3046 kg-cal. are developed, the lower heat value of the gas is given by the expression

$$H_n = 3046 \times 0.347 = 1057 \text{ kg-cal.}$$

The combustion with the theoretical minimum of air produces 0.347 cu.m. carbon dioxide plus 1.306 cu.m. nitrogen. With an excess of air of 20 per cent there is added to this 0.261 cu.m. nitrogen and 0.069 cu.m. oxygen, which bring the total volume of exhaust gases to 1.983 cu.m.

The heat carried off by the exhaust gases is

$$W_R = 1000 \times (0.347 \times 0.501 + 1.636 \times 0.325) = 706 \text{ kg-cal.}$$

which means that the useful heat with cold air is equal to the initial heat of the gas (1057 kg-cal.) less the smokestack losses (706 kg-cal.) or to 351 kg-cal.

One cubic meter of gas, however, contains 1057/1.983 or 533 kg-cal., which gives an initial temperature of 1464 deg. cent.

On the other hand, with preheating of air we find that instead of the theoretical volume 0.826 cu.m., we have an increased volume of 1.156 cu.m. When preheated to 800 deg. cent. the heat content of this volume is

$$W_L = 1.156 \times 800 \times 0.32 = 296 \text{ kg-cal.}$$

which means that 1.983 cu.m. of smokestack gases carry the initial heat of 1057 kg-cal. and the heat added by the preheating of the air 296 kg-cal., or a total of 1353 kg-cal., equal to 682 kg-cal. per cu.m. of gases, which gives an initial temperature $T_0 = 1812$ deg. cent. It would appear, therefore, that for a temperature of preheating $t = 800$, the following equation expresses the conditions of equal output with and without preheating:

$$\frac{1464 - 1000}{l(1464 - 800) - l(1000 - 800)} = \frac{1812 - T_1}{l(1812 - 800) - l(T_1 - 800)}$$

from which T_1 can be found to be equal to 894 deg. cent. and

$$W_R = 894 \times (0.347 \times 0.504 + 1.636 \times 0.32) = 632$$

which gives the starting result, namely, that the useful heat is $1353 - 632 = 721$ kg-cal., or some 370 kg-cal. more with air preheated to 800 deg. cent. than with air at zero deg. cent., notwithstanding the fact that through preheating only 296 kg-cal. have been added.

In other words, the calculator shows that the increase in usefully employed heat is equal to 125 per cent of the increase of the heat content of the air.

Because of the fact that the initial air temperature has been raised, the smokestack temperature has been reduced and with it the smokestack losses have been reduced. The contention that the increase in efficiency produced by preheating the air of combustion is more than equivalent to the direct effect of the heat supplied to the air, is claimed to be a novel one, and it is further claimed that the same results are obtained if not air but the gas is preheated. From this point of view it can be seen how undesirable results are introduced by the usual cooling of gases in ammonia by-product recovery producers, apart from the fact that the large volumes of steam usually present in producer gas also act in the way of reducing the gas temperature and increasing the volume of the stack gases.

Other parts of this interesting article may be abstracted at a later date. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, no. 40, Oct. 2, 1920, pp. 810–814, 1 fig., *tA*)

Helical Springs, W. Norman Thomas. It has been observed that in practice many springs fail under smaller loads than those for which they were originally designed. Investigation shows that there are two considerations which may easily be overlooked in the design and use of a spring, namely, (1) the effect of eccentricity of the load, and (2) the effect of the direct shear stress as distinct from the torsional shear stress in the material of the spring. Failure may be due either to entirely overlooking these two points, or, more often, to underestimation of the magnitude of the applied loads and of the effects of impact and repetition of stress. In a considerable number of cases failure may be due to the fact that the springs were designed for normal-temperature work and then afterward employed under very high- or very low-temperature conditions.

Equations are developed for the design of close-coiled springs and open-coiled helical springs, and curves are given, among other things, showing the bending and twisting moments in various parts of springs for different eccentricities of load, and the maximum principal stress and the maximum shear stress at the extremities of the vertical diameter of the cross-section of the wire. From these equations it appears that for the same value of M (eccentricity) the deflection is smaller with an open-coiled spring

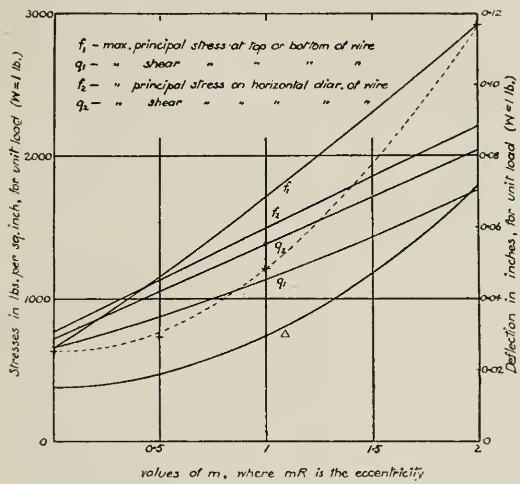

Fig. 3 Graphs of Stresses in the Wire of Helical Springs Calculated by Various Formulas

than a close-coiled spring containing the same length of wire. If the number of coils is the same for each spring, then for the same value of M the deflection is greater with an open-coiled spring than with a close-coiled spring. In addition to this, the values of the stresses in the wire calculated by the various formulas given in the article are tabulated and plotted in Fig. 3. From these it would appear that unless the load is axially applied upon a spring, the stresses may be considerably greater than those for which the spring was designed.

Thus, in an example worked out in the original article, 665 W would represent the load for which the spring was probably designed, that is, assuming axial loading and neglecting the direct shear stress; whereas the maximum shear stress even with axial loading is 721 W, and the maximum principal stress f_2 is 779 W.

With an eccentricity of $0.5R$, which could easily occur, the maximum shear stress is about 1053 W and the maximum principal stress f_1 about 1168 W.

If the eccentricity of the load is greater than $0.5R$ the stresses are still more in excess of the nominal safe load for axial loading. It is very important, therefore, that the ends of springs should be so designed as to insure axial loading. This is moderately

and therefore still further to increase the stresses.

Some experiments were undertaken in order to test the truth of the general formula for deflection obtained in the original article, and they have generally confirmed it. (*Journal of The Institution of Mechanical Engineers*, no. 7, Nov. 1920, pp. 869–889, 13 figs., *tpA*)

MEASURING APPARATUS

Measuring Lengths to Within 1200 of a Millionth of an Inch

The Ultra-Micrometer. Prof. R. Whiddington. Not so long ago working "to a hair's breadth" was considered quite an achievement. Then, the thousandth of an inch became a fairly common limit of precision in machine work, and a thousandth of an inch is only a fraction of a hair's breadth. It had been found, however, that in order to permit work to a thousandth

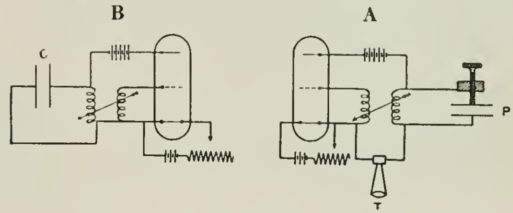

Fig. 4 Diagram of Main Electrical Elements in the Whiddington Ultra-Micrometer

of an inch the gages had to be made far more precise, and various methods, in particular the so-called interferometer methods of measurement, were developed, permitting a precision as high as one-millionth of an inch.

Interferometer methods, however, are limited in accuracy of measurement by the wave lengths of light used in the production of the fringes. It is not always easy to see at once where precision of measurement in excess of a millionth of an inch may be required, but in scientific work there are already cases where a higher precision is desirable. The ultra-micrometer, a new device, permits measurement to the scarcely creditable precision of one two-hundredth of a millionth of an inch. As an idea of what one two-hundredth of a millionth part of an inch means, it may be said that it bears very roughly the same relation to one inch that one inch bears to the distance by rail between New York and San Francisco.

The new measuring apparatus is based on the fact that if an electric circuit, consisting of a parallel-plate condenser and inductance, be maintained in oscillation by means of a thermionic valve, a small change in distance between the plates produces a change in the frequency of the oscillations which can be accurately determined by certain methods. The sensitiveness of the apparatus is extremely high.

The theory of the method is comparatively simple. If a capacity C be connected to an inductance L, the frequency of oscillation N natural to the circuit is given by

$$N = \frac{1}{2\pi\sqrt{LC}}$$

If the condenser be composed of two parallel plates of area A separated by distance x, then the capacity C is determined by the equation

$$C = \frac{A}{4\pi x}$$

If we substitute this value C into the above equation for N, we obtain

$$N = \left(\frac{x}{\pi LA}\right)^{1/2}$$

which shows that a change in distance x between the plates pro-

duces a change in the frequency of oscillations N, so that inversely a change N may be taken as an indication of a change in x.

On the basis of this theory was built the apparatus shown in Fig. 4. In this diagram A is the oscillating-valve circuit involving a parallel-plate condenser P; T is a loud-speaking telephone, shown for simplicity directly inserted in the valve-anode circuit, although in actual practice an amplifier intervenes.

The values of the coils in the grid and anode circuits of the thermionic valve were so chosen as to produce oscillations N of about a million frequency. In order to bring about any change in N a second valve circuit B was set up close to the circuit A. The frequency of this circuit could be adjusted by means of the condenser C so as to be nearly but not quite equal to N. This produced a loud audible note in T, the frequency of which could be adjusted to any desired value by a suitable choice of C. Another valve circuit was provided with proper capacities and inductance in order to provide a constant standard of pitch to which the note in T could be adjusted. This additional circuit is now shown in Fig. 4.

As regards the sensitiveness of the apparatus, it may be mentioned that the bending of a very substantial table, produced by an English penny coin laid on its edge, was clearly indicated by a change in the note from the telephone T.

The details of the method of measuring are not given. The method has been of service, however, by proving that Hooke's law was obeyed to the limits of accuracy set by a micrometer capable of measuring to 10^{-4} inch. (*London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, vol. 40, no. 239, Nov. 1920, pp. 623–639, 2 figs. and 1 plate of photographs, *dA*)

METALLURGY

New Method of Carbonization. Earl W. Pierce and John W. Anderson, Mem.Am.Soc.M.E. In this article the authors question whether the conventional method of carbonizing produces a tough core. They claim that the hardening of the outer wearing surface is produced at the expense of the core.

The treatment which they recommend to avoid this disadvantage is based on the idea of keeping the carbonizing temperature as near the first hardening heat as possible, or vice versa.

The method requires a lowering of the carbonizing temperature close to the core-refining heat, as it would not be practical to raise the hardening heat to the carbonizing temperature without danger of ruining the part. This method makes a longer carbonizing time necessary to produce the necessary depth of case, but this increased time is made up in the subsequent hardening heats.

Actually, the process is carried out in the following manner: The carbonizing temperature is lowered to that of the core-refining heat, namely, to 1600 deg. fahr., so that the carbonizing is carried on well within the carbonizing zone and at the same time at a temperature insuring as fine a grain as possible. When the work has become heated through at this temperature, it is quenched and the fine structure formerly produced in the carbonizing operation is trapped. It is well to hold the heat at the hardening temperature a few minutes to recover any crystalline growth which may have occurred in cooling after carbonizing between that temperature and the upper critical point of this kind of steel, which is about 1550 deg. fahr.

It is claimed that this method permits straightening with ease work distorted to some extent in hardening, and with practically no breakage loss nor cracking of the case-hardened surface. (*The Iron Age*, vol. 106, no. 21, Nov. 18, 1920, pp. 1315–1316, *dp*)

Important work is being done in the field of metallurgical applications of the so-called rare metals. During the war zirconium is said to have been extensively used in gun steel, as it imparts an increased hardness to the metal. In this country apparently successful attempts have been made to use cerium as a deoxidizer for cast iron. No metallurgical applications have yet been discovered for barium, strontium and beryllium, while lithium is used only sparingly in one or two special alloys.

MOTOR-CAR ENGINEERING

Steam Power Plants as Applied to Vehicles for Common Roads. F. L. Egan. Discussion of the application of steam power to motor vehicles, in particular passenger cars and trucks and covering English and American practice.

From data presented in the article it would appear that substantial progress in the direction of application of steam has been achieved in England where the high cost of gasoline makes the use of cheaper fuels with steam more attractive than in this country.

The two following facts are presented in reference to the practice of a large company operating motor buses in London. Although the company formerly operated gasoline- and kerosene-engine buses, it is regularly replacing the gasoline units with steam machines. Furthermore, in 1915, on steam-driven machines a change was made from kerosene to coke fuel, sufficient coke for about 50 miles being carried.

The larger part of the paper is devoted to the description of the Stanley and Doble-Detroit systems. As regards the probable trend of future developments, the author believes that the steam-generation and combustion system will be simplified, and states that a distinctly new type of boiler made possible by a new application of combustion is now in the experimental stage.

The engine, in the opinion of the author, will stand practically as it is, except that for the larger trucks it may be advisable to use a separate engine to drive each rear wheel through an internal gear on the road wheel meshed into a pinion on the end of a short crankshaft, which would do away with differential-gear and live-axle troubles. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 36, no. 7, Oct. 1920, pp. 455–484, and discussion pp. 485–491, 23 figs., *g*)

FUELS AND FIRING (See Producer Gas)

INTERNAL-COMBUSTION ENGINEERING (See Producer Gas)

PRODUCER GAS

British Practice in the Operation of By-Product Plants for Power Purposes

Notes on Operating a By-Product Producer-Gas Plant for Power and Heating. Description of a plant built for the Hoffmann Manufacturing Co., Ltd., in England, and operating on the Lymn system. The plant is in two units of 30 tons capacity each and is intended to have by-product recovery.

In a plant of that character it is very important to prevent the destruction of ammonia, which means that large quantities of steam have to be introduced with the air into the producer; this has the effect of facilitating the formation of ammonia and preventing its destruction by keeping the temperatures in the producer comparatively low. From 2 to $2^1/_2$ lb. of steam per pound of coal gasified may be taken as an average figure, and the provision of so much steam is a serious item in the cost of production. In the plant described the method adopted is to cool the gases by contact with water and heat up and saturate the air with the hot water so obtained. The process is continuous and results in having approximately 0.75 lb. of steam picked up by the air for every pound of coal gasified, which corresponds to a temperature of 68 deg. cent. (154.4 deg. fahr.) saturation. The balance of steam required is obtained from a boiler plant in which a superheater is included for steam required in the plant for other purposes outside the gas installation. It was found, however, when superheated steam was used for the gas plant that the air was not saturated to the extent indicated by the thermometer. In order to obtain steadier operating conditions the pipe arrangement was changed and saturated steam used for the gas plant in place of superheated.

The introduction of highly saturated and comparatively cool air into the producer results in cooling the fuel bed below a good working temperature. To prevent this a regenerator is provided wherein the temperature of air and steam mixture is increased to about 220 deg. cent. before it enters the producers, the necessary

Fig. 5 shows a diagrammatic view of a plant on the Lymn system. The air enters at the lower part of the No. 3 air washer, called the air saturator. The upper part of No. 3 is divided off by a diaphragm, the only connection between the two being through a water seal. The water which is made hot by contact with the gas in the upper part of the vessel passes through this seal into the air saturator and there meets the gas coming from the bottom of the vessel. The additional steam is blown into the air main between the air saturator and the regenerator (referred to in the figure as superheater), which consists of a nest of concentric cylinders so arranged that the hot gases from the producer and the saturated air pass in countercurrent. From the regenerator the hot gas is passed through a dust trap before it enters a vertical dust washer No. 1, in which the remaining dust is removed by water. From the top of the dust washer the gases pass down to the bottom of washer No. 2. In their upward flow through this washer they are brought into intimate contact with a solution of sulphate of ammonia containing a slight excess of sulphuric acid which absorbs ammonia from the gas. In the design of the Lymn washers no obstructions in the shape of packing boards

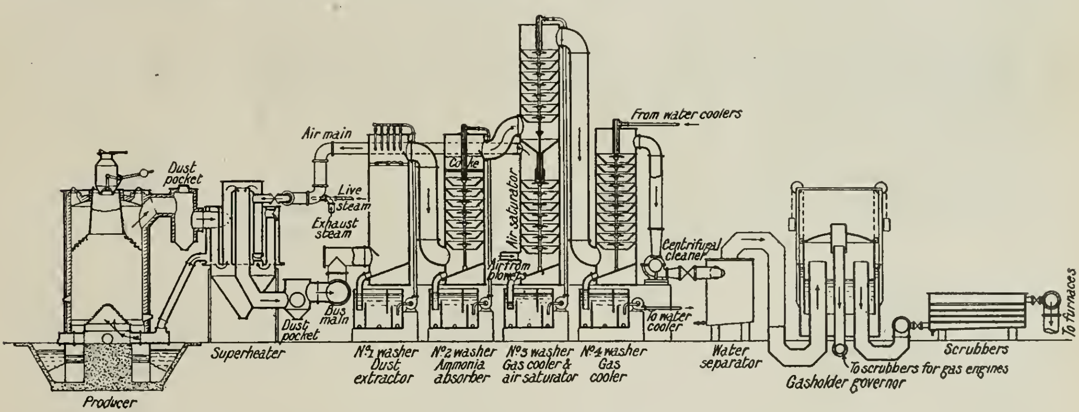

Fig. 5 Lymn Gas Plant, Sectional Diagram

or tiles and no moving parts are employed. The apparatus consists simply of several vertical cylindrical chambers, No. 1 of which is simply fitted with water jets at the top which fill the vessel with spray through which the gas passes in an upward direction and is thereby washed. Nos. 2, 3 and 4 contain a series of truncated cones axially placed in the center of the apparatus; a vertical shaft carries a number of fixed disks opposed to these cones. The water entering at the top is distributed on the topmost disk from which it flows in a film or sheet on to the surrounding cone, thence it falls on to the next disk and so on to the bottom of the washer. The gas passes upward, countercurrentwise, through the sheets of falling water. By this means the gas and the washing liquids are brought into intimate contact, with a minimum expenditure of energy.

In this instance the ammonia absorber was built of steel and the usual lead lining dispensed with. No particular corrosion was observed.

The gas, after leaving the final cooler No. 4, is passed through two Jenkins centrifugal gas cleaners and then through a water separator of the cyclone type, from which it goes into the gasholder, governor which is so arranged that in the event of the gas failing, the supply to the gas engines is cut off before that to the furnaces. This prevents any suction caused by the engine coming on the furnaces which might lead to an explosion should the gas come again suddenly. Gas intended for use in the engines is passed also through sawdust scrubbers to extract the last traces of tar. This proved to be necessary as the centrifugal-fan cleaners do not make the gas sufficiently clean for use even in furnaces, which in this instance are supplied through comparatively small pipes (down to $^3/_4$ in. pipes, the presence of small amounts of tar could not be detrimental.

As regards the power units, multi-cylinder horizontal Otto engines of about 500 b.hp. were selected, each gas engine being fitted with an exhaust boiler, the exhaust being connected to the boiler with a by-pass.

The original article contains extensive data as to the costs and operating results which would be of only minor interest in view of the fact that only British coals were used.

Careful inspection was maintained with respect to the possible corrosion of steel vessels, which in this case were not lead-lined. Practically no corrosion was observed which might have possibly been the result of the composition of the coal. The author's experience would lead one to believe that little corrosion takes place with mild steel unless the metal is also either subject to erosive action or is under stress.

In general, and as far as English conditions are considered, the author believes that low-grade fuel must be better utilized in the future than in the past. While not all coal will be either gasified or coked, there is every probability of much more coal undergoing one of these processes in the future than is the case at present. To what extent sulphate of ammonia recovery from fuel will pay will depend not only on the nitrogen content of the fuel and its price (together with cost of recovery, including capital charges), but also on the selling price of the sulphate, and this may be greatly affected by some of the processes of nitrogen fixation that have been so largely developed during the war. This last consideration is likely to have an important bearing on the adoption of a process for recovering ammonia from coal.

It may be of significant import that the writer claims the shortened week with only one operating shift as a most disturbing element in connection with power generation. The load factor is the most important element in cheap power and a high load factor is impossible with a short working week and only one shift working in the 24 hr. as this deprives the central station of the diversity factor which might make up for the short working hours employed by the consumers. (*The Journal of The Institution of Electrical Engineers*, vol. 58, no. 292, June 1920, pp. 417–430 4 figs., *d*)

REFRIGERATION

Ice Tank of New Design, C. Wilkie. Description of ice-freezing tanks installed in the Finney Avenue Plant of the Merchants' Ice and Coal Company, St. Louis, Mo.

During the season of 1919 it was decided to increase the capacity of the ice-freezing tanks in the plant, which could be done either by building a new tank or extending the old tanks. The latter

was much the cheaper plan but would make an excessively long tank, calling for a coil 1500 ft. long, provided the coil ran the full length of the tank.

The design finally resorted to called for a tank 114 ft. long, holding 856 cans freezing 400-lb. blocks. The general layout is shown in Figs. 6 and 7. In the first place, there is an expansion header made of 5-in. pipe and provided with nipples to receive the two connections from each double coil. The header lies in the bottom of the tank and fits the two bottom pipes of each double coil, which gives an even ammonia feed for each coil as the head must be half full of liquid before any of the coils can receive any of it.

The whole tank is arranged so that direct-expansion coils are in one end and flooded coils with the horizontal accumulator at the other end. In the direct-expansion end of the tank the coils are double, that is, two coils in one; in the flooded end of the tank triple or three-in-one coils are used, each 220 ft. long. The liquid ammonia for the flooded end passes through the direct-expansion coils, then through the 7-in. line to the accumulator, thence by gravity feed into the bottom of the flooded coils, the gas passing from the coils back into the side of the accumulator above the liquid fuel (Fig. 6).

Agitation is produced by a single propeller designed on the theory that higher efficiency can be secured with a large unit than with very small ones. The propeller is 36 in. in diameter and has three steel blades. It has a blade-tip speed of 16 ft. per sec. and is located in the center of the tank. It produces 7 in. of agitation, or one inch to seven cans.

In the original article tables are given showing the performance

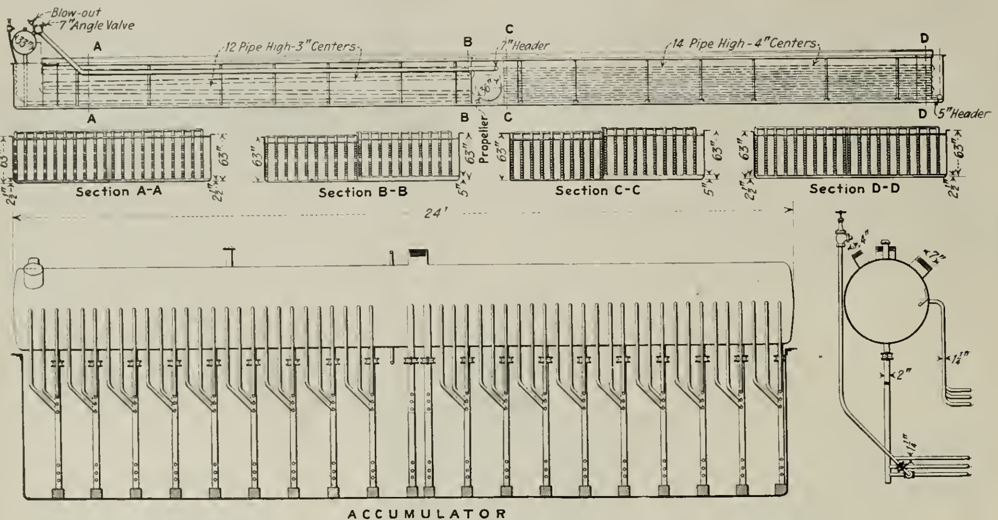

Fig. 6 General Layout of Ice Tank and Connections to Horizontal Accumulator

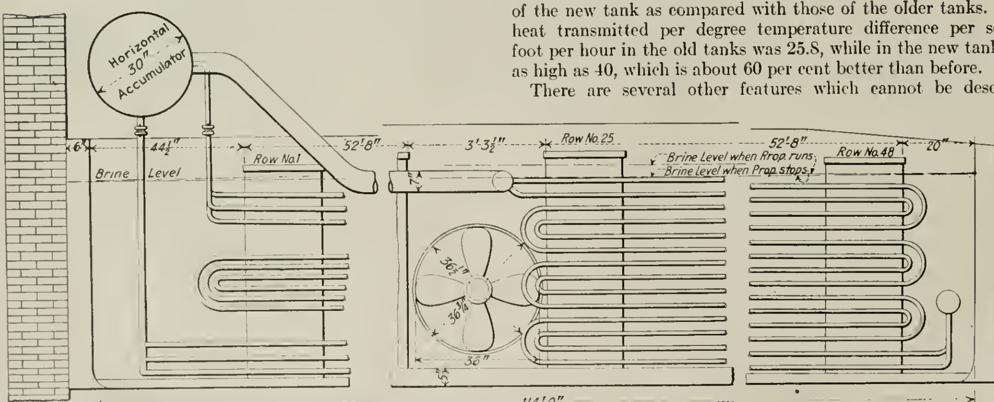

Fig. 7 Connection of Flooded Coils to Accumulator in Ice Tank

of the new tank as compared with those of the older tanks. The heat transmitted per degree temperature difference per square foot per hour in the old tanks was 25.8, while in the new tank it is as high as 40, which is about 60 per cent better than before.

There are several other features which cannot be described here for lack of space, such as the use of a special floor design, higher cans, means for holding cans vertical, and interesting hoisting and handling appliances. (*Power*, vol. 52, no. 21, Nov. 23, 1920, pp. 823–826, 8 figs., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquires for further information in connection with articles reported in the Survey.

A Department Conducted by the Research Committee of the A.S.M.E.

A Research Information Bureau

THE National Research Council has established the Research Information Service as a general clearing house and informational bureau for scientific and industrial research. This "Service" on request supplies information concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc.

Ordinarily inquiries are answered without charge. When this is impossible because of unusual difficulty in securing information, the inquirer is notified and supplied with an estimate of cost.

Much of the information assembled by this bureau is published promptly in the "Bulletin" or the "Reprint and Circular Series" of the National Research Council, but the purpose is to maintain complete up-to-date files in the general office of the Council. Announcement will be made from time to time of special informational files which have been prepared.

Requests for information should be addressed, Research Information Service, 1701 Massachusetts Ave., Washington, D. C.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A1–21. COMPARISON OF ELECTRICAL INSTRUMENTS. The Bureau of Standards has recently coöperated in the comparison of the standards of the various laboratories of a large electrical manufacturing company. The instruments used for measuring current, voltage and power were carried from one laboratory to another and to the Bureau of Standards. The instruments were carefully checked against the working standards of each laboratory and showed a close agreement between the apparatus used in the various plants. The test also indicated that the different types of instruments tested maintain their accuracy under varying conditions of transportation. Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Cement and Other Building Materials A1–21. POPPING OF LIME PLASTER. An eight-page article is to appear in the *Journal of the American Ceramic Society* on the Popping of Lime Plaster, by Warren E. Emley and Cecil H. Bacon. The work was done at the request of Committee C-7 of the American Society for Testing Materials. Seventy-two specimens were made in the original series of experiments to determine the effect of underburned or overburned lime, the method of slaking, the quality of the sand and the presence of certain suspicious impurities. It was shown that the chlorides of sodium and magnesium, while they do not cause popping, cause serious discoloration. Another series of experiments showed that impure hydrate soaked overnight with water developed the usual buff color, but when soaked in an airtight container the color was green. This accidental discovery led to the suspicion of ferrous iron, which was confirmed. A third series of tests confirmed the fact that iron in the metallic, ferrous or ferric condition was quickly changed into the ferric condition, with consequent expansion and popping. The iron from the coal ash is apt to enter the lime in the methods usually employed in operating kilns. Other compounds from coal ash may cause trouble as compounds formed from lime and silica or lime and alumina will hydrate slowly when exposed to water and will expand as they hydrate. It is impossible to identify these compounds by means of analytical chemistry, and being in a colloidal state identification by microscope is difficult. Experiments were made by picking the centers out of pops and analyzing these chemically and microscopically.

The following conclusions are drawn:

1 The popping of a lime plaster is caused by the presence of grains of a material which hydrates slowly and expands as it hydrates.

2 This material may be a compound of calcium with silica, alumina, or iron, or it may be an incompletely oxidized salt of iron.

3 Such compounds may be introduced as impurities in the limestone, as ash from fuel, or as impurities in the sand.

4 When such impurities are uniformly distributed throughout the limestone, they will not cause trouble, even when the lime is overburned, if two precautions are observed: the hydrate should be screened through a No. 48 sieve and should be soaked overnight before using.

5 When the impurities occur along bedding planes on the stone, or as balls of clay adhering to the stone, or are introduced as ash from the fuel, they can be identified by the formation of a dark vitreous crust on the surface of the lime. All such lime should be discarded as unfit for plastering.

6 The sand should contain not more than 1 per cent of the chlorides of sodium and magnesium. Common clay, leaf mold, and similar impurities, do not cause popping. Ferrous carbonate and magnetite are apt to cause trouble if they occur in particles coarser than 48 mesh.

7 Referring only to these impurities which commonly occur in lime, it may be stated that those particles which are large enough to stay on a No. 30 screen will be almost certain to cause noticeable popping. Those which pass a No. 30 and are retained on a No. 48 screen may or may not be troublesome. These which pass a No. 48 screen will not cause noticeable popping, if the lime is soaked overnight before use.

8 Production of lime which will not pop may be assured by following these three precautions: (*a*) Reject all lumps of lime which are encrusted with vitreous material. (*b*) Screen all hydrate through a No. 48 sieve. (*c*) Soak all lime putty overnight before using it as a plaster.

9 Popping can be caused by impurities in the brown coat as well as in the finish coat. The above precautions should therefore be applied to both mason's hydrate and finishing hydrate.

10 The method of testing for popping now in use is fundamentally sound and gives satisfactory results. It is believed, however, that a requirement for fineness would be of greater value as a part of standard specifications for lime.

Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Glass and Ceramics A1–21. CERAMIC PUBLICATIONS. The following publications dealing with ceramics have recently appeared:

1 The Rate of Vitrification of Porcelain Molded under Different Conditions, by R. F. Sherwood, in the October number of the *Journal of the American Ceramic Society.*

2 The Post-War Status of the Ceramic Industry, by A. V. Bleininger, *Chemical and Metallurgical Engineering*, Sept. 29, 1920.

3 Enamels for Sheet Iron and Steel, by Prof. J. B. Shaw, Technologic Paper 165 of the Bureau of Standards.

Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Metallurgy and Metallography A1–21. BEARING METALS. Experimental work on the compressive strength and hardness of white-metal bearing alloys at temperatures up to 100 deg. cent. has been completed and a paper has been prepared entitled Some Properties of White Bearing Alloys at Elevated Temperatures. The apparatus is described for determining the yield point and ultimate strength of white-metal bearing alloys. A new design of heating apparatus is described for determining the Brinell hardness of such metal under varying temperatures. The results of the compression test and the Brinell hardness are given for five typical white bearing-metal alloys, three tin-base alloys, one lead-base alloy, and one intermediate alloy. These tests show that the tin-base alloys maintain their properties better at elevated temperatures than those containing lead. Results indicate that up to 3 per cent the lead in a high-grade babbitt does not affect the yield point or ultimate strength at 25 deg. cent. or 75 deg. cent. The yield point of the tin-base alloy is not affected by heating for six weeks at about 100 deg. cent. The yield point of the lead-base alloy is lowered by heating for only two weeks at this temperature. Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

Metallurgy and Metallography A2–21. MAGNETIC PROPERTIES OF EUTECTOID STEEL. A simple carbon steel of eutectoid composition has been examined to find the effect of the rate of cooling on the magnetic properties and other properties of an annealed eutectoid carbon steel. A paper describing this investigation has been prepared. It was found that the magnetic properties are considerably influenced by variations in the rate of cooling from above the critical range and the corresponding variations are produced in the microstructure. There was an agreement between the values of the coercive force and the scleroscope hardness. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Mining, General A1–21. ASBESTOS. Report Serial No. 2179, by Oliver Bowles, gives the usability of asbestos from South Africa. The material is found in Rhodesia, the Union of South Africa, Transvaal, Cape and Natal. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Optics A1–21. Ultra-Violet Rays. The effect of ultra-violet rays from arc-welding outfits on the human eye has proven very serious. Conjunctivitis is produced unless heavy lenses made up of alternate layers of red or blue glass or orange glass of sufficient thickness are used. When eyes are injured by these ultra-violet rays, treatment should be given under the care of a physician. The usual treatment is to use ice packs for 15 minutes to an hour three to four times a day, to irrigate the eye with a salt solution of one teaspoonful to a quart of sterile water or saturated solution of boric acid several times daily. With pus discharge a few drops of 25 per cent solution of argyrol should be used in the eye three times to six times a day. The patient should be confined in a darkened room. Pain may be so severe as to require the administration of morphine. Report by Dr. C. R. Kindall, Surgeon, Bureau of Mines. Address Bureau of Mines, Washington, D. C., F. G. Cottrell, Director.

Petroleum, Asphalt and Wood Products A1–21. Evaporation Losses from Crude Oil. Evaporation Losses from Crude Oil during Piping and Storage on Oil Leases is the subject of a report, Serial No. 2169, by A. R. Elliott. The results show that the evaporation depends on temperature and amount of disturbance to which the oil is subject. Open tanks will lose more oil on a cool, windy day than on a hot, still day. A gastight metal roof is better than one made of timber. The atmosphere above the oil in a tank is saturated with oil vapors. Under sun heat a temperature sufficient to distill the higher fractions from the oil is obtained. To maintain a low temperature a lagged or shedded tank should be used. A water-sprinkled tank painted white was proven to be most effective. This was followed by a water-sprinkled tank painted black, a glossy-white-painted tank, a water-topped tank, a black tank and an oil-stained, loose-wooded roof tank. The evaporation of gasoline from the crude oil amounted to from 5 to 25 per cent. Bureau of Mines, Washington, D. C. Address F. G. Cottrell, Director.

Railway Rolling Stock and Accessories B1–21. Thermal Stress in Steel Car Wheels. An investigation to determine the stresses in steel car wheels similar to that recently completed on chilled-iron wheels has recently been begun and tests on six wheels have been completed during the month of October. Address Bureau of Standards, Washington, D. C., S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of those investigators are given for the purpose of correspondence.

Agricultural Equipment and Engineering B1–21. Wastes. The recovery of valuable by-products from agricultural wastes in California is being investigated by the Beckman & Linden Engineering Corporation. Address J. W. Beckman, President, Beckman & Linden Engineering Corporation, Atlas Building, San Francisco, Cal.

Apparatus and Instruments B1–21. Bourdon Tubes. An investigation of the characteristics with a study of hysteresis effects of bourdon tubes, using an optical lever system for the exact determination of displacements under varying conditions. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Automobile Vehicles and Equipment B1–21. Wear of Automobile Parts. Work for the Motor Transport Corps has been undertaken by weighing a number of bearings and gears on a sensitive balance, after which these are to be placed on cars in service. After a certain length of time these parts will be weighed. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Cement and Other Building Materials B1–21. Terra Cotta Investigation. The thermal expansion of seven different glazes and ten underslips is being determined from rods recently made. The therma expansion of clay specimens has been determined. The transverse strength is being investigated to determine the difference between pressed and cast terra cotta. The results on the transverse strength show that the glazed side does not have as great a tensile strength as the unglazed side of the terra cotta. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemistry, Inorganic B1–21. Magnesia and Carbon Black. Researches on the electrolytic production of magnesium and on the manufacture of carbon black are under way at the laboratories of the Beckman & Linden Engineering Corporation. Address J. W. Beckman, President, Atlas Building, San Francisco, Cal.

Electrochemistry B1–21. Lead Storage Battery. A lead storage battery built on a new principle is being investigated by the Beckman & Linden Corporation. Address J. W. Beckman, President, Atlas Building, San Francisco, Cal.

Paints, Varnishes and Resins B1–21. Fireproof Paint. The Glenn L. Martin Company is at work on tests of fireproof paint in connection with aircraft. Address L. C. Milburn, Assistant Chief Engineer, Glenn L. Martin Company, Cleveland, O.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Mechanics C1–21. Strength of Tubings. Data are required on torsional stresses induced in light-wall steel tubes from 1 in. to $2^1/_2$ in. O.D. and of Nos. 14 to 22 B.W.G. wall thickness. The stress determined by the formula $S = Pac/J$ is desired. Pa is the turning moment, c the distance from the neutral axis to the outside fiber and J is the polar moment of inertia. The curve in Fig. 1 shows the results acquired thus far. Address L. C. Milburn, Assistant Chief Engineer, The Glenn L. Martin Company, Cleveland, Ohio.

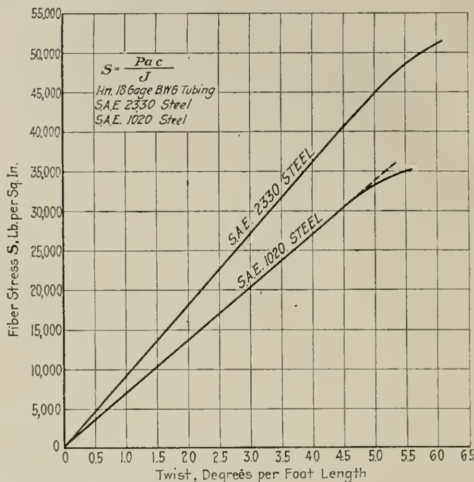

Fig. 1 Relation between Twist and Fiber Stress in 1-In. No. 18 B. W. G. Steel Tubing

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Beckman & Linden Engineering Corporation D1–21. See *Beckman & Linden Engineering Corporation E1–21.*

Glenn L. Martin Company, Cleveland, Ohio, D1–21. The laboratory of this company consists of the usual chemical and physical departments. The Materials Testing Department includes one 50,000-lb. Olsen tension machine, one Erichsen sheet-metal testing machine, one pendulum-type combined testing and shock-testing machine, one rib-testing machine. Address L. C. Milburn, Assistant Chief Engineer, Glenn L. Martin Company, Cleveland, Ohio.

Metal & Thermit Corporation D1–21. The Research Laboratory of the Metal & Thermit Corporation is equipped with various types and sizes of furnaces, including reverberatory furnsces, smelting furnaces and muffles. Equipment for leaching, grinding of laboratory samples and for quantities used in manufacturing. The research equipment is divided into three classes according to size. The smallest is used in the laboratory and the largest in separate buildings devoted to research work. Address Mr. J. H. Deppeler, Chief Engineer, Thermit Dept., Metal & Thermit Corporation, 120 Broadway, New York.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Beckman & Linden Engineering Corporation E1–21. The laboratory has worked out successfully the separation of salts from natural brines and the production of various strontium and barium compounds from local ores. It has devised an efficient, cheap way of concentrating vinegar to a high percentage of acetic acid and hss suggested economical utilization of various waste products of the rice industry. The laboratory is at work on the electrolytic production of magnetism, on a lead storage battery built on a new principle, on the manufacture of carbon black and on the recovery of valuable by-products from agricultural wastes in California.

voltages. Semi-commercial units are installed for extracting and distilling processes. Address J. W. Beckman, President, Beckman & Linden Engineering Corporation, Atlas Building, San Francisco, Cal.

Metal & Thermit Corporation E1–21. The research staff of the Metal & Thermit Corporation, 120 Broadway, New York, consists of about ten men, including the following:

Dr. E. A. Beck, from the Technical Universities of Munich and Aix-la-Chapelle. Dr. Beck worked on iron, steel, lead, silver, copper and zinc. In 1908–1909 he worked with the Roechling Iron and Steel Works, using the electric furnace. In 1910 he worked for the American Smelting and Refining Company and the American Vanadium Company. Since 1911 he has worked with the Metal & Thermit Corporation.

Mr. S Lubowsky (B.S. and Ch.E.), Carnegie Institute of Technology 1913, Ch.E. in 1917. Formerly Chief Chemist, Reduction Works, Crucible Steel Company of America.

Mr. L. C. Mazzola, B.Sc. Cooper Union, 1917. Worked with the Dexola Chemical Company and the Wright-Martin Aircraft Corporation.

F—Bibliographies

The purpose of this section of Engineering Research is to inform bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society which is probably the largest Engineering Library in this country.

Mechanics F1–21 Fatigue of Metals. See *Properties of Engineering Materials F1–21.*

Petroleum, Asphalt and Wood Products F1–21. Recent articles on petroleum and allied substances prepared monthly by the Bureau of Mines. Address F. G. Cottrell, Director, Bureau of Mines, Washington, D. C.

Properties of Engineering Materials F1–21. Fatigue of Metals. The Joint Committee on the Investigation of the Fatigue of Materials under the direction of Prof. H. F. Moore has prepared a 16-page bibliography of books, monographs and articles dealing with the fatigue of metals and with related phenomena. Address Prof. H. F. Moore, University of Illinois, Urbana, Ill., or A.S.M.E., 29 West 39th St., New York.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Readers Requested to Send Suggestions

To the Editor:

In my lectures on the principles of management, students are required to do coördinate reading from books written by prominent engineers and business men. This part of the course is proving to be of great value, but in order to make it as effective as possible I would like the help and suggestions of engineers as to the best books for this purpose.

The problem is one of selecting the volumes which will inspire the student to strive for high ideals in engineering and in the management of industrial affairs. My present list is made up from my own experience, but I am sure that many helpful suggestions might be received from practicing engineers who employ engineering graduates. I would be very glad to have suggestions from the readers of Mechanical Engineering.

Bruce W. Benedict.

University of Illinois, Urbana, Ill.

DeLamater Ericsson Tablet Committee Report

To The Editor:

In your October issue you printed a statement regarding the DeLamater Ericsson Commemoration held during the last annual meeting of the A.S.M.E. and the movement since then to erect memorial bronze tablets on the sites of four buildings in this city with which the lives and work of Mr. DeLamater and Captain Ericsson were associated.

As it was largely through the courtesy and assistance of the A.S.M.E., of which Captain Ericsson was a member, that this meeting and movement took place, the Committee feel that it would be proper to report in the columns of its publication the status of the subscriptions which have been made to them so far.

For the Commemoration Meeting each of the following societies subscribed $50.00:

American Scandinavian Alliance of Greater New York
American Scandinavian Foundation
American Society of Mechanical Engineers
American Society of Refrigerating Engineers
American Society of Swedish Engineers
Associated Veterans of the DeLamater Iron Works
Engineers' Club of New York
John Ericsson Memorial Committee (by Mr. John Aspegren, Chairman)
New York Historical Society
Society of Naval Architects and Marine Engineers
Union League Club.

Total Subscriptions	$550.00
Total Expenses	375.00
Balance	$175.00

The A.S.M.E. also furnished the auditorium, lantern and ushers, and the American Scenic and Historic Preservation Society, through its secretary, Dr. E. H. Hall, gave valuable assistance in arranging for the meeting and is printing an account of it, with excerpts from the addresses, in its report to the state legislature. Reprints of this report will be furnished to the subscribers to the meeting and to the Tablet Fund, which latter to date comprises individual members of the following societies and individuals:

Amaranthus Lodge, Independent Order of Odd Fellows	$25.00
American Scandinavian Foundation	10.00
American Scenic and Historic Preservation Society	25.00
American Society of Mechanical Engineers	99.00
American Society of Refrigerating Engineers	30.00
American Society of Swedish Engineers	250.00
Associated Veterans of the DeLamater Iron Works	256.00
Bredablick Lodge, Free and Accepted Masons	250.00
Capt. John Ericsson Memorial Society of Swedish Engineers	130.00
General Society of Mechanics and Tradesmen	323.04
John Ericsson Memorial Committee	75.00
Past District Deputy Grand Masters' Association of Greater N. Y.	10.00
United Swedish Societies of N. Y.	250.00
DeLamater family	700.00
Thomas F. Rowland	500.00
Ogden Mills	250.00
Wm. H. Todd	100.00
Stevenson Taylor	50.00
Brought forward balance of Commemoration Fund	175.00
Total Subscriptions (to date)	$3508.04
Total Expenses (to date)	$ 105.00
Balance	$3303.04

It is hoped that subscriptions from American societies will exceed or at least equal those of the Swedish societies and that there will be besides many patriotic and public-spirited individuals who realize and appreciate the valuable services which Mr. DeLamater and Captain Ericsson rendered to this country and will help to raise

the amount of the fund to $5000, which is what is needed to make and erect the tablets which the Committee have in hand.

The Committee has in hand the development of a motion-picture scenario of the life of Captain Ericsson, which was full of highly dramatic occurrences. This will be of great educational benefit to the public in advance of the dedication of the John Ericsson Memorial in Washington, D. C., on the 60th anniversary of the battle of the *Merrimac* and the *Monitor*, March 9, 1922.

Names of individual subscriptions will be supplied later.

H. F. J. Porter, *Chairman*,
DeLamater Ericsson Tablet Committee.

25 W. 39th St., New York City,
December 1, 1920.

Eliminating Monotony from Work

To The Editor:

At the meeting of the Society held on November 5, a very important principle was emphasized by Mr. Gompers when he stated that the efficiency of human life must take precedence of the efficiency of human production, and it was of the highest significance that Mr. Dickson, presumably viewing the situation from the opposite end of the industrial scale, in effect endorsed the statement of Mr. Gompers.

This statement admits the principle that the man is greater than either the dollar or the machine, and its acceptance by such representative men as Mr. Gompers and Mr. Dickson amounts in a sense to an official indorsement on behalf of all parties interested in the adjustment of industrial relations.

It will doubtless be readily admitted as a theoretical proposition that the man is more than the dollar or the machine, but actually to design our machines and processes with a view, firstly, to their effect upon the operator, and secondly, to their productive efficiency, means a radical departure from our present methods of procedure; and yet it would appear that the time has come when we must at least make some serious effort in this direction if we are to avoid the rocks which lie ahead.

The situation presents to the engineer a problem the solution of which must call into play his highest qualities, both social and professional, but at the same time it opens to him a field of usefulness which far transcends the mere production of physical wealth, and places him in a position of leadership in the upward progress of humanity.

It is most desirable that in dealing with this matter we should conserve, as far as possible, all that is best in our present system, not applying revolutionary methods, but guiding development along sound evolutionary lines.

One of the most productively efficient, but at the same time most humanly destructive, factors in our present system is monotony of operation, and it seemed to be the consensus of opinion that the evils of this could not be overcome without destroying the method. The productive advantages of this method however, are so great, both to the community at large and to the producers, that every effort should be made to ameliorate the evils without too great a sacrifice of efficiency, and the writer is hopeful that much may be accomplished in this direction.

The question which presents itself is: Are the evils of a monotonous process entirely inherent in the monotony, or can they to some extent be eliminated? To be more specific, is the distress chiefly caused by the contemplation of a monotonously recurrent process, or by what we may term a monotonously received fatigue shock?

The validity of this question will be apparent if we consider such an operation as hand knitting. Those who are expert in this work carry it on in such an automatic manner that they can engage in conversation or other form of mental activity without detriment to the work, and yet it is such as these who find knitting to be a pleasurable occupation; but if we look into the matter closely we shall find that the work is generally carried out under the most comfortable conditions and with a minumum of fatigue.

There is an old superstition which is dying, it is true, but dying hard, that a workman earns his wages in exchange for his fatigue. Let us forget this superstition and admit that fatigue is an evil and the enemy of efficiency; would it not then be possible to redesign some of our more monotonous processes so that they may be carried out under the most comfortable conditions and with a minimum of fatigue shock?

The writer does not expect that all the evils of monotonous operations can be eradicated, but as it is obvious that most of them have been designed without due consideration of the above factors, he is very hopeful that a full investigation of the subject may lead to valuable results. James O. G. Gibbons.

East Orange, N. J.

Specialized Training in College

[An article on The Training of Engineering Students in Industrial Management by Prof. W. B. Benedict of the University of Illinois, published in the September issue of Mechanical Engineering, p. 492, brought forth a letter of discussion by W. D. Ennis, New York, N. Y., which appeared in the November issue of Mechanical Engineering, p. 640. The following is a further discussion of this subject, presented in a letter to Mr. Ennis and here published by permission.—Editor.]

I have read your letter in the November number of Mechanical Engineering with much interest, because, having spent the major part of sixteen years in technical teaching, and eight in marine engineering, about four years at sea, and the remainder in designing and estimating, I feel that I have combined engineering and commercial experience in sufficient quantities to enable me to get a good idea of just how much of what a man gets in college is useful to him afterward. I might add that during all my teaching years I had from three to four months every summer as vacation, and that I devoted nearly all these periods to practical work in various engineering plants.

Now there is nothing at all brilliant about myself; I am today "rotten" at pure calculus; much of theoretical thermodynamics; the higher and more mathematical parts of alternating currents; and all the more abstruse parts of naval architecture. Consequently, I feel that it is quite fair, in such things, to judge others by myself. The net result of this judgment is that we cannot afford in the four years that is all most boys can spend in college, to specialize them too much. In other words, we cannot turn out managers, superintendents, production engineers, time- and motion-study experts, transportation men, automotive men, internal-combustion experts, etc. I took my own course in mechanical engineering under the stern but beloved administration of the late Dean Joseph F. Klein; and as an undergraduate I often criticized Lehigh because there were no shops there, and no "practical work" such as other colleges had. To be sure, we had our "shop visit" courses, with the free run of the Bethlehem Steel Co., the Bethlehem Foundry & Machine Co. and other local industries, besides the Lehigh Valley Shops and the Ingersoll-Sergeant Works at Easton, and occasional trips to Niagara Falls and other centers of industry or power development; but *we did no work with our hands*, with the exception of a little in the college laboratories. But we did have the principles, the mathematics and the mechanics of it all most thoroughly drilled into us, and I think we went out able to tackle, *at the bottom*, any branch whatever of mechanical engineering. I had grown up, myself, in the mining and manufacturing city of Wilkes-Barre, Pa., and had spent much of my spare time around the shops and mines; and when I entered college, I was quite "fingerwise," as Gilbreth says.

And when I left college, and through the kindness of the late James S. Doran was allowed to go away to sea on the old *Pennsylvania* of the Red Star Line, I found that even the small store of practical experience I had already acquired was of small use. Even jobs that seemed similar were done in a different way. I learned how to "take leads;" how to work up a set of indicator cards without a planimeter; that Whitworth nuts will run down on a Sellers stud, but Sellers nuts won't run down on a Whitworth stud; and that taking the "lost motion" out of a 24-in. crankpin was an entirely different job from taking it out of a 3-in. one. During the years I spent at sea I was transferred around from ship to ship as all engineers are, and served under several different chief engineers; and two of these men were masters of

Shipbuilding Corporation on Shooter's Island, and Mr. Coxe is once more my chief, as he is now vice-president and general manager of the Pusey & Jones Company. They were the only "post-graduate professors" I ever had, and none could have been better. ....And after some years at sea I went into a marine drafting room and began to get another line of instruction and experience.

I found, for instance, that it was possible to get out all the principal dimensions of a triple-expansion engine in a few hours, and that my college bugaboo, thermodynamics, could be entirely dispensed with, barring a few figures and tables. And I remembered that Mr. Hunter had once told me at sea that all engineering consisted of "decimal fractions, common-sense and experience." Another time, when I was overhauling an especially mean set of metallic packing, Mr. Coxe had come along the grating and said, "All that trouble comes from too much 'white shirt' in the drafting room."...And through all this I wondered whether going to college had done me one bit of good....But I see now, and have seen for a good many years, that it had done me all the good in the world: for one thing, it taught me not to be afraid of anything that came up. Had I learned how to take leads or chip oil grooves and keyways in college, it would have been at the expense of some of those general principles that had been hammered into me.

Since I have been with my present employers my work has been principally marine estimating. We have here a pretty good system, and we are making it better right along. I could teach this system or method in a college, but I should want students who were at least seniors, and good ones at that; and I should want at least a year to do it, with lectures, recitations, practicum and quizzes. And when I had a boy as well taught as possible, do you think any shipyard would give him a *responsible* job at a good salary? Not in twenty years! He'd have to work up to it from the drafting room, the shops or the yard. So many boys seem to have a horror of the drafting room. They place where they can make an immediate use of what they have learned in college. If they go into the shop, the youngest apprentice boy can "show them up," and their ignorance of shop practice is apt to make the so-called practical men about the plant think that, because they don't know much about the way things are done in the shop, they don't know anything. Nobody seems to think that an architect ought to be a skillful bricklayer, yet lots of shop men think that if a man can't run a milling machine or line up an engine, he can't do anything in the plant. Not that a good knowledge of shop practice is not a tremendous asset to any mechanical engineer: in fact, it is a *sine qua non* of really good design. And any chap with proper ambition can get all he needs by putting in his summer vacations at it while he is still in college. And after he goes to work, if he starts in the drafting room, he can learn a great deal by making friends with the various foremen, and submitting preliminary designs to them for their criticism. This is especially helpful, not only in fostering a spirit of coöperation, but in enabling a draftsman to design to suit his own plant's shop equipment; for often what is the best way to design for one shop is the wrong way to design for a shop with a different outfit of machine tools. I learned this by costly experience, and pass it along for what it is worth.

Probably you have been able to guess that my principal object in this letter, though not very precisely stated, is: Don't introduce *any* highly specialized course into a *college*. Leave them to trade and industrial schools and to post-graduate courses How many boys entering college *know* what they want to do? Not one in fifty. So give them the great General Principles, and let them hew out a niche for themselves, where they will fit, after they get out. I once heard the late Eckley Coxe say, "If your four years in college have taught you nothing but that you are unfitted for the profession you set out to study, they have not been wasted."

Wilmington, Del. W. S. Ayars.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 318 to 321 inclusive, as formulated at the meeting of October 14, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 318

(In the hands of the Committee.)

Case No. 319

Inquiry: Is it allowable, under the requirements of Par. 308 of the Boiler Code, to connect to a boiler to be operated at a pressure exceeding 15 lb. and not to exceed 100 lb. for the return of condensation to a heating system, a 4-in. return connection, this same return connection being used as a blow-off, but the blow-off connection therefrom being reduced, however, to $2^1/_2$ in. pipe size or less?

Reply: It is the opinion of the Committee that such a connection for return of condensation will not be in accordance with the requirements of Par. 308 of the Code. It will be necessary to use an independent connection for the return.

Case No. 320

Inquiry: Will it meet the requirements of Par. 303 of the Boiler Code where a non-return angle valve is mounted directly on the steam outlet nozzle of a boiler, and to the outlet of this valve there is bolted a gate valve, forming the two stop valves required, to provide the ample free-blow drain between the two valves by a $1^1/_2$-in. pipe tap in the side of the non-return angle valve just above the seat, in order to avoid the necessary of placing a fitting between the two valves?

Reply: It is the opinion of the Committee that such a construction will fully meet the requirements of Par. 303.

Case No. 321

Inquiry: Is a boiler of the porcupine type where stub tubes are screwed in the furnace sheet subject to the requirements of Par. 250 of the Boiler Code, or is the screwed connection of such stub tubes permissible?

Reply: Par. 250 refers specifically to fire-tube boilers and is therefore not applicable to a boiler of the porcupine type in which the tubes are operated under conditions similar to those of the water-tube type of boiler. Par. 251 refers to tubes which are expanded into the tube sheets and does not apply to tubes with screwed ends. It is the opinion of the Committee that the pipes or tubes should meet the requirements recommended by the Committee in the reply for Case No. 296—that special redrawn pipe, not to exceed $1^1/_2$-in. standard pipe size made from lap-welded iron of puddled stock and tested to 1000 lb. hydraulic pressure, may be used for a working pressure not to exceed 200 lb. per sq. in., provided the wall thickness is at least 50 per cent greater than the wall thickness required by the Code for tubes of water-tube boilers. The minimum number of threads should conform with the values given in Table 8 of the Code. The closed ends of the stub tubes may be welded by the forging process.

MECHANICAL ENGINEERING

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The Engineer's Work at Hog Island

Carl C. Thomas

THE great shipyard at Hog Island, built by the American International Shipbuilding Corporation for the Emergency Fleet Corporation of the United States Shipping Board, has served successfully the purpose for which it was built and will soon be closed. Many of the members of this and of the other engineering societies were instrumental in carrying forward this undertaking, and the building of the plant and ships is one of the greatest examples of engineering and industrial coöperation. Not only were the executives and engineering forces drawn from many branches of the engineering profession, but the material for the ships and their equipment was supplied by more than 3500 different companies located in widely separated sections of the country. To the able and enthusiastic efforts of these organizations is due in large measure the marked success with which the program was carried out. The closest coördination was necessary to bring together materials and equipment in proper sequence to fit into a carefully planned construction program of such magnitude.

The Hog Island Yard is just completing the last of its contract for 122 steel vessels of the highest rating in Lloyd's and the American Bureau of Shipping Registries. Most of these ships have been in service for many months—and the *Quistconck*, the first to be completed, has steamed upward of eighty thousand miles. A recent examination showed here to be in first-class condition in every respect. Similar records have been made by many of the other Hog Island ships and all have given entirely satisfactory performance. The *Liberty Glo* was blown in two by a mine in the North Sea in December, 1918. Both ends floated ashore on a Dutch island some miles away, saving both crew and cargo, with the exception that two men who left the ship in a small boat died from exposure, and the cargo in the one ruptured hold was of course lost. The ship was put together again in Holland and has been in satisfactory service ever since under her original rating. At least six cases are on record in which Hog Island ships have rescued disabled vessels and towed them safely to harbor. The twelve 8000-ton troop-carrying vessels built in addition to one hundred and ten 7800-ton cargo ships, are to be used principally by the Army Transport Service, their interior arrangements having been radically changed from the original design to suit the revised army requirements. The last of the troopships are now about to go into service and the great yard, which was taken over by the United States Shipping Board according to the original arrangement with the American International Shipbuilding Corporation, is to be disposed of by the Shipping Board.

Hog Island is the largest shipyard in the world. The 50 ways occupy a waterfront over a mile in length, the wet basins and outfitting piers about three-quarters of a mile, and the storage yards at the two ends bring the total length to about two and a half miles. The width of the yard is about three-quarters of a mile. There are 84 miles of standard-gage track serving the storage yards, warehouses, ways and wet basins. Each of the seven outfitting piers is 1000 ft. long and accommodates four ships, so that 28 ships can be berthed at one time. During the war, in the period of greatest activity at the yard, fully 36,000 employees were constantly at work. The shipyards and engineering establishments of the country as a whole were in urgent need of all the labor that could be made available and it was an enormous task to maintain the great force of men required by such an undertaking as that at Hog Island. The work of building the yard was started in September 1917, and by the early part of February the 900 acres of swamp land had been so far drained, graded and built upon that the first keel could be laid at that time. Wherever buildings, tracks or ways were to be constructed the ground required that piles should be driven. An enormous amount of dredging was necessary along the river front and all of this work was done in spite of the unprecedented severity of the weather in the winter of 1917–1918. The building of adequate roads and providing of transportation facilities between Philadelphia and the shipyard, a distance of about nine miles, was in itself a great task; and in addition housing accommodations were provided for several thousand employees at the Island.

The designing of the ships and their equipment and the ordering of material proceeded contemporaneously with the designing and building of the shipyard, and material for the ships was rushed to the Island with the greatest possible speed. The work of storing the enormous quantities of material required for so large a number of ships and of arranging for delivery in the sequence necessary for systematic progress in construction, required the services of a large and well-organized storage department. Perhaps an even greater task devolved upon the purchasing department because of the fact that everything going into the ships was made and purchased and inspected in distant places. This required a very large force of inspectors and expeditors as well as an elaborate system for tracing the vast shipments of material.

In the old-line shipyards the material constituting the ships, from hull steel to and including equipment, is largely worked up and made at the yard. In the case of Hog Island everything had to be made away from the shipyard and delivered in a condition so true to the drawings that the parts would fit together satisfactorily. This involved much more detailed design work than would otherwise have been necessary and an unusual amount of care upon the part of the inspection force. This was especially true because the greater part of the material was made by firms who had never before done marine or shipbuilding work. For example, rudders were made at steel works in Kansas City, Minneapolis, Pittsburgh and Cleveland; anchor windlasses in Chattanooga; winches in Minneapolis and Ashtabula; capstans in Denver; and hull steel was worked up, sheared and punched to templet in some forty different fabricating shops in as many localities.

The close coöperation required by these conditions has undoubtedly had the effect of uniting the engineers of this country and bringing them into closer working contact. It has also given great cause for a feeling of encouragement as to the ability of our industries to rise to an emergency and serve the country with energy and enthusiasm in time of need. The difficult conditions

It is greatly to be regretted that misinformation regarding this great project was spread throughout this and other countries. In common with other undertakings for which Government agencies were ultimately responsible, Hog Island suffered from malicious attacks from political groups. Expensive and time-consuming investigations were set on foot by these agencies which greatly delayed shipbuilding and which, far from discovering any of the dishonesty or incompetence charged, only served to show conclusively that the work was being done energetically and effectively; and in spite of great difficulties, attaining a speed of production and excellence of output which could not be brought about by any but an exceedingly high-grade and well-organized body of engineering executives.

Hog Island now stands in the eyes of the country as one of the striking examples of what American engineers can do. It is one of the very few instances in which a war venture has been so conceived, constructed and operated as to be able to continue producing a successful product in times of peace.

Elaborate investigations conducted after the yard was completed and in operation showed that it had cost far less than the sum which would have been necessary to reproduce it at the time of the investigations.

This country may well be proud of its great engineering firms which have carried through with fidelity enormous undertakings for the benefit and convenience of mankind; and of the fact that one of these firms organized and brought to successful issue the great undertaking at Hog Island, in response to the emergency call for ships. Carl C. Thomas.

Measuring the Two-Hundred Millionth Part of an Inch

Our knowledge of engineering phenomena is limited by our ability to measure them. The difference between engineering knowledge and guess lies in the fact that the former is based upon data obtained from actual measurements, while the latter presupposes and assumes things which may or may not be so.

With this in mind it is easy to see why any refinement in our methods of measurement is likely to bring about a material increase in our knowledge of engineering phenomena. This has been well illustrated in the great realm opened up by the ultra-microscope. In the field of measurement of lengths the micrometer has been of incalculable value for many years. Of late, however, new methods of measurement based on the employment of light waves have extended the precision achieved by micrometers to within the region of one-millionth of an inch, and now comes the ultra-micrometer of Professor Whiddington of Leeds University, by means of which measurements to within the scarcely credible limit of one two-hundred millionth of an inch can be carried out with apparently great precision. This novel method is based on certain electrical phenomena which may be in general described as follows:

If a current be sent through a circuit containing an inductance coil and a condenser, the circuit will have what is known as a natural frequency, that is, a certain frequency of alternations depending on the respective values of the inductance and capacity involved.

If another circuit with an inductance and capacity be magnetically linked with the first circuit and a telephone be inserted in the first circuit, a sound will be heard in this telephone whenever the frequencies in the two circuits do not exactly coincide. The volume of the sound and hence its audibility depend, however, on the current flowing and the difference between the frequencies in the two circuits, and it is obvious that in order to make the device very sensitive it is necessary to make the telephone sensitive to extremely small variations, which can be done only by having both the current and the difference in frequencies very small.

On the other hand, as stated, the frequency in the primary circuit varied by varying the distance between the condenser plates, which is the distance that has to be measured, or is proportional to the distance measured.

Here again it is obvious that if the distance between the condenser plates changes by a magnitude of the order of a small fraction of a millionth part of an inch, the circuit must be extremely sensitive to record it. An ordinary oscillating circuit does not have this great sensitiveness, but by using the so-called "thermionic valve" developed primarily for wireless telephone and telegraph work the current in the primary circuit may be magnified many times before it is sent into the telephone without, however, materially disturbing either the frequency or the shape of the wave. In a thermionic valve the initial current, which may be and usually is extremely minute, establishes a flow of ions between two elements enclosed in a vacuum. This flow varies in frequency, direction and intensity exactly as does the initial current. There is also a secondary circuit established which is linked with the primary circuit in such a manner that one of its terminals is constituted by one of the elements of the valve between which the ionic flow takes place, while the other is located between the two elements. It is now obvious that when there is no current in the primary valve circuit, there is no flow of ions between its two terminals. Hence there is a vacuum between the terminals of the secondary circuit and no current can flow therein. As soon, however, as a current is established in the primary circuit, ions are projected from one of its terminals to the other over the terminal of the secondary circuit located between them. As a result a sort of bridge is established between the terminals of the secondary circuit, permitting the current in that circuit to flow. Every interruption in the primary circuit is accompanied by a corresponding interruption in the secondary circuit, and the strength of the secondary current varies as the resistance in the gap between its terminals in the valve, which, in its turn, varies as the number of ions in that gap, or as the strength of the primary current.

Now a variation of one two-hundredth of one-millionth part of an inch between the plates of the condenser would be far below the range of sensitiveness of an ordinary telephone, but it is sufficient to affect the sensitiveness of the thermionic valve and to change the flow of ions between its terminals, which, in turn, produces changes in the much larger current taken from an independent source and thus gives a sufficient current to affect the diaphragm of the telephone.

If the Whiddington ultra-micrometer can be developed to the practical stage so as to make its use possible in engineering laboratories (sufficient information is not yet available to show whether this has been done or not), its applications may prove to be both extensive and important. It has already been found that it permits measuring the deflection of a solid wooden table produced by the weight of a coin placed on its edge. There is certainly need of an apparatus capable of measuring the minute deflections produced by the application of small loads and stresses to members of large cross-section. For example, it would be of interest to see how large bridges are affected by small loads. Many years ago it was stated that it would be possible to wreck the Brooklyn Bridge by means of a violin so played that the vibrations set up would always be in unison with the oscillations of the bridge. Whether this can be done or not is not very important; but whether such structures undergo minute oscillations or not may prove to be a matter of considerable value.

Another problem that might be investigated by means of the new apparatus is the law of deflection of springs under small loads, a law of which we are entirely ignorant. The question of expansion of metals under very small changes of temperature is also one that might be considerably cleared up by our ability to carry out measurements in the region of fractions of a millionth part of an inch.

The foregoing are only a few of the problems in whose solution the ultra-micrometer might be of service. And to repeat again what was said in the opening paragraph, our knowledge of engineering phenomena is limited by our ability to measure them.

Government Reorganization and a National Department of Public Works

At the last meeting of Engineering Council held in Chicago, M. O. Leighton, Washington representative of the Council, presented a report dealing with the activities of the National Department of Public Works Association.[1] With Congress now in session, interest in a National Department of Public Works has naturally revived, and it is therefore timely to make a rather complete report on the progress of the movement. The following has accordingly been abstracted from Mr. Leighton's report:

Two outstanding facts which were not anticipated when the public works movement took shape in April 1919, are first, that the engineers of the country in good faith started something which they do not now seem inclined to finish, and second, that the scope of the movement and its ramifications extend beyond all limits written or spoken of at the time.

The Movement for Government Reorganization

The fundamental arguments for a Department of Public Works apply with equal force to the entire Government organization. There has grown in a short space of time a country-wide movement for Government reorganization. The National Education Association, the Women Voters' League and the Federation of Women's Clubs, are supporting a proposed Department of Education. The American Public Health Association and other organizations in the realm of sanitation and preventative medicine are supporting a Department of Health. Certain welfare organizations are advocating a Department of Public Welfare; there is also a movement for a Department of Aeronautics; and an old movement for a Department of Mines still exists. The National Budget Committee, having practically completed its labors in behalf of a budget system of Federal Finance, is actively turning its attention to the entire field of Federal reorganization. The National Budget Committee, the Public Works Department Association, and the National Education Association are participating in the activities of what is known as the National Committee for Governmental Economy, the purpose of which is to make and report upon a complete study for governmental reorganization. The report is practically completed.

In all of these organizations, with possibly one exception, the creation of a Department of Public Works is an accepted doctrine. Opposition exists in some of the organizations to the purposes of some others, but all unite in favoring a public works program, and the most favorable feature of this is the general agreement that the Department of Public Works should be created not through the creation of an additional Cabinet office but by a readjustment of the agencies already existing. It is the other new departments, therefore, that will have to carry the heavy legislative burden of overcoming the opposition to enlargement of the Cabinet.

The Amalgamation of Reorganization Efforts

Early in October there was a meeting in New York City, attended by Messrs. John T. Pratt, head of the National Budget Committee; Herbert Hoover; Henry L. Stimson, former Secretary of War; Paul Warburg; Major C. T. Chenery, and the writer, at which matters of Government reorganization were discussed, and particularly the need for and the possibility of amalgamating all reorganization efforts under a commonly accepted and supported program. It was brought out that if the many organizations conduct campaigns separately, each for its own particular project, the confusion created in Congress will probably result in no legislation. It was therefore decided to call a meeting of delegates from the several organizations advocating reform in the Government departments, to organize a Federal Reorganization Council, which would be the common body through which an accepted program would be carried forward.

The aforesaid meeting of such delegates was held in New York on October 14, at which time the nearly completed report of the National Committee on Governmental Economy was presented. That program provided for a general rearrangement of Government activities along functional lines, including the creation of a Department of Public Works by a reorganization of the present Interior Department, and an additional department to be called the Department of Education and Health, into which would be drawn such welfare activities as war risk insurance, vocation and rehabilitation, pensions, etc. The meeting for final organization will take place about November 15. The prospective field of such a council is not limited to the mere reorganization of Federal activities. It should become the authoritative unofficial body to engage in the work which will eventually lead to a distinct separation of the political features of our Government system from the conduct of departmental business.

The obvious result of all this is that a Department of Public Works, if created, will not be an achievement of engineers and architects solely, but of men and women of many professions and avocations. Such credit as will come to the engineers will be merely that of starting a good thing, unless the members of the profession revive their interest and resume a leading part in the campaign. If such a revival does not take place the cream of achievement will be skimmed by the members of other professions.

To summarize as to the prospects for a Department of Public Works. It is the writer's belief that the principle is thoroughly settled in the minds of the public and of a majority of the members of Congress. The important question remaining is the kind of a department that we shall have. This involves a discussion of the matter of engineering control of Government operations. Shall it be civil or military?

Civil or Military Control of Government Operations

It is easy enough for the thousands of engineers of the United States to assert that engineering work of the Government shall be under civilian control, but it is quite another thing to establish that control. The engineers of the country must decide speedily whether it be their desire to have military engineers in control of the public works of the nation, for if they do not bestir themselves and take a sustained and active interest in this matter they will suddenly find that the die has been cast. When Government reorganization takes place the provisions made for engineering control will crystallize and will not become mobile again for at least a generation. It all comes down to a question of what the civilian engineers want and what they will work for. They are strong enough numerically and powerful enough in influence to guide the decision if they choose to do so, but they must not entertain the notion that their adversary is asleep.

[1] The National Public Works Department Association is a league composed of individuals, associations and of national, state and local societies, having an aggregate membership of over 100,000 business men, engineers, architects, constructors, manufacturers, chemists, geologists and economists. Its purpose is to organize under one department the many and varied public-works functions of the Federal Government. M. O. Leighton is chairman of the Association, and C. T. Chenery, secretary. The Association's headquarters are in the McLachlen Bldg., 10th and G St., Washington, D. C.

Federal Power Commission

Perhaps the most important item to engineers in the 1921 estimates of Government expenditures was a relatively small one calling for a total appropriation of $482,065, for the requirements of the Federal Power Commission. Of this $100,000, it is estimated, is required to reimburse executive departments for investigations requested by the Commission; $137,000 for general expense for the authorized work of the Commission and $240,000 for salaries. All of these estimates appear to be conservative, in fact, as small amounts as will permit of effective operation of the Commission under the requirements of the law.

Before these estimates can be acted on for appropriation by Congress, however, it is necessary under the law to so amend the existing power act as to permit the Commission to spend the money so appropriated. If the law is not amended giving the Commission this additional power any appropriation bill carrying the item above referred to is subject to a point of order because regular appropriation bills cannot carry new legislation. It was evidently the intent of the original Federal power bill to give the Commission authority to hire and pay its personnel and to expend funds which were appropriated for it, but under a ruling of the controller of the Treasury these funds did not become available.

Since this whole appropriation will affect practically every phase of the engineering field, it is probable that engineers and engineering organizations as such should use their efforts to obtain, first, adequate legislation that will enable the Commission to properly expend this money, and second, an appropriation that will permit of proper execution of the law. The need of this legislation and its proper administration is best shown by the fact that 115 applications for permits or licenses for power development have been filed with the Commission in less than six months with an aggregate horsepower of over eight million.

A.S.M.E. Student Prize Award

The A.S.M.E. Student Prize for 1920, it was announced at the Business Meeting of the Society held during the Annual Meeting, has been awarded to Howard G. Allen, a graduate of Cornell University, for his paper on Wire Stitching Through Paper. This prize, consisting of an engraved certificate signed by the President and Secretary of the Society, and twenty-five dollars, is given to the member of a Student Branch who submits the best paper adjudged from the standpoints of applicability (practical or theoretical), value as a contribution to mechanical engineering literature, completeness, originality of matter and conciseness. This prize is provided for by a fund of $1000 established through the generosity of a member of the Society as an incentive to the young engineer to undertake original work and is in line with the practice of many other societies. A similar fund provides an award for the best paper submitted by a Junior Member; there were, however, no contestants for the latter award this year.

ber, 1858, in Boston, Mass. He was educated in the Boston schools and attended the Massachusetts Institute of Technology from which he received his S.B. degree in 1879.

Upon graduation he became connected with the C. B. & Q. Railroad, leaving that road several years later to become general foreman of the car shops for the Eastern Railroad Company. From 1885 to 1888 he was general foreman of the car department for the same company. In 1888 he became connected with the Boston & Maine Railroad as assistant master car builder and the following year took a position in the same capacity with the L.S. & M.S. Railroad. Three years later he became general master car builder for that company and was with them until 1899 when he became superintendent of motive power and rolling stock of the New York Central Railroad. He held this position until 1903 when he resigned to open consulting offices in New York City in which field of work he was engaged until the time of his death.

During the War, however, Mr. Waitt, who held the commission of Major, gave up his practice temporarily to organize one of the largest purchasing branches of the Ordnance Department in New York and Hartford. His death was due to overwork in this undertaking into which he entered so whole-heartedly.

During his connection with the New York Central he was made a member of the Electric Traction Commission which planned the electrification of the road from New York to Harmon. He also assisted in designing one of the best locomotives in use at that time, among them the engines of the series 1400 and 2900. He was asso-

Arthur M. Waitt

ciated after his retirement from the New York Central with Colonel William J. Wilgus in the appraising of the rolling stock of the Lehigh Valley Railroad. He was an enthusiastic supporter of the automatic train control and a director of the Sprague Safety Control & Signal Corporation.

In 1893 Mr. Waitt was elected president of the Central Railroad Club of Buffalo and in 1895 president of the Western Railroad Club of Chicago. As one of the officers of the Lake Shore & Michigan Southern Railroad, he was a participant in the famous high-speed run of October 24, 1895, from Chicago to Buffalo; a run which, it is believed, has never been equalled. The test started at 3:29 a.m. in Chicago and ended at 11:30 a.m. in Buffalo, a total distance of 510.1 miles, done in eight hours, one minute and seven seconds.

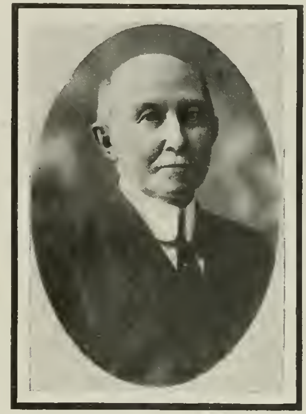
In 1901 Mr. Waitt was elected president of the American Railway Master Mechanics' Association. In 1916 he became a member of the Connecticut Assembly and it was he who wrote the automobile laws now in force in that state.

Mr. Waitt was also a member of the Connecticut Chamber of

He became a member of The American Society of Mechanical Engineers in 1893 and held the office of vice-president from 1900 to 1902.

Edward W. Thomas

Edward W. Thomas, former president of the National Association of Cotton Manufacturers and for the last eleven years agent of the Boott Mills, Lowell, Mass., died of heart disease at his residence in that city on November 15, 1920. Mr. Thomas was generally regarded as one of the ablest cotton manufacturers



Edward W. Thomas

in the country, having held responsible positions with mills both in the North and in the South. His eminent fairness in all matters of mill routine which came to him for discussion had won the confidence of the employees and this quality, combined with an unfailing courtesy even to the most humble operative, was a potent factor in the successful development of the large plant which he directed for the past eleven years.

He was born on February 22, 1858, in Lowell, Mass. He spent all of his business life in cotton manufacturing, starting as a draftsman with the old Lowell Machine Shop and leaving that concern to enter the employ of the American Thread Company at their plant in Willamantic, Conn. In 1882 he became superintendent of the Tremont & Suffolk Mills, Lowell, and four years later became agent for the corporation.

During this period he was particularly active in the affairs of the National Association of Cotton Manufacturers, serving as vice-president from 1892 to 1894 and as president in 1894 and 1895.

About 1900 Mr. Thomas went south to become general manager of the Cooleemee (N. C.) Cotton Mills, and in 1904 he assumed the more responsible position of general manager of the Olympia and Granby Cotton Mills, Columbia, S. C. Three years later he became general manager of all the plants of the Consolidated Cotton Duck Company, Baltimore, Md. In 1909 Mr. Thomas returned to Lowell as agent for the Boott Mills, which position he held at the time of his death.

Mr. Thomas was a member of both the National and American Associations of Cotton Manufacturers, the Boston Textile Club, the Yorick Club of Lowell and the Lowell Historical Society, of which latter he was vice-president. He had long been prominent in masonry and was a Knight Templar and a thirty-second degree mason.

He became a member of The American Society of Mechanical Engineers in 1880, attending the organization meeting at Stevens Institute of Technology on April 7, 1880. He served as secretary of the sub-committee on Textiles from 1912 to 1914.

SIDE CUTTING OF THREAD-MILLING HOBS

(*Continued from page 11*)

fore, if the correction is taken as the tangent of the profile at the pitch line of the thread, the angle C' will remain unchanged. The formulæ for determining this angle are as follows:

Let C = $\frac{1}{2}$ included angle of thread
C' = $\frac{1}{2}$ included angle of corrected hob
H = helix angle of thread at pitch line

Then

$$\tan H = \frac{1}{\pi N \times \text{pitch diam. of thread}}$$

and

$$\tan^2 C' = \tan^2 C + \tan^2 H$$

It is evident from the above that if the form of the cutting edge of a hob of a certain diameter be corrected to cut a thread of a certain diameter and pitch, a variation in the diameter of the hob of, say, 25 per cent will have but little effect on the form of the thread produced on the work.

In order to determine the effect of varying the diameter of the work, the following tabulation was made for a hob 2.000 in. in diameter with 5 Acme threads per inch:

Work diam. =	1.000 in.	2.000 in.	4.000 in.
x_2 =	0.003475	0.001161	0.000350
y_2 =	0.012344	0.004103	0.001512
$2C'$ =	30° 0′ 16″	29° 14′ 8″	29° 3′ 6″
$F - 2x_2$ =	0.0619	0.0666	0.0682
K =	0.000054	0.000012	0.000003

The above tabulation shows that the amount of side-cutting at the bottom of the thread (x_2) decreases as the diameter of the work increases. The height of the fillet at the bottom of the thread (y_2) decreases as the diameter of the work increases. In this case it decreases about four times as much as x_2. The included angle of the corrected hob decreases quite rapidly as the diameter of the work increases. The width of the point of the corrected hob increases about 0.006 in. as the diameter of the work is increased from 1 in. to 4 in. The dimension K in Fig. 5-B decreases as the diameter of the work increases. In this case the amount of error introduced by a straight-line correction in the hob is in the fifth and sixth decimal place and is negligible. It is evident, therefore, that a hob which is corrected for a certain diameter of work cannot be used on work which varies very much in diameter if accurate results are desired. The smaller the diameter of the work, the more this condition is accentuated. This is due in large measure to the rapid increase of the helix angle on smaller diameters. On work of large diameters, where the helix angle employed is very small, little or no correction is required on the hob.

RAILWAY TERMINALS AND TERMINAL YARDS

(*Continued from page 21*)

There is but one railway whose freight tracks reach Manhattan Island. All the other lines maintain the connection by lighters. One hundred years ago it was the Hudson River that furnished an outlet for the Erie Canal and carried New York to the first place among American cities, thus establishing its ever-increasing commercial supremacy. On the advent of railways they, one by one, except the Hudson River Railroad, located their terminals on the Jersey shore and lightered their traffic across the water. As their business developed they increased their facilities, and as the city grew they created new points of delivery, but always maintaining their separate and individual identities. The consequence is that every railway coming from the west maintains on the Jersey shore great yards occupying valuable space whence freights are transferred by floats to various points not only on the edge of Manhattan Island, which was New York when railway traffic originated, but to the greater parts of what is now New York, namely, Brooklyn, Long Island and the Bronx.

Is this necessary? If it is not necessary, is it the best and most economical arrangement? Should not the terminal facilities of the several roads be pooled, thus concentrating operation on the part of the railways? Instead of maintaining special delivery stations in New York, can there not be a combining there, with perhaps a further segregation into places for delivery according to commodities? If the principle of "store door" delivery be adopted there seems to be no necessity for water-front terminals in New York and water-front yards in Jersey. New yards with switching connections at both ends can be constructed with modern freight houses and unloading tracks equipped with labor-saving freight-handling machinery. These could be located in any convenient place, even on the wide expanse of the Jersey meadows. To them motor trucks with trailers carrying not part but full loads would transport merchandise between cars and points of origin or destination in any part of the Metropolitan District. In such a system would there not be economy in handling, time saved in trans-terminal shipments and a relief to street congestion through diminished number of trucks? The first two are for the immediate benefit of the railways and shippers, but the last is for the benefit solely of the city.

There is a fourth advantage in which the nation as a whole and the Metropolitan District would share jointly. Already New York's harbor terminal facilities are overtaxed and there is danger of surplus foreign traffic seeking against natural laws other and consequently less well-situated ports. The freeing of such a large area of water-front property now held for local freight purposes only would render available a site for the finest kind of ocean-steamship terminals. This property is most advantageously located for such purposes. It would have complete rail connection with all lines and could be physically improved with piers having ample storage facilities and cargo-handling machinery. The opportunity would be presented whereby the port of New York could be almost indefinitely extended and with advantages, vastly superior to those now existing or obtainable elsewhere.

The writer is aware that none of these questions are new. They have all been asked before, but the present moment is a fitting one to ask them all again when our transportation lines are entering upon new principles of operating economy, and when all men feel the need of general readjustment of business methods to meet the new world conditions.

A Correction

We are advised that the superheaters installed at the new Ford plant, a description of which was published in Mechanical Engineering for November, were designed, manufactured and installed by the Locomotive Superheater Company, of New York. Credit was inadvertently omitted from the article.

Index to Volume 42 of Mechanical Engineering

An index to Volume 42 of Mechanical Engineering is now in the course of preparation, which, it is expected, will be issued early in February. A copy of this index will be sent to each member of the Society or subscriber who sends in a written request therefor. In order that no more copies than are necessary to supply the demand may be printed, requests for copies should be received at headquarters not later than February 1.

1921 Year Book

On the recommendation of the Publication and Papers Committee and the Finance Committee, the Council has agreed to defer the publication of the A.S.M.E. 1921 Year Book until about October 1.

The 1920 Year Book was corrected on March 1, but on account of printing difficulties did not reach the membership until about July 1. In deferring the publication of the new book until October the interval between the two volumes will be only fifteen months.

The list of Council officers and Committees published in the front part of the volume will probably be issued about February 10. This will be printed in the usual page size and slipped into the 1920 book for the time being.

Standard Ton of Refrigeration Defined

A special committee of The American Society of Mechanical Engineers consisting of Messrs. Fred Matthews, Chairman, Henry Torrance, Jr., Secretary, Charles W. Berry, Peter Neff, John E. Starr, and Gardner T. Voorhees, the membership of which was endorsed by the American Society of Refrigerating Engineers, was recently appointed to fix a "Standard Tonnage Basis for Refrigeration." Its findings reported to The American Society of Mechanical Engineers at its Annual Meeting held on December 7–10 were as follows:

(1) A standard ton of refrigeration is 288,000 B.t.u.

(2) The standard commercial ton of refrigeration is at the rate of 200 B.t.u. per min.

(3) The standard rating of a refrigerating machine[1] using liquefiable vapor is the number of standard commercial tons of refrigeration it performs under adopted refrigerant pressures.[2]

[1] A refrigerating machine is the compressor cylinder of the compression refrigerating system, or the absorber, liquor pump and generator of the absorption refrigerating system.

[2] These pressures are measured outside and within 10 ft. of the refrigerating machine, distances which are measured along the inlet and outlet pipes, respectively; (a) the inlet pressure being that which corresponds to a saturation temperature of 5 deg. fahr. (−15 deg. cent.) and (b) the outlet pressure being that which corresponds to a saturation temperature of 86 deg. fahr. (30 deg. cent.).

The Committee and The American Society of Mechanical Engineers will welcome a full and free discussion of these three propositions. Communications should be addressed before February 15 to the Standards Department of The American Society of Mechanical Engineers, at 29 West 39th Street, New York City. As we go to press, we are informed that this report has been approved by the American Society of Refrigerating Engineers.

What is "Wrought Pipe?"

When the pipe maker takes a length of steel skelp and a length of wrought-iron skelp and forms them into pipe, he performs exactly the same operation on both materials, that is, he bends them into tubular shape and welds the edges. Quite correctly, therefore, the American Society for Testing Materials in their specifications use the word "welded" in conjunction with both wrought-iron and steel pipe made by the processes of welding.

Probably some thirty years ago, after the introduction of welded steel pipe, the term "wrought pipe" or "wrought steel pipe" was coined by steel-pipe manufacturers; this term gradually came into use by dealers and jobbers; thus steel pipe would be billed and listed as "wrought pipe." The average consumer of pipe, not acquainted with this trade name frequently labors under the impression that it means wrought-*iron* pipe. In fact, the names being so much alike, have led to the term "wrought-iron pipe" by the jobbers and contractors being interpreted as meaning steel pipe, defying architects' and engineers' specifications and resulting in endless confusion.

The manufacturers of wrought-iron pipe, actively aided by the American Institute of Architects, have therefore taken up with the supply associations the matter of clarifying these so-called trade names, suggesting instead names that would ultimately result in eliminating all confusion of puddled wrought iron with pipe made from soft steel. It was argued that trade names which conceal the truth are misleading, even to buyers who are supposed to be well informed, and that the substitution of the word "welded" for "wrought" would create a common term for both kinds of pipe impossible of misinterpretation. As a result the National Pipe and Supplies Association at their meeting held in New York on November 11, voted that the terms employed by the American Society for Testing Materials in differentiating between iron and steel pipe, viz.: (a) Welded Wrought-Iron Pipe, and (b) Welded Steel Pipe, should be accepted and adhered to by the distributors of both iron and steel pipe, this being in the interest of the manufacturers of the pipe, those who distribute it, and those who use it, each of these parties being entitled to know clearly and without doubt the make and quality of the pipe involved in the transaction.

This step should result in the term "welded pipe" being applied when *both* wrought iron and steel pipe are referred to, and that the latter two terms alone, namely, "wrought-iron pipe" on the one hand and "steel pipe" on the other hand, be used and interpreted respectively to mean exactly what these terms imply. Thus "wrought-iron pipe" will mean only pipe which is made from genuine puddled wrought iron, and "steel pipe" will be used exclusively to designate pipe made of soft bessemer or open-hearth steel.

American Engineering Standards Committee Recently Enlarged

The American Engineering Standards Committee has recently been enlarged by the representatives of four additional member-bodies. These bodies and names of their representatives are as follows:

(1) U. S. Department of Agriculture; T. H. MacDonald, Chief, Bureau of Public Roads

(2) U. S. Department of Interior; O. P. Hood, Chief Mechanical Engineer, Bureau of Mines

(3) Gas Group (consisting of American Gas Association; Compressed Gas Manufacturers' Association; International Acetylene Association); A. Cressy Morrison, Vice-President, Compressed Gas Manufacturers' Assn.

(4) American Electric Railway Association (official representative not yet designated).

There are now forty-seven members on the Committee, representing seventeen member-bodies, and twenty-four organizations as three of the member-bodies are groups of organizations.

The Committee recently held its annual meeting in New York and A. A. Stevenson, a representative of the American Society for Testing Materials, was reëlected chairman for 1921, and George C. Stone, a representative of the American Institute of Mining and Metallurgical Engineers, was reëlected Vice-Chairman. The following were also elected to represent the respective member-bodies on the Executive Committee:

Comfort A. Adams, American Institute of Electrical Engineers
Martin Schrieber, American Society of Civil Engineers
Fred E. Rogers, American Society of Mechanical Engineers
A. H. Moore, Electrical Manufacturers Council
Dana Pierce, Fire Protection Group
A. Cressy Morrison, Gas Group
N. A. Carle, National Electric Light Association
Albert W. Whitney, National Safety Council
Coker F. Clarkson, Society of Automotive Engineers
Thos. H. MacDonald, U. S. Department of Agriculture
E. B. Rosa, U. S. Department of Commerce
O. P. Hood, U. S. Department of Interior
Francis J. Cleary, U. S. Navy Department
J. H. Rice, U. S. War Department.

National Standardizing Body Organized in Austria

There has recently been formed in Austria a national engineering standardizing body. It is called the "Normenausschuss der Oesterreichischen Industrie" and is organized under the auspices of the "Hauptverband der Industrie Deutschoesterreichs." The Secretary is Dr. Jaro Tomaides.

This is the tenth national standardizing body to be formed, the others being in Belgium, Canada, France, Germany, Great Britain, Holland, Sweden, Switzerland, and the United States. Mechanical Engineering for September contained a brief description of the form of these organizations, all of which, with the exception of the British Engineering Standards Association, whose work dates from 1901, have been formed since the beginning of the European war.

The Recataloging of the Engineering Societies Library, New York

Work Begun in September, 1919—The Steps Involved and Difficulties Encountered—Results to be Gained and their Great Value to Engineers

By HARRISON W. CRAVER, DIRECTOR

THE Engineering Societies Library of today has for its ancestors four separate libraries which began at different periods, were developed in different ways and with varying ideals, and had not attained the same degrees of development when they were combined. The methods of classifying the books and of cataloging them in use in the separate libraries were so dissimilar that a revision of all this work was essential if members were to nse the collection conveniently, and with any assurance that all the material available had been found.

The Library Board therefore decided, early in 1919, to undertake the recataloging of all the material. As no nniform scheme for classifying the books was in use, much reclassification is also involved. A special corps of workers was assembled for the task and since the fall of 1919 the energies of the staff have been chiefly concentrated upon it.

As it is believed that the methods adopted will not only fix the practice of the Library for years to come, but may also become the standard for other engineering collections, every effort has been made to adopt methods that will both meet present needs and also provide for future developments, so far as these can be predicted. This has involved the sacrifice of speed, but as the work is intended to be permanent, basic soundness has been considered the prime quality.

At present, approximately one-fourth of the work is done. The recataloged material inclndes all the pnblications of the past four years, and those classes of the older material most in use; among others, the periodicals, and the geological material for many states. Work on the remaining material is proceeding class by class, the most important classes being treated first.

The following extracts from a report submitted in October by Miss Margaret Mann, chief cataloger, give detailed information on certain phases of the problem. They will, it is hoped, be of interest to many engineers and members of the A.S.M.E. as showing what has already been done, the difficulties to be overcome and the results anticipated when the work is finished.

During the year from September, 1919, to October, 1920, 23,204 books have been completely cataloged, and 31,679 volumes have been handled in order to catalog these 23,204. The 23,204 volumes represent 5000 titles. From these 5000 titles we have made available 10,301 subjects. To catalog 23,204 volumes, or 5000 titles, completely by author and subject, we have had to handle 31,679 volumes, which has necessitated the preparation and filing of 53,793 cards and the typing and filing of 840 sheets into loose-leaf binders. This has been accomplished with a staff averaging ten.

Steps Involved in Recataloging

The recataloging involves the following processes:

1 *Classification of the Book.* This means fitting the book into an accepted system of classification and getting it into its proper relation with all other books in the collection. Requires *expert* assistants.

2 *Compiling an Alphabetical Key or Index to This Classification.* This key now numbers 10,000 entries.

3 *Developing the Classification.* Making additions for the new subjects which are constantly coming up in engineering.

4 *Cataloging.* So recording the book that it may be reached from any angle—author, subject or title. This often involves the preparation of ten or more cards for each title and necessitates careful bibliographical research.

5 *Shelf Record of Books.* A record of every book as it stands on the shelves by number. Necessary (1) as an inventory of the library collection and (2) to avoid duplicating the individual symbol by which each book is known in a library.

6 *Record of Magazines and Transactions of Societies.* A loose-leaf record of every set in the library, showing not only the volumes on our shelves but also what volumes, indexes, etc., are needed to make our files complete. The compilation of this list has been slow work because of the condition of the sets. Many volumes are unbound, making it necessary to do very careful collating, while other volumes are incorrectly bound and incorrectly marked, making reference to them impossible. Many duplicates have necessarily been handled in the process of combining the several societies' collections.

7 *"Want" List of Magazines and Transactions of Societies.* This list shows at a glance what volumes are needed to complete our files. It can be sent to dealers for bids on missing numbers and volumes, and can also be printed in our own society journals and used as a means of calling the attention of members to our wants. Many incomplete sets might be filled through this channel. The Library has never before been able to take advantage of offers of duplicate volumes from other libraries or from individuals because no such list of our needs was available.

8 *Binding.* Every volume sent to the bindery must be collated, tied up and a record made of the author, title and volnme number, together with directions to the binder as to style and kind of binding. When the volumes are returned, these records must be checked.

9 *Preparation of Books for the Shelves.* Every book must bear a symbol which shall distinguish it from every other book in the collection, so that it may take its proper place on the shelves. This symbol is placed on the back of every book, and the societies' book plate is pasted into each volume before it is sent to the shelves.

10 *Shelving of the Books.*

11 *Filing of the New Catalog Cards and the Removal of the Old Records from the Old Catalogs.* The removal of old cards is an important but arduous task. To leave these cards in the catalog means that readers or assistants will look for books under the old numbers and so be misled. This is one of the difficulties of keeping both the old and the new going at one, and the same time.

Difficulties Encountered

The work has been necessarily slow this year because of the following difficulties:

1 *Difficulty of Keeping All Material Available While the Recataloging is in Process.* So long as the Library is kept open, every book must be available when needed. This often retards the work of the cataloger by requiring him to keep the books he is cataloging accessible to readers, when different methods would be more efficient for the cataloging process.

2 *The Necessity of Making Old Records Guide One to the New Records.* Constant references must be made to show what classes of books are in process, what have been recataloged, where they are located and to what extent completed.

3 *Inadequate Equipment*, especially shelving, book trucks, filing cabinets, etc.

4 *Distance of Records* from the catalog workman. The main catalog, which must be constantly consulted, is on the 13th floor, while the work room is on the 14th.

5 *Scattering of Material on Three Floors.* We have found it necessary in tracing a periodical set to inspect twenty different records or shelves before we were sure all material and information had been collected which bore on that special title.

6 *Necessity of Collating Unbound Material.* The collection is made much more difficult to handle because so little binding has been done. The tying and untying of hundreds of unbound volumes adds materially to the time required for recording these.

7 *Inability to Get Binding Done During the Current Year.* It has been difficult to get adequate work or service and the cost has been increased.

8 *Difficulty of Getting Good Trained Assistants.* The "after war" advance in library salaries has made it impossible for us to get the kind of assistants which such specialized work as this really requires. We were forced to take workers who were inexperienced in this line and train them, with the result that we have only been able to get efficient service during the latter half of the twelve months during which the work has been in progress. The training of the staff has often made it difficult for the chief recataloger to give adequate time to the solution of problems which necessarily arise in connection with any such piece of reorganization.

The possibilities for service are not limited to the Library; our service should be extended to those engineers who are groping for the best methods of indexing and classifying engineering literature. Many requests have already come for help along these lines, which opens up a field of work not only mnch needed but which must be developed if our influence, our methods and our material are to reach all members of the engineering field.

9 *Care of Duplicates.* In this consolidation of libraries the handling of duplicates form no small part of the work. An effort is constantly being made to dispose of our surplus stock. This means the listing, checking and packing of these books and considerable correspondence relative to their disposal.

The Results to be Gained by Recataloging

1 *Making the Resources of the Library Available.* By the recataloging, the varying methods of cataloging and classifying formerly used by the societies are being eliminated, bringing the collection together into a logical whole. Much of the material handled by the cataloging staff this year cannot be called recataloging, because many classes of books now in the Library have not, up to this time, been represented in the catalog. Such difficult work as the cataloging of the state and federal documents is quite new to this Library. Some of the most valuable material covering such subjects as Mining, Geology, Foreign Trade, Water Supply, Road Engineering, etc., is to be found in the reports and bulletins issued by state surveys, commissions and experiment stations.

now in process of making can be used and printed ...
arranged that one class such as Hydraulic Engineering is complete in itself and is not scattered under Pumps, Dams, Water Flow, etc. An alphabetical index takes care of Pumps, Dams and Water Flow, while the whole class of Hydraulic Engineering remains as a unit. Should a smaller class be needed, such as Dams, this will also be found to be a complete unit.

3 *Weak Spots in the Collection* will be revealed and records furnished for filling in the gaps. Until the books are combined under one classification it is quite impossible to see wherein the Library is weak.

4 *Establish a System of Classifying Engineering Literature* which can be applied not only to books but also to the indexing of periodicals.

5 *An Alphabetical Key* to the classification will thus be compiled, which, if published, will enable any engineer to index his own library, and his own periodicals, by the most approved international method at a minimum cost. This has never before been accomplished by any library or any individual and its completion will see a real contribution to engineering literature. It is an aid which engineers are seeking.

Book Notes

Industrial Relations Association of America. Procedings, Annual Convention, Chicago, 1920. Paper, 6 x 9 in., 592 pp., $5.

The papers presented at this conference, held in May 1920, are divided into two groups, one consisting of general problems and the other of those peculiar to specific industries. The collection covers a wide range of topics connected with the relations of workmen and employers.

Engineering Electricity. By Ralph G. Hudson. John Wiley & Sons., Inc., New York, 1920. Cloth, 9 × 12 in., 190 pp., illus., tables, $2.50.

This text represents the lectures given at the Massachusetts Institute of Technology to those technical students who are not specializing in electrical engineering. The course covers the general principles of electrical engineering and magnetism most frequently applied in engineering practice.

Financial Engineering. A Text for Consulting, Managing and Designing and Designing Engineers and for Students. By O. B. Goldman. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 271 pp., illus., tables, $3.50.

The author of this treatise has in mind the practicing engineer, interested in installing plants that will have the highest financial efficiency, although not necessarily the highest mechanical efficiency. The book is therefore an exposition of methods for determining the comparative value of the things which the engineer must use, and the financial efficiency of undertakings.

Elements of Engineering Thermodynamics. By James A. Moyer, James P. Calderwood and Andrey A. Potter. John Wiley & Sons, Inc., New York; Lond., Chapman & Hall, Ltd., 1920. 216 pp., illus., tables, folded chart, 6 × 9 in., cloth $2.50.

This treatise is an extension of a briefer work entitled Engineering Thermodynamics, by James A. Moyer and F. A. Calderwood. It is intended to bring out the fundamental principles of the subject, particularly for use in technical colleges where special courses on steam turbines, internal-combustion engines, refrigeration and other applications of thermodynamics can be given. Additions and changes have been made to the original material, to make the book better adapted to special requirements.

Fundamental Principles of Electric and Magnetic Circuits. By Fred Alan Fish. First edition. McGraw-Hill Book Co., New York, 1920. Cloth, 6 × 9 in., 194 pp., illus., $2.75.

This volume is intended as an introduction to the study of electric-power machinery and transmission. It discusses the principles that the author considers fundamental, is intended for undergraduate students, and therefore does not go deeply into the physical and mathematical theory of electricity, nor include all the possible variations in conditions which might affect the application of the principles as stated.

Fuel Oil in Industry. By Stephen O. Andros. The Shaw Publishing Company, Chicago, 1920. Cloth, 6 × 9 in., 214 pp., illus., tables, $3.75.

The volume opens with a discussion of the physical and chemical properties of fuel oil, the principles of its combustion, a comparison boiler furnaces and on types of burners. The remaining portion of the book describes the applications of fuel oil in steamships, locomotives, iron and steel manufacture, heat treating, central stations, the sugar, glass and ceramic industries, and in heating buildings. The treatment is concise and practical rather than theoretical.

Handbook for Heating and Ventilating Engineers. By James D. Hoffman, assisted by Benedict M. Raber. Fourth edition, McGraw-Hill Book Co., New York, 1920. Flexible cloth, 4 × 7 in., 478 pp., illus., tables, $4.50.

Supplement: A Course of Instruction for Technical Schools with Questions, Problems and References. To be used in connection with the Handbook for Heating and Ventilating Engineers—Hoffman; paper, 4 × 7 in., 51 pp.

This volume is intended to fill the need of those engaged in the design and installation of heating and ventilating apparatus for a pocket book covering the entire subject in simple form and containing the tables commonly used. The present edition has been entirely rewritten and reset, and considerably enlarged, to bring it into accord with present practice.

Industrial Housing. With Discussion of Accompanying Activities; Such as Town Planning, Street Systems, Development of Utility Services, and Related Engineering and Construction Features. By Morris Knowles. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 408 pp., illus., tables, $5.

The author endeavors to develop the things which must be considered in order to provide not merely houses but homes, with all the attendant attributes of a living and livable town, and his book is the result of a realization that the preparation of a successful town plan and the development of a contented industrial community are dependent upon the action of many agencies and require the coördination of men of many professions. Although the work of an engineer, the book is not a treatise on technical practice, but is intended to represent the views of experts in architecture, town planning, landscape gardening, engineering, sanitation, public utilities, building, real estate, civics and business, for whom, together with city officials, the book is intended.

Tin, Sheet-Iron and Copper-Plate Worker. By Leroy J. Blinn. New enlarged edition. Henry Carey Baird & Co., Inc., New York, 1920. Cloth, 5 × 8 in., 334 pp., illus. tables, $3.

A revised edition of a well-known work on the working of sheet metal, containing rules for laying out work, recipes for solders, cements, and lacquers, as well as the tables and other data used by the mechanic.

The Ownership and Valuation of Mineral Property. Being an Elementary Treatise on the Nature of Mineral Interests and Royalties, and the Correct Method of Valuing such Property for the Purpose of Sale, Probate, and Rating and Taxation, together with a Statement of the Law relating to Rating and Taxation. By Sir R. A. S. Redmayne and Gilbert Stone. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 256 pp., $4.50.

The primary object of this book is to assist the mining expert who desires to have available a statement of the interests involved and the mode of valuing those interests in the mining industry generally. The work consequently contains, in addition to chapters on royalties and valuation, a general explanation of the law relating to mining interests, way leaves and subsidence, and also the law relating to the rating and taxation of mineral properties.

The Practice of Lubrication. An Engineering Treatise on the Origin, Nature and Testing of Lubricants, their Selection, Application and Use. By T. C. Thomsen. First edition. McGraw-Hill Book Co., New York, 1920. Cloth, 6 × 9 in., 607 pp., illus., $6.

After a brief, practical description of commercial oils, fats and greases, the author describes the chemical and mechanical tests used and explains the laws of friction. Methods of lubrication are then described. The greater portion of the book is given to a discussion of the selection and use of lubricants for specific types of machinery, covering all classes of machines. Oil recovery, purification, storage and distribution, oils for cutting and for transformers are also discussed. The viewpoint throughout is that of the engineer rather than the chemist.

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press. At the end of the year the monthly installments are combined and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Foundries. Coöperative Methods for Preventing Foundry Accidents, R. A. Salisbury. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1268–1269. Committee system of organization including employees is suggested. Paper read before Nat. Safety Council.

Organization for. Employees Rewarded for Self-Protection. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1189–1191, 4 figs. Organization for accident prevention at plant of Joseph T. Ryerson & Son. One of features is offering prizes to employees with safety records.

ACCIDENTS

Building Construction. Keeping Track of Accidents, F. A. Davidson. Bul. Associated Gen. Contractors, vol. 11, no. 10, Oct. 1920, pp. 14–16, 2 figs. Systematic method for checking safety. Report adopted by Construction Section of National Safety Council.

Foundries. Dangers in Casting. Metal Industry (Lond.), vol. 17, no. 17, Oct. 22, 1920, pp. 323–325. Extracts from annual report of British Chief Inspector of Factories for 1919.

Railway Shops. Shop Accidents, J. A. McNally. Ry. Rev., vol. 67, no. 19, Nov. 6, 1920, pp. 715–716. Costs of accidents in railway shops. From records of Wabash Railroad.

Recording of. Standard Method of Recording Construction Accidents. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 845–847, 3 figs. Argument and instructions for compiling accident statistics formulated by Construction Section of National Safety Council.

ACCOUNTING

Amortization of War Facilities. The Amortization of War Facilities—II, Arnold F. Van Pelt. Indus. Management, vol. 60, no. 5, Nov. 1920, pp 345–351. Practical examples of tax relief through amortization.

ADSORPTION

Colloidal. Colloidal Adsorption, Arthur Mutscheller. Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2142–2160, 4 figs. Experimental study of migration velocity of anions as influenced by presence of reversible colloids, concentration of anions and cations as influenced by presence of reversible colloids, etc.

AERIAL PHOTOGRAPHY

Uses in War and Peace. Aircraft Photography in War and Peace, H. Hamshaw Thomas. Jl. Royal Soc. Arts, vol. 68, nos. 3543, 3544, Oct. 15 and 22, 1920, pp. 749–753 and 763–766. Oct. 15: Taking and production of aeroplane photographs. Cantor lectures; Oct. 22: Uses of aerial photography for securing military information. Graphic record of results of operations.

AEROPLANE ENGINES

B. M. W. IIIa. The 185-Hp. Bavarian Aeroplane Engine B.M.W. IIIa (Der 185 PS Bayern-Flugmotor B.M.W IIIa). Otto Schwager. Motorwagen, vol. 23, nos. 22, 23 and 24, Aug. 10, 20 and 31, 1920, pp. 399 404, 421–425 and 441–445, 14 figs. Six-cylinder engine with 150 mm. bore and 180 mm. stroke constructed along lines of the Mercedes engine, but differing from this, however, in the high degree of compression (6.5), and in the construction of the carburetor, in which the output of 185 hp. remains unchanged up to altitude of three km. Results of experiments are given in tabular form showing efficiency of aeroplane.

Fuels for. See GASOLINE, Alcogas Fuel vs.

Ignition. See IGNITION.

German. Development of German Aircraft Engines, Otto Schwager. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 186–189, 4 figs. (Concluded.) Translated from Technische Berichte.

Machining. Machining Airplane Engine Parts. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 233–238, 11 figs. Tooling equipments and special indexing work-holding fixture used in connection with turret lathe practice of Alfred Herbert, Ltd., Coventry, England.

Rotary. French Rotary Airplane Engine Uses a Variable Stroke, W. F. Bradley. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 862–863, 2 figs. Damblanc type in which compression is changed by varying length of stroke.

Superchargers. Experiments with and Practical Use of Superchargers in Germany, Eric Hildesheim. Automotive Industries, vol. 43, no. 17, Oct. 21, 1920, pp. 810–816, 13 figs. Translated from Zeitschrift des Vereines Deutscher Ingenieure, Motorwagen and Flugsport.

Supercharging. Aeroplane Performances as Influenced by the Use of a Supercharged Engine, George De Bothezat. Aerial Age, vol. 12, no. 6, Oct. 18, 1920, pp. 174–179, 2 figs. Equations for calculating ceiling.

AEROPLANES

All-Metal. All-Metal Airplane Comprises Novel Engineering Features. Automotive Industries, vol. 43, no. 17, Oct. 21, 1920, pp. 808–809, 2 figs. Construction and performance of JL all-metal aeroplane. Chief mechanical features of design are self-supporting, deep sectioned, internally trussed wings.

The Short All-Metal "Silver Streak." Aviation, vol. 9, no. 7, Nov. 1, 1920, pp. 217–219, 3 figs. Specifications: Engine, Siddelay Puma; b.hp., 260; surface, 370, sq. ft.; span, 37 ft. 6 in.; length overall, 26 ft. 5 in.; height, 10 ft. 6 in.; total weight, 2870 lbs.; speed, maximum, 120 m.p.h.; climb, 10,000 ft. in 11 min.

British Air Ministry Competition. The Small Airplanes of the British Competition. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 193–196. First report on British Air Ministry competition for commercial aircraft by Edward P. Warner, acting technical assistant in Europe of National Advisory Committee for Aeronautics.

Control Surfaces. The Design of Aeroplane Control Surfaces with Special References to Wing Ailerons, H. B. Irving. Eng., vol. 110, nos. 2858–2860, Oct. 8, 15, and 22, 1920, pp. 461–463, 493–494, and 527–528, 19 figs. Oct. 8: Aerodynamic properties of control surfaces. Factors which govern controlability of aeroplanes; Oct. 15: Comparison of efficiencies of control of ailerons on wings with differently shaped tips; and Oct. 22: Graphs showing rolling moment and hinge moment for ailerons of various chords.

Chassis, Retractable. Retractable Chassis as an Aid to Aeroplane Speed and Efficiency, Jas. V. Martin. Aerial Age, vol. 12, no. 10, Nov. 15, 1920, p. 274, 2 figs. Importance of retracting aeroplane chassis to increase speed. Tests are quoted in which speed was increased 30 miles an hour when chassis was retracted and extended.

Cost of Operating. The Operation of Civil Aircraft in Relation to the Constructor, H. White-Smith. Flight, vol. 12, no. 42, Oct. 14, 1920, pp. 1079–1088. Detailed study of cost of operating commercial service.

Dayton-Wright. The Dayton-Wright R. B. Racer Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 190, 1 fig. Dimensions: Span, 21 ft. 2 in.; overall length, 22 ft. 8 in.; total weight, loaded, 1850 lb.; cruising radius, 275 miles; ceiling, 15,000 ft.

Design. Analytical Process for Calculating the Polar Equation of an Aeroplane (Procédés analytiques pour le calcul des polaires d'avions), Maurice Le Sueur. L'Aérophile, vol. 28, nos. 15–16, Aug. 1–15, 1920, pp. 226–229. Analytical method claimed to be equally as precise as graphic method, and more rapid than the latter.

Flight, Conditions Governing. The Aerotechnical Institute of St. Cyr. Sci. Am. Monthly, vol. 2, no. 3, Nov. 1920, pp. 260–263, 110 figs. Apparatus for testing mechanical conditions governing flight of airplanes.

German Types. Linke-Hofmann Giant Aeroplanes—Type R-II. Aeronautics, vol. 19, no. 364, Oct. 7, 1920, p. 260. Multi-engined aeroplanes with engines centralized as one unit, developed by Linke-Hofmann Aeroplane Co., of Breslau, Germany.

Junkers. Cause of the Superiority of the Junkers Aeroplanes. (Was macht die Junkers-Flugzeuge überlegen). Luftfahrt, vol. 24, no. 9, Sept. 2, 1920, pp. 131–133, 5 figs. Said to be due partly to exclusive use of light metal, but principally to use of suspended, strutless aerofoils.

Laird Swallow. The Laird "Swallow." Aerial Age, vol. 12, no. 9, Nov. 8, 1920, pp. 253 and 259, 3 figs. Specifications: Span, 36 ft.; overall length, 23 ft. 4 in.; overall height, 8 ft. 8 in.; total supporting area, 324 sq. ft.; total weight, 1750 lb.; range at full speed, 255 miles, maximum speed, 86 m.p.h.; ceiling, 17,000 ft.

Landing Stations. Landing Fields are a Major Problem Development of Air Traffic. Automotive Industries, vol. 43, no. 19, Nov. 4, 1920, pp. 928–929. Present situation and suggested methods for improvement.

Martin Bomber. Trans-Oceanic Airplane. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 471, 2 figs. Seven-ton Martin bomber under test by U. S. Army. Engine's speed is 2,000 r.p.m. and propeller speed 1,000.

Single vs. Twin-Engined. A Comparison of the Flying Qualities of Single and Twin-Engined Aeroplanes, R. M. Hill. Flight, vol. 12, no. 44, Oct. 28, 1920, pp. 1134–1136, and also Aeronautics, vol. 19, no. 367, Oct. 28, 1920, pp. 307–309. Comparison from pilot's point of view. Paper read before Roy. Aeronautical Soc.

Small Machines. De Pischof's "Avionnette." Aeronautics, vol. 19, no. 364, Oct. 7, 1920, p. 260, 1 fig.

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

per hour; maximum height, 500 ft.

Stress Analysis. Airplane Stress Analysis, A. F. Zahm and L. H. Crook. Nat. Advisory Committee for Aeronautics, report no. 82, 1920, 70 pp., 42 figs. Theory of aeroplane stress analysis taking into consideration forces within engine and propeller.

Sperry Amphibious Triplane. The Sperry Amphibious Triplane. Aviation, vol. 9, no. 7, Nov. 1, 1920, pp. 222–224, 2 figs. Specifications: Wing span, 48 ft.; depth of wing chord, 60 in.; gap between wings, 60 in.; length overall, 31 ft. 6 in.; height, 15 ft. 4 in.; total supporting surface, 678 sq. ft.; total weight, 5056 lbs.; engine, Liberty 12-cylinder V type 400 hp.; speed, 91 m.p.h.

Waterman Type. Waterman Type 3–L400 Airplane. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 191–192, 2 figs. Dimensions: Speed, maximum, 126 m.p.h.; crusing speed, 105 m.p.h., engine, 400 hp. Liberty. weight, loaded, 4135 lb., climb, 10,000 ft. in 9 min.

Wings. The Handley Page Wing. Flight, vol. 12, no. 44, Oct. 28, 1920, pp. 1123–1125, 4 figs. Account of first public demonstration of patented high-lift wing.

The Handley Page Wing Patent. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 197–199, 6 figs. Object of invention is to provide construction whereby burbling effect on back or upper surface of forward portion of wing can be overcome, so that same lift can be obtained at slower speeds than is now possible even when wing is inclined at greater angle to air.

AIRSHIPS

Commercial. The Commercial Airship—Its Operation and Construction, Trevor Dawson. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 558–560. Airplane versus airship. Airship is found more advantageous for commercial service, and its traffic possibilities are pointed out. (Abstract.) Paper read at Air Conference, London, Oct. 14, 1920.

Rigid. The Aerial Cruiser. Sci. Am., vol. 123, no. 16, Oct. 16, 1920, pp. 400, 409 and 412, 3 figs. Particulars: Gross displacement, 38.25 tons; disposable lift, 17.80 tons; total b.hp. at full power, 1000; range in miles, full power, 3900; maximum height attainable with crew and stores, 17,000 ft.

[See also BALLOONS.]

ALCOHOL

Ethyl, from Wood Waste. The Manufacture of Ethyl Alcohol from Wood Waste, G. H. Tomlinson. Dominion of Canada, bul. no. 7, 1919, 9 pp. Chemical processes.

Waste Sulphite Liquor as Source. Canadian Waste Sulphite Liquor as a Source of Alcohol, Vernon K. Krieble. Dominion of Canada, report no. 5, 1919, 14 pp., 2 figs. A dozen representative Canadian sulphite liquors were analyzed. Results showed that best liquors contained as high a percentage of sugar as those produced in Europe. Yield from Canadian sulphite liquors is estimated at at least one per cent of alcohol by volume.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Non-Expanding. Important Swiss Discovery Affecting Watchmaking. Commerce Reports, no. 260, Nov. 4, 1920, p. 569. C. E. Guillaume, director of International Bureau of Weights and Measures announces discovery of alloy steel which will experience no changes with variation in temperature. Alloy is a nickel steel with 12 per cent chrome.

Uranium and Chrome-Vanadium. Uranium as a Structural Steel Alloy, Hugh S. Foote. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 695–696. Characteristics of uranium steel. Static and dynamic tests of uranium and chrome-vanadium steels.

ALLOYS

Molybdenum, Cobalt and Chromium. The Analysis of Molybdenum, Cobalt, and Chromium Alloys, J. R. Camp and J. W. Marden. Jl. Indus. and Eng. Chem., vol. 12, no. 10, Oct. 1920, p. 998. Results of series of analyses made on samples of metal obtained by alunimothermic reduction method.

Ternary. Ternary Alloys and the Equivalence Coefficients (Les alliages ternaires et les coefficients d'equivalence), Léon Guillet and Albert Portevin. Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 561–567, 4 figs. Technical study. Special reference made to copper-aluminum-zinc alloys.

[See also ALUMINUM ALLOYS.]

ALTERNATORS

See ELECTRIC GENERATORS, A. C., Slow-Speed.

ALUMINUM

Atomic Weight. A Revision of the Atomic Weight of Aluminum. The Analysis of Aluminum Bromide. Preliminary Paper, Theodore W. Richards and Henry Krepelka. Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2221–2232, 1 fig. Synthesis and analysis of pure aluminum bromide. Atomic weight for aluminum is computed at 26.963.

Automobile Parts. Machining Aluminium Automobile Parts. Machy. (Lond.), vol. 17, no. 422, Oct. 28, 1920, pp. 97–101, 9 figs. Account of recent practice.

num-dust explosion and manner in which explosion occurred, and results of this investigation.

Nickel Plating of. Nickel-Plating Aluminum and Alloys. Sci. Am. Monthly, vol. 2, no. 3, Nov. 1920, p. 267. It was found in tests that sheet metal treated with fine ground sand and under pressure of 1500 grams per sq. cm. could be kept in good state if wrapped in sheet of filter paper for 30 days before being nickel-plated. Sheets of metal treated with sand blast under these conditions were nickel-plated up to 0.04 mm. Translated from Revue de Métallurgie.

ALUMINUM ALLOYS

Analysis of. A Rapid and Systematic Method for the Analysis of Light Aluminium Casting Alloys, Russell M. Berry. Jl. Indus. and Eng. Chem., vol. 12, no. 10, Oct. 1920, pp. 998–1000. Method developed at U. S. Navy Yard, Philadelphia, Pa.

No. 12 Alloy. Experiments in Manufacturing No. 12 Alloy, Robert J. Anderson. Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 883–887, 4 figs. It is concluded from experiments that No. 12 alloy may be conveniently and economically prepared by charging aluminum ingot, No. 12 ingot and scrap and copper-rich alloy into melting furnace, and that there is no advantage in any other procedure.

APPRENTICES, TRAINING OF

Engineering Apprentices. The practical Training of Engineering Apprentices [Die praktische Ausbildung der Ingenieurlehrlinge (Praktikanten)]. Betrieb, vol. 2, no. 15, Aug. 1920, pp. 413–415. Advice to machine industrials. Proposal of the German Committee for Technical Instruction.

German Works. The Apprentice School of the Thyssen & Co. Machine Factory, Mülheim-Ruhr (Aus der Lehrlingsschule der Maschinenfabrik Thyssen & Co., Mülheim-Ruhr, E. W. Seyfert. Werkstattstechnik, vol. 14, no. 15, Aug. 1, 1920, pp. 409–420. Conditions in training school are described which are said to be particularly interesting partly because it is a happy medium between municipal continuation schools and the purely technical training school, and partly because of its curriculum, effort being made to bring instruction in closest relationship with vocation of apprentice in order to stimulate his interest in learning. Sheets showing plan of instruction for the different classes are reproduced.

Machinists. A Worth-While Training Department, L. C. Morrow. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 893–896, 3 figs. Methods at shop of American Tool Works, Co., Cincinnati.

Training Apprentices for Permanent Jobs, Norman G. Shidle. Automotive Industries, vol. 43, no. 19, Nov. 4, 1920, pp. 923–925, and p. 929, 3 figs. Training course for machinists operated for 40 years at works of Warner & Swasey Co., Cleveland.

Methods. Modernizing the Apprenticeship, Erik Oberg. Machy. (N.Y.), ol. 27, no. 3, Nov. 1920, pp. 220–224, 7 figs. Review of methods used by Taft-Pierce Mfg. Co., Woonsocket, R. I., in training apprentices along broad, comprehensive lines, intended to ultimately fit them for important position in mechanical industries.

Programs of Apprenticeship and Special Training in Representative Corporations—IV, J. V. L. Morris. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 847–852, 8 figs. Methods of Westinghouse Electric Mfg. Co., East Pittsburgh, Pa.

Secondary Technical Education, F. H. Sexton. Jl. Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 505–509. Discussion of present and proposed methods of training in industry: vocational training, what it has accomplished in Great Britain and America, and part to be played by engineers.

ARCHES

Brick. Arch Brick Work, A. D. Williams. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1264–1265, 1 fig. Formulæ and tables for fantail or taper arches.

ASPHALT

Gas vs. Oil for Melting. Taking All Factors into Consideration, Gas can be Proved Least Expensive as Well as Most Economical Fuel for Asphalt Melting C. H. Kallstedt. Am. Gas. Eng. Jl., vol. 113, no. 18, Oct. 30, 1920, pp. 345–348 and 350–351. Comparative costs of gas and oil. Advantages of using gas.

Refineries. The Largest Asphalt Refinery in the World. Mun. & County Eng., vol. 59, no. 4, Oct. 1920, pp. 130–132, 4 figs. Refinery operated by Texas Co. at Port Neches, Texas.

ATMOSPHERE

Electrical Phenomena at High Levels. Electrical Phenomena Occurring at High Levels in the Atmosphere, C. Chapman. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 209–216 and (discussion) pp. 217–222, 4 figs. General outline of subjects based on published reports of observations.

AUTOGENOUS WELDING

Purity of Oxygen. Investigation of the Purity of Oxygen for Autogenous Welding (Untersuchung der Reinheit des Sauerstoffs fur Autogenschweisserein). Autogene Metallbearbeitung, vol. 13, nos. 14 and 15, July 15 and Aug. 1, 1920, pp. 157–162 and 175–177, 5 figs. Includes two tables giving

AUTOMOBILE ENGINES

Cam Grinding. A New Attachment for Grinding of Cams. Automotive Industries, vol. 43, no. 19, Nov. 4, 1920, pp. 921–922, 3 figs. Landis cam-grinding attachment.

Ignition. See IGNITION.

Starters. Electric Starting and Lighting of Automobiles (Éclairage et démarrage électriques des automobiles). Génie Civil, vol. 77, no. 14, Oct. 2, 1920, pp. 273–276, 5 figs. Bicompound dynamo built by Bleriot Works, Paris.

Impulse Starters. Automobile Engr., vol. 10, no. 143, Oct. 1920, pp. 417–418, 6 figs. Notes on new M–L device.

Tylor-Ricardo. The Tylor-Ricardo Engine. Automobile Engr., vol. 10, no. 143, Oct. 1920, pp. 386–393, 13 figs. Four-cylinder power unit for heavy vehicles. Description and results of road tests.

AUTOMOBILE FUELS

Acetol. New Motor Fuel in South Africa, Charles J. Pisar. Commerce Reports, no. 252, Oct. 26, 1920, p. 411. Particulars regarding acetol, a mixture of alcohol and ether with other ingredients.

Alcohol. Possible New Sources of Power Alcohol, C. Simmonds. Nature (London), vol. 106, no. 2660, Oct. 21, 1920, pp. 244–245. Report by Fuel Research Board, department of Scientific and Industrial Research.

Gasoline Substitute. Alternative Fuels. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 543–544. Editorial comment on conflict in views presented at Fuel Section meetings of Imperial Motor Transport Conference held in London during Commercial Vehicle Exhibition.

Mixtures. Fuel Mixtures on London 'Buses, G. J. Shave. Motor Traction, vol. 31, no. 817, Oct. 25, 1920, pp. 493–494, 2 figs. Experiments carried out by London General Omnibus Co. Alcohol benzole, alcohol-ether, and alcohol-ether-benzol mixtures have been investigated.

[See also GASOLINE.]

AUTOMOBILES

Air Brakes. Air Brakes for the Automobile, C. W. Geiger. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 467 and 480, 2 figs. System tested at Safety First Exposition held in conjunction with Nat. Traffic Officers' Convention at San Francisco. Air pressure is obtained from one cylinder of engine and is automatically maintained by means of accumulator valve with only one moving part.

Quantity Production. Machine Tool Practice as Applied to Motor-Car Production. Machy. (Lond.), vol. 17, no. 421, Oct. 21, 1920, pp. 68–75, 13 figs. Review of production methods employed by Vulcan Motor & Eng. Co. (1906), Ltd., Southport, England.

Warming Apparatus. Motor-Car Warming Apparatus. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 472, 5 figs. Apparatus designed and constructed by Arc & General Equipment, Ltd., Engineers, London.

Wheels. Single-Disc Metal Wheels, A. L. Putnam, Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, p. 437 and (discussion) p. 442. Advantages.

Wire Wheels, C. S. Walker. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 441–442, 4 figs. Advantages and disadvantages.

Wood Truck Wheels, S. Vance Lovenstein. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 438–440 and (discussion) pp. 442–445, 2 figs. Advantages and disadvantages. Results of strength tests.

AVIATION

Aerial Mail Service. Aerial Postal Service (La voie postale aérienne), Georges Brunel. L'Aérophile, vol. 28, nos. 15–16, Aug. 1–15, 1920, pp. 240–245. Survey of developments throughout the world.

Mail Transport, P. L. Holmes. Aeronautics, vol. 19, no. 366, Oct. 21, 1920, pp. 293–294. Cooperation of aircraft and surface craft.

Aerial Transportation. Time Table and Tariff of Air Companies Operating at Paris. Aeronautics, vol. 19, no. 364, Oct. 7, 1920, p. 262. There are four companies operating between Paris-London; one between Paris and Geneva; one between Toulouse and Bordeaux; two between Paris and Brussels; one between Toulouse and Montpellier; and one between Toulouse and Agen.

Alaskan Expedition. The Alaskan Flying Expedition. Flying, vol. 9, no. 10, Nov. 1920, pp. 626–630, 3 figs. Records of flight.

British Air Ministry. The Air Conference. Eng., vol. 110, nos. 2859 and 2860, Oct. 15 and 22, 1920, pp. 512–515 and 528–532. Proceedings of Air Conference called by Air Ministry for purpose of discussing technical and economic problems connected with aviation. (Abstract.)

Civil. Civil Aviation and Air Services, S. H. Sykes. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 524–526. Growth and present position of air mail passenger and goods services in British Empire, France and United States. (Abstract.) Paper read at Air Conference at London, Oct. 12, 1920.

Contests. Two Great Aviation Contests in 1920 (Deux grandes épreuves d'aéronautique de 1920). Génie Civil, vol. 77, no. 17, Oct. 23, 1920, pp. 325–

ENGINEERING INDEX (Continued)

328, 8 figs. Contest for the Gordon-Bennett Cup held on Sept. 28, and the Buc Meeting, Oct. 8–10.

Key West-Havana Route. Key West-Havana Route Inaugurated. Aviation, vol. 9, no. 7, Nov. 1, 1920, pp. 226–227 and p. 230, 3 figs. Aircraft used is development of F-5-L flying boats which United States Government produced during the war for extended anti-submarine patrols both in home waters and in North Sea.

[See also FLIGHT.]

AVIATORS

Physiological Phenomona at High Altitudes. Aviators at High Altitudes (Les aviateurs aux hautes altitudes), Jacques Boyer. Nature (Paris), no. 2422, Sept. 4, 1920, pp. 145–148, 3 figs. Physiological experiments at French Aerotechnical Inst.

B

BALLOONS

Dilatable. Dilatable Balloons, James F. Boyle. Aviation, vol. 9, no. 6, Oct. 15, 1920, pp. 184–186, 6 figs. Balloons recently built and tested by War Department.

Hydrogen-Helium Mixtures for. Inflammability of Jets of Hydrogen and Inert Gas, P. G. Ledig. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1098–1100, 4 figs. Experimental work to determine maximum amount of hydrogen which can be used with helium in balloons without losing advantage of noninflammability. Up to 18 to 20 per cent of helium was found to be safe proportion.

BARGES

Adjustable Prow. French Devise Adjustable Prow to Increase Speed of Barges. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 851–852, 2 figs. Resistance lowered 23 per cent in tests made with folding panels that sharpen barge's flat bow. Translated from Annales des Ponts et Chaussées.

BATTERIES

Clark Standard Cell. The Two Common Failures of the Clark Standard Cell, E. C. McKelvy and M. P. Shoemaker. Sci. Papers, Bur. of Standards, no. 390, July 21, 1920, pp. 409–420, 8 figs. Cracking at amalgam terminal is remedied by employing platinum wire previously subjected for a short time to the action of hot ten per cent zinc amalgam, using lead sealing-in glass. Interruption of circuit by gradual formation of gas in amalgam limb is reduced by using smallest excess of crystals required to insure saturation at highest temperature at which cell is likely to be used.

Dry Cells, Testing. Automatic Apparatus for Intermittent Testing, G. W. Vinal and L. M. Ritchie. Technologic Papers, Bur. of Standards, no. 171, July 22, 1920, 7 pp. 6 figs. Apparatus devised at Bureau of Standards for making tests of dry cells and storage batteries. It is applicable to any form of intermittent test requiring closing of electrical circuits at regular time intervals.

New Cell. A New Electric Battery (Une nouvelle pile électrique), A. Troller. Nature (Paris), no. 2424, Sept. 18, 1920, pp. 180–181, 1 fig. Leclanché type with electrodes arranged to permit depolarization of oxygen of atmosphere.

BEAMS

Bending Moments. A Self-Checking String Polygon, Theodore Bleckmann. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 880–881, 3 figs. Graphical method in which paralleling is replaced by measurement.

Cantilever. The Calculation of the Deformation of Cantilever. Beam Systems (Beitrag zur Berechnung der Formänderung von Kragträgersystemen), Eduard Cecerle. Eisenbau, vol. 11, no. 17, Sept. 3, 1920, pp. 296–313, 14 figs. Method according to which the elastic weights are calculated from the internal forces (deformations) due to load (change of temperature, etc.); with these weights the described reciprocal beam system is loaded; and line of moments of the elastic weights is the bending line. Includes table for calculation of bending line.

[See also GIRDERS.]

BEARINGS, BALL

Roller and. What is the Difference Between Roller and Ball Bearings, A. Danielson. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 857–858, 5 figs. Suggestions for definite classification of these two types.

BELTING

Substitutes. Investigation of Substitute Belts (Untersuchung von Ersatzriemen), H. Schlesinger and M. Kurrein. Werkstattstechnik, vol. 14, nos. 14 and 15, July 15, and Aug. 1, 1920, pp. 385–388 and 420–426, 18 figs. Account of tests on various types of belts to determine their adaptability, etc., and description of test arrangements. Results are given in tables and charts and show that braided belts give the poorest and twill texture the best results. Report from machine-tool testing station of the Berlin Technical Academy.

BENZOL

Recovery from Coal Gas. The Recovery of Vapours from Gases Particularly of Benzene and Toluene from Coal Gas, Harold S. Davis and Mary Davidson Davis. Dominion of Canada, report no. 2, 1918, 15 pp., 2 figs. Results of research carried out in University of Manitoba, and of tests conducted at Light Oil Recovery Plant of Toronto Chemical Co.

BLAST-FURNACE GAS

Cleaning. Cleaning Blast-Furnace Gas, A. Hutchinson and E. Bury. Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 453–456, 4 figs. Rough-cleaning of blast-furnace gas at Skinningrove by the Lodge Electrostatic Process. Paper read before Iron & Steel Inst.

Power Production from. The Production of Power from Blast-Furnace Gas, S. H. Fowles. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 431–436, and (discussion) pp. 437–463, 3 figs. Survey of old and new methods of utilization of waste heat.

BLAST FURNACES

Heat Supplied to. The Effect of Heat Supplied to the Blast Furnace, W. W. Hollings. Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 459–460. Variations in heat supplied to blast furnace, and their effect on fuel consumption. Paper read before Iron & Steel Inst.

Large Hearths. Development of Large Furnace Hearth, Walter Mathesius. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 588–592, 6 figs.; Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 867–872, 6 figs.; Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1211–1213, 6 figs.; and Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1106–1109, 1 fig. Wide hearth permits steeper bosh and flatter stack lines with many resulting economies, especially for smelting Mesaba ores. Operating data, construction details and theoretical considerations point to its definite superiority. Paper read before Am. Iron and Steel Inst.

Remodeling. Rebuilt Furnace Conserves Labor. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1123–1126, 5 figs. How capacity of furnace of Belfont Iron Works Co., Ironton, O., was increased two-thirds.

Remodeled Blast Furnace at Ironton, Ohio, F. H. Willcox. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 599–602, 3 figs. How capacity of blast furnace has been increased two-thirds.

Stack Design. Designs Stack for Foundry Iron. Iron Trade Rev., vol. 67, no. 16, Oct. 14, 1920, pp. 1068–1070, 4 figs. Bosh is cooled by series of louvers which keep film of water flowing over entire jacket. Big bell suspended from yoke on account of filling system. Charge weighted on floor-type scale.

BOILER FEEDWATER

Automatic Regulator for. An Automatic Feed Regulator. Engr., vol. 130, no. 3380, Oct. 8, 1920, p. 352, 3 figs. Manufactured by A. G. Mumford, Ltd., Colchester, England. Regulator acts directly on feed check valve and relies for its effect on control of leakage past piston connected with valve.

Testing. Simple Methods of Determining Dissolved Gas Content in Boiler-Feed Water, J. R. McDermet and Daniel Wertheimer. Power, vol. 52, no. 18 Nov. 2, 1920, pp. 686–688, 3 figs. Methods which do not require special laboratory glassware or skilled operator.

BOILER FIRING

Lean Gas as Fuel. Lean Gas as Boiler Fuel. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1261–1262, 1 fig. Low grade coals used in coke ovens and coke utilized in gas producers. Experiments carried on by Société deséres de Montrambert et de la Béraudière at St. Étienne, France.

BOILERS

Electrically Heated. Recent Developments of Electrically Heated "Revel" Boilers in Switzerland, E. G. Constam-Gull. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 563–565, 4 figs. Revel boiler has overall diameter of 24 in. and total height of 8 ft. It produces 1200 lb. of steam per hour at gage pressure of 225 lb. per sq. in. when supply current is at 500 volts. Efficiency corresponds to evaporation of 2.8 lb. of standard steam per kilowatt-hour. Evaporation and heating of steam is accomplished within immediate vicinity of water level.

Gas-Fired. French Experience with Gas-Fired Boiler Installation Demonstrates Possibility of Complete Combustion of Low B.t.u. Gas Without Preheating Supporting Air, John H. Bartlett, Jr. Am. Gas Eng. Jl., vol. 113, no. 17, Oct. 23, 1920, pp. 321–324, 2 figs. Installation made by French Company, employing patented process and equipment of Surface Combustion Co. of New York.

Use of Gas Fired Boilers, C. M. Grow. Gas Rec., vol. 18, no. 7, Oct. 13, 1920, pp. 39–42. Appliances for domestic and commercial heating on Pacific coast. Paper read before Pacific Coast Gas Assn.

Industrial Code. Rules as Amended Relating to the Construction, Installation, Inspection and Maintenance of Steam Boilers. Bul. no. 14, Industrial Code, State of New York, Dept. of Labor, State Industrial Commission, 148 pp., 33 figs. Rules amended and readopted to become effective July 1, 1920.

Oil-Fired. Soot Deposits in Oil-Fired Boiler, Robert June. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, pp. 1061–1063, 2 figs. Description of tests indicating advisability of equipping oil-fired boilers with soot blowers.

Patches. Design of Patches. Universal Engr., vol. 32, no. 4, Oct. 1920, pp. 38–40, 1 fig. Factor diagram for diagonal patch seams on bottoms of horizontal return tubular boilers.

Temperature Measurements. Temperature Measurements with Special Regard to Steam-Boiler Investigations (Einiges über Temperaturmessungen, insbesondere bei Dampfkesseluntersuchungen), H. Hilliger. Zeitschrift für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 33, 34, 35 and 36, Aug. 13, 20, 27 and Sept. 3, 1920, pp. 249–251, 257–260, 267–269 and 275–276, 14 figs. Discusses work by Knoblauch and Hencky on the accurate technical temperature measurements with liquid and electric thermometers, and other viewpoints and experiences in connection with furnace and steam-boiler investigations.

Through Stays. A Limiting Formula for Long Through Stays, John S. Watts. Boiler Maker, vol. 20, no. 10, Oct. 1920, pp. 297–298, 1 fig. Discussion of method of determining proper sizes of through stays in boilers. Chart developed to simplify calculations.

Tubes. The Constitution and Properties of Boiler Tubes, Albert E. White. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 603–606, and p. 618. Experimental investigations carried out at Detroit Edison Co. Causes of failure of boiler tubes were found to be: (1) Failure due to tube brittleness resulting from absorption of hydrogen by metal; (2) failure due to blowholes or other imperfections in metal, and (3) failure due to recrystallization of metal. Further study disclosed that increased carbon content in tubes would insure longer life and safer boiler operation. It is suggested that carbon content should vary between 0.30 and 0.35 per cent.

BORING MACHINES

Heavy-Duty. Heavy-Duty Boring Machine. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 259–260, 3 figs. Machining headstock and tailstock castings for ninety-inch driving wheel lathes.

Milling Attachment for. Vertical Boring Mill with Milling Attachment (Karusseldrehwerk mit Fräsvorrichtung), H. Weil. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 39, Sept. 25, 1920, pp. 793–794, 8 figs. Describes machine with table 4500 mm. in diam. built by the Schiess machine factory, Düsseldorf, and equipped with a special milling attachment. Shows that such special arrangements can be advantageously applied, and that in certain cases they save the installation of a new machine.

BRACKETS

Design. Stresses in Brackets and Their Bolts, Victor M. Summa. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 239–241, 4 figs. Formula for computing stresses, bending moment diagrams, etc.

BRASS

Melting with Fuel Oil. Melting Brass with Fuel Oil—I, S. D. Rickard. Metal Industry (N.Y.), vol. 18, no. 10, Oct. 1920, pp. 460–463, 2 figs. Analysis of costs and comparison with other fuels, showing that fuel oil is most economical.

BRIDGES, HIGHWAY

Reconstruction. Strengthening and Reconstructing Highway Bridges for Heavy Motor Truck Traffic. Eng. & Contracting, vol. 54, no. 17, Oct. 27, 1920, pp. 412–414. Progress report of Committee of American Road Builders' Association.

BRIDGES, LIFT

Bascule. A New Type of Bascule Span in the Highway Bridge over the Eider River Near Friedrichstadt (Neuartige Klappbrücke in der Strassenbrücke über die Eider bei Friedrichstadt). Zentralblatt der Bauverwaltung, vol. 40, no. 61, July 31, 1920, pp. 386–387, 6 figs. Describes an electrically driven, two-leaf bascule span with fixed axis of rotation. Points out advantages of two-leaf over single-leaf bridges.

BRIDGES, MOVABLE

Electric Operation. Electric Operation of Movable Bridges (La manœvre électromécanique des ponts mobiles), Joseph Chanteux. Annales des Travaux publics de Belgique, vol. 21, no. 4, Aug. 1920, pp. 515–594, 45 figs. on 15 supp. plates. General theory. Design formulæ. Three types are considered: Lift bridges; turning bridges; and bascule bridges. (To be continued.)

[See also BRIDGES, LIFT.]

BRIDGES, RAILWAY

Poland, Official Regulations. Official Regulations for the Construction of Railway Bridges in Poland (La réglementation officielle des ponts-routes en Pologne), Maximilien Thublie. Génie Civil, vol 77, no. 15, Oct. 9, 1920, pp. 293–295, 9 figs. Classification of bridges. Elastic limits permissible.

Reconstruction. Heavy Spans to be Rolled and Jacked in Difficult Bridge Reconstruction. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 904–907, 3 figs. New double-track structure of increased load capacity provides wider channel openings and greater clearance height. Erection under traffic. Will shift track to higher elevation in one day.

Specifications. New Steel Railway Bridge Specification. Can. Engr., vol. 39, no. 17, Oct. 21, 1920, pp. 443–445. Canadian Engineering Standards Association issues specification for bridges not exceeding 500-ft. span based on draft prepared by Engineering Institute. Cooper's loadings and American Railway Engineering Association's impact formula adopted. Secondary stress computation optional. Parabolic column formula. Movable bridges.

BRIDGES, WOODEN

Poland. Construction of the Bridge over the Dubiss

Gustavsburg, of wooden bridge, about 700 m. long and 40 m. high, having nine openings spanned by superstructures of 62.40 m. each, in the form of parallel trussed girders with diagonals rising and falling alternately.

BRONZES

Manganese. Note on a Failure of "Manganese Bronze," J. H. S. Dickenson. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 556–558, 15 figs. Experimental study of conditions under which alloys of manganese-bronze type are prejudicially affected by contact with fluid solder and effect of variation in composition and microstructure. Paper read before Inst. of Metals.

BUILDING CONSTRUCTION

See WALLS.

C

CARBON BLACK

Manufacture. The Disk, Plate and Cylinder Processes for the Production of Carbon Black, Roy O. Neal. Chem. & Metallurgical Eng., vol. 23, no. 16, Oct. 20, 1920, pp. 785–789, 8 figs. Description with mechanical details of disk, plate and cylinder process carbon black plants. Driving mechanism and heat variations. Comparison of processes.

CARBURETORS

Fuel-Feeding Devices. The N. K. F. Vacuum Fuel Feeder (Der N. K. F.-Unterdruck-Brennstofförderer), Wa. Ostwald. Allgemeine Automobil-Zeitung, vol. 21, no. 28, July 10, 1920, pp. 26–27, 1 fig. Describes fuel-feeding device which is said to have the advantage that the carburetor is always provided with fuel at starting of motor and is never without fuel when climbing a hill. The two chambers are constructed, not one above the other, but one within the other.

Various Construction Types of Vacuum Fuel Feeding Devices (Verschiedene Bauarten bei der Unterdruck-Förderung des Brennstoffs), H. v. Löw. Allgemeine Automobil-Zeitung, vol. 21, no. 26, June 26, 1920, pp. 29–30, 7 figs. Describes working method of such apparatus.

CARS

Buffers. A Self-Contained Railway Buffer with Non-Breakable Shank. Ry. Gaz., vol. 33, no. 17, Oct. 22, 1920, p. 550, 2 figs. Railway buffer fitted with George Spencer Moulton & Co.'s patent rubber spring.

Tipping. Railway Loading and Off-Loading Arrangements, H. Aumund. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 309–313, 13 figs. Problems of rail transport. Railway tipping cars and their various designs. Arrangement, construction, application, and capacity of new portable tipping device. Comparison with automatic tipping arrangements.

Weighing Machines. A New Railway Wagon Weighing Machine, T. J. Primrose. Ry. Engr., vol. 41, no. 490, Nov. 1920, pp. 454–455, 5 figs. Apparatus for measuring load on locomotive and car wheels with object of finding pressure with which wheels bear upon rails.

CARS, PASSENGER

Pullman Improvements. Improvements in New Pullman Sleepers. Ry. Age, vol. 69, no. 16, Oct. 15, 1920, pp. 661–664, 9 figs. Changes in details which have been developed to add to comfort and safety of travel.

CAST IRON

Nickel and Cobalt, Effect of. The Influence of Nickel and Cobalt Additions on the Physical and Chemical Properties of Cast Iron (Der Einfluss eines Nickel- und Kobaltzusatzes auf die physikalischen und chemischen Eigenschaften des Gusseisens), O. Bauer and E. Piwowarsky. Stahl u. Eisen, vol. 40, no. 39, Sept. 30, 1920, pp. 1300–1302, 3 figs. Results of investigations are given in tabular form, from which it is concluded that for production of high-grade castings for machine parts, gear wheels, etc., a nickel addition up to 1.2 per cent can be thoroughly recommended, but an addition of cobalt for the refining of cast iron is not feasible. Report from Metallurgical Inst. of Technical Academy of Breslau.

CEMENT GUN

Fireproofing with. Tests Show that Buildings May Be Rendered Fireproof with Gunite, B. C. Collier. Coal Age, vol. 18, no. 19, Nov. 4, 1920, pp. 939–942, 3 figs. Tests made by Anaconda Copper Mining Co. and at Underwriters Laboratory in Chicago.

CENTRAL STATIONS

Cuba. Central-Station Operation in Tropical America, L. E. Gowling. Power, vol. 52, no. 16, Oct. 19, 1920, pp. 606–609, 5 figs. Central station in Havana, Cuba. Plant supplies current for operation of electric railway and electric light and power service for city of Havana.

Electrical Equipment. The Electrical Equipment of the Golpa Central Station (Die elektrischen Einrichtungen des Kraftwerkes Golpa), Heinrich Probst. Elektrotechnische Zeitschrift, vol. 41, nos. 34 and 35, Aug. 26 and Sept. 2, 1920, pp.

Middle West. Power Service for a Middle West Section, Lyle A. Whitsit. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 969–971, 2 figs. Survey in Western Pennsylvania and Eastern Ohio by power section of War Industries Board indicates aggregate power peak demand during 1918 of 568,000 kw. and total central-station output in this district of 2,440,000,000 kw-hr. Estimated increased peak load of 1,000,000 kw. by 1927.

CHEMICAL INDUSTRY

Sweden. Chemical Industry and Trade of Sweden, O. P. Hopkins. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1045–1054. Statistics showing strengthening of industries since 1914.

CHROME-NICKEL STEEL

See ALLOY STEELS, Non-Expanding.

COAL

Conservation. George Otis Smith on Thrift in Coal. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1122–1124, 3 figs. Suggestions for economical use of coal in steel industry and by railroads. Paper read before Am. Iron & Steel Inst.

Thrift in Coal, George Otis Smith. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 716–718, 3 figs. Suggestions in regard to coal combustion. Paper read before Am. Iron and Steel Inst.

Distillation of. The Low-Temperature Distillation of Coal in a Revolving Kiln (Die Tieftemperaturentgasung der Kohle im Drehofen), H. Gwosdz Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 35, Aug. 27, 1920, pp. 265–267, 1 fig. Account of distillation tests in a large revolving kiln, 24 m. long and 2 1/2 m. in diameter, into one end of which the fuel is fed while from the other end the semi-coke is carried out. Favorable results were obtained.

Mixtures. Graphic Method of Determining Proportions of Coal Mixtures, Edward J. Clarke. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, p. 1066, 1 fig. Chart for determining proportions of coal mixtures.

Oil vs. Coal Versus Oil Performance Chart, L. C. Lichty. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 351–352, 5 figs. Calculations are based on cost per ton of coal delivered at plant, its heating value and efficiency of boiler plant when burning coal, in comparison with results determined by making use of density of oil fuel, heating value per barrel, cost per barrel delivered and efficiency when burning fuel.

Supply. The Problems of Coal Supply, Eugene McAuliffe. Elec. Ry. Jl., vol. 56, no. 16, Oct. 16, 1920, pp. 754–759, 5 figs. It is said that storage at point of consumption will improve "load factor" of fuel production and distribution. It is believed that national legislation providing for seasonal variation in coal-haulage rates would encourage uniformity of demand for coal and reduce mining costs. (Abstract.) Paper read before Am. Elec. Ry. Assn.

COAL BREAKERS

Dry Treatment. Preparing Anthracite for Market Without the Use of Water, Dever C. Ashmead. Coal Age, vol. 18, no. 19, Nov. 4, 1920, pp. 935–938, 8 figs. It is claimed that mechanical equipment and dust suckers render dry treatment almost as free from dust as wet preparation.

COAL GAS

Detarring. The Detarring of Gas by Electrical Precipitation, J. G. Davidson. Dominion of Canada, report no. 3, 1918, 45 pp., 4 figs. Report of experimental work. Successful tests of process of electrical precipitation for detarring of gas on commercial scale were made in wood, coal and petroleum distillation plants.

COAL MINES

Bituminous, Gas Explosion Prevention. Rules for Prevention of Gas Explosions, R. A. Walter. Coal Age, vol. 18, no. 19, Nov. 4, 1920, pp. 945–947. Rules based on writer's experience gained in bituminous coal mines as mine owner and manager for many years. Paper read before Ninth Annual Safety Congress.

COAL MINING

Difficulties Overcome. By New Operating Methods Estimated Life of Seneca Colliery has been Tripled, Dever C. Ashmead. Coal Age, vol. 18, no. 17, Oct. 21, 1920, pp. 839–845, 8 figs. Many difficulties, such as subterranean outcrops in glacial drift, mining under river beds, large inflow of water and one bed squeezed over practically entire area, have been encountered and surmounted in operating this mine.

COAL STORAGE

Fire Hazard. A Few of the Less Emphasized Causes Why Fine Sizes Ignite Soft-Coal Piles, O. P. Hood. Coal Age, vol. 18, no. 17, Oct. 21, 1920, pp. 845–848, 8 figs. One ton of coal in solid exposes 47 sq. ft. of surface to air. Crushed so as to pass sixteen-mesh sieve it exposes about one acre of surface. Extent and freshness of surface exposed and rapidity of ventilation are chief factors governing spontaneous heating. (Abstract.) Address delivered before Pennsylvania Elec. Assn.

Fire Prevention. The Storage of Coal, W. D. Langtry. Power, vol. 52, no. 18, Nov. 2, 1920,

Advantages as Fuel. Coke in Relation to Cheap Power, Transport and Smoke Abatement, E. W. L. Nicol. A Thousand and One Uses for Gas (Supp.), vol. 8, no. 81a, pp. 4–20, 20 figs. Advantages of coke as fuel. Performance record of coke-fired boilers.

Hydrogen as Desulphurizing Agent. The Desulfurizing Action of Hydrogen on Coke, Alfred R. Powell. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1077–1081, 1 fig. Curves showing elimination of sulphur as hydrogen sulphide from coal when coked under different conditions.

COKE MANUFACTURE

Reactions in. A Study of the Reactions of Coal Sulfur in the Coking Process, Alfred R. Powell. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1069–1077, 3 figs. Experimental studies at Bureau of Mines.

COKE OVENS

Rotating. Low-Temperature Distillation of Coal in Rotating Coke Oven, Ing. E. Roser. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 678–679, 1 fig. Low-temperature tar is reported to yield 90 per cent bitumens in coal as against 50 per cent under present methods. Translated from Stahl und Eisen.

COLLOIDS

Colloid Mill. Colloidal Chemistry and a "Colloid Mill." Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 429–430. New Type of fine grinding disintegrator or "colloid" mill claimed to be ideal apparatus for extremely fine grinding required for homogenizing and dissolving substances and for obtaining emulsions and colloidal preparations. Translated from Chemiker-Zeitung.

COMBUSTION

Initial Gas Temperature. The Importance of the Initial Gas Temperature and Scientific Stoking (Die Bedeutung der Anfangstemperatur und die feurungstechnische Kritik), J. Hudler. Zeitschrift des Vereines deutscher Ingenieure, vol. 64, no. 40, Oct. 2, 1920, pp. 810–814, 2 figs. It is shown that for maintenance of a certain hour-output of a given boiler furnace plant, every increase of initial temperature causes a decrease of temperature of gases on leaving flue, which is brought about by reducing rate of combustion; increase of initial temperature also signifies reduction of chimney losses in temperature and volume of flue gases. The true ratio of value of different fuels, such as peat and peat dust, to anthracite is calculated.

COMPASSES

Gyroscopic. Principles of the Gyro-Compass, George B. Crouse. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 619–623, 16 figs. Problems of design, special compensation of disturbing factors, methods of suspension and methods of damping.

COMPRESSED AIR

Pneumatic Mail Despatch. Pneumatic Mail Despatch in the Municipality of Berlin, Postbaurat Kasten. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 305–308, 5 figs. Alternating air-current service with double-tube line, each tube for one direction only. Connection between old and new central telegraph office in Berlin. Equipment and switch connections. Graphic reproduction of pressure in tube.

CONCRETE

Pavement Slabs. Study of Temperature Stresses in Rigid Pavement Slabs, C. H. Scholer. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 943–944, 3 figs. Research at Engineering Experiment Station of Kansas State Agricultural College.

CONCRETE CONSTRUCTION

Marine Structures. The Durability of Maritime Structures. Nature (London), vol. 106, no. 2660, Oct. 21, 1920, pp. 235–236. Report of Committee of Instn. of Civil Engrs., appointed to investigate deterioration of structures of timber, metal and concrete exposed to action of sea water.

CONCRETE CONSTRUCTION, REINFORCED

Coal Mines. Ferro-Concrete Pit-Head Frame at Bently Colliery, Doncaster. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 498–501, 71 figs. partly on supp. plate. Main building is about 132 ft. long by 32 ft. wide, with height, from foundations to roof of 64 ft.

Supports. Determination of Stress in Reinforced-Concrete Supporting Parts of any Given Cross-Section with Inclined Loading (Spannungsermittlung bei Eisenbetontragteilen beliebigen Querschnitts mit schrägem Lastangriff), G. Hartschen. Beton u. Eisen, vol. 19, no. 14, Sept. 4, 1920, pp. 167–169, 3 figs. Supplementary to author's article in no. 17–18, 1918, of same journal. Formulæ are derived for determination of main tensions for reinforced-concrete supports with inclined load, under two conditions, namely, when position of main axis of cross-section is known and when it is unknown.

CONCRETE, REINFORCED

Flat-Slab. Diagram for Flat Slab Design, O. Wolpert. Eng. & Contracting, vol. 54, no. 17, Oct. 27, 1920, p. 411, 1 fig. Diagram for estimating amount of reinforcing steel and thickness of slab required by New York City 1920 regulations.

ENGINEERING INDEX (Continued)

Liquid Mixtures. Liquid Concrete Mixtures for Reinforced-Concrete (Flussige Betongemische für Eisenbeton), H. Amos. Beton u. Eisen, vol. 19, no. 14, Sept. 4, 1920, pp. 164–167. Discussion of report on experiments in Royal Material-Testing Station, Berlin-Lichterfelde by Director M. Gary, from which following conclusions are drawn: Iron molds, heretofore commonly used, are not feasible for liquid concrete mass; wooden molds exhibit uncertainties in test; plaster molds produce samples whose strength is almost equal to that of concrete.

CONDENSERS, ELECTRIC

Electrostatic. Electrostatic Condensers, V. E. Goodwin. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 976–983, 13 figs. Fundamental characteristics of condensers and their relation to electric circuits containing inductance and resistance. Effects of switching condensers on and off such circuits. Applications of condensers.

CONDUITS

Concrete. Casting and Steaming Reinforced Pipe. Public Works, vol. 49, no. 16, Oct. 16, 1920, pp. 358–360, 6 figs. Fabricating and seasoning in contractor's yard ten miles of reinforced concrete pipe 5½ ft. in diameter and 8 in. thick.

Reinforced-Concrete Pressure Pipes in Hydroelectric Plants (Druckrohre aus Eisenbeton bei Wasserkraftanlagen), Leo Nagel. Beton u. Eisen, vol. 19, no. 14, Sept. 4, 1920, pp. 153–155, 6 figs. Description of 1.4-km. pipe line in hydraulic plant of the Perlmooser Corp., Kirchbichl-Tirol, with diameter of 2.20 m. and pressure of 2 atmos., demonstrating economic advantages of use of reinforced-concrete pressure pipes.

CONNECTING RODS

Machining. Machining the Connecting Rods of Two Well Known Motors, Fred H. Colvin. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 829–834, 20 figs. Method of manufacturing connecting rods for Oakland and Studebaker motors.

CONTRACTS

Cost Plus. Dam Contract Has Special Cost-Plus Feature. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 878–879. Provision made for sliding scale of payments depending on actual cost of Wanaque water supply project in New Jersey.

CONVEYORS

Marcus Trough. The Use of the Marcus Conveying Trough in Foundries and Other Plants (Ueber die Anwendung der Marcus-Rinne in Giessereien und anderen Betrieben), Wilhelm Venator. Der praktische Maschinen-Konstrukteur, vol. 53, no. 29–30, July 22, 1920, pp. 257–264, 24 figs. Consists of a rigid sheet-iron trough resting on rollers with a uniform acceleration forward and a corresponding retardation on return path. Describes its many useful possibilities and points out that its cost is low in comparison to its practicability and advantages.

CORROSION

Galvanized Iron. Destruction of Galvanized Corrugated Iron through Flue Gases (Zerstörung von verzinktem Eisenwellblech durch Rauchgase), Pb. Siedler. Rauch u. Staub, vol. 10, no. 9–10, June-July, 1920, pp. 43–50, 18 figs. on 6 supp. plates. Based on investigations and literature, it is concluded that the resistivity of galvanized corrugated iron, when used for structures exposed to flue gases containing SO_2 or to flue-dust deposits, is of short duration, and when its employment for this purpose is unavoidable, it is advisable to add a protective coating against rust. Bibliography.

Iron. Corrosion of Iron in Sulphuric Acid. Effect of Chromium Compounds, George W. Heise and Amando Clemente. Philippine Jl. of Sci., vol. 16, no. 5, May 1920, pp. 439–446, 1 fig. Experiments conducted to determine effect of (1) varying concentration of sulphuric acid and of potassium dichromate, and (2) of additions of chromium salts.

Steel. Studies on the Corrosive Action of Chlorine-Treated Water. I—The Effects of Steel on the Equilibrium: $Cl_2 + H_2O \rightleftharpoons HCl + HClO$, and of Products of the Equilibrium of Steel, George L. Clark and R. B. Iseley. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1116–1122. Based on records of corrosion produced by water of various American cities.

Theories of. The Effect of Air and Water on Materials Used in Engineering Work, H. E. Yerbury. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 118–126 and (discussion) pp. 126–133. Chemical and electrolytic theories of corrosion. Effects on iron and steel and non-ferrous alloys. Instances of damage to metals, etc., subjected to air and water.

COST ACCOUNTING

Machine Shops. Machine Rate Hour in Distributing Expense, Christopher Haigh. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1207–1208. General advantages of method. (Abstract.) Paper read before Am. Gear Manufacturers' Assn.

Predetermining Needs. When, What and How Much to Buy, Charles W. Dean. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 362–364, 5 figs. Predetermining raw material needs as function of cost accounting.

CRANES

Electric. 25-Ton Electric Luffing Crane. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 501–503, 5 figs. Electric crane fitted with Toplis horizontal luffing gear and balanced jib supplied to Port of London Authority by Stothert & Pitt, Ltd., England.

60-Ton Electric Overhead Traveling Forge Crane. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 572–574 and p. 576, 6 figs. Constructed by William Arrol & Co., Ltd., Glasgow. Crane has span of 56 ft. 11 in. and height from floor to rail level of 28 ft. 9 in. With load of 60 tons hoisting motor of 50 b.hp. running at 470 r.p.m. gives lift of 8 ft. per minute.

Floating. Two Hundred-Ton Floating Crane for Liverpool. Engr., vol. 130, no. 3381, Oct. 15, 1920, pp. 375 and 378, 3 figs. Crane lifts weight of 200 tons and hoists up to height of 170 ft. above water line at distance of 110 ft.

Safety Devices. Crane Safety Devices, Nicholas Prakken. Metal Trades, vol. 2, no. 11, Nov. 1920, pp. 453–455, 5 figs. Typical safety devices for cranes used in foundries, machine shops, yards, shipyards and warehouses. Paper read before Nat. Safety Congress.

CRANKSHAFTS

Torsional Vibration. The Critical Speeds of Torsional Vibration, F. M. Lewis. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 418–424 and (discussion) pp. 424–431, 14 figs. Mathematical study.

Torsional Vibration and Critical Speeds in Crankshafts, J. F. Fox. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 413–417 and p. 435, 14 figs. Vibration chambers constructed to overcome torsional vibration in crankshaft of submarine engine.

CUPOLAS

Slag from. Operating Analysis of Cupola Furnace Slag (Betriebsanalyse der Kupolofenschlacke), Bernhard Osann. Giesserei Zeitung, vol. 17, no. 17, Sept. 1, 1920, pp. 275–276. Notes on the rapid determination of CaO, Mn, Fe, and S contents.

CUTTING METALS

Drilling. Supplement to Frederick W. Taylor's "On the Art of Cutting Metals"—XII, Carl G. Barth. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 365–372, 14 figs. Writer shows how intelligent study of drill shapes, speeds and feeds may be made to contribute to tool endurance and increased production.

[See also OXY-ACETYLENE CUTTING.]

CYANAMID PROCESS

Action of CO on. Studies on Calcium Cyanamide, Naoto Kameyama. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 9, Aug. 25, 1920, pp. 309–347, 7 figs. Action of carbon monoxide upon calcium cyanamide.

Heat of Formation. Heat of Combustion and Heat of Formation of Calcium Cyanamide, Naoto Kameyama. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 10, Aug. 30, 1920, pp. 239–253. Experimental determination.

Preparation. On the Preparation of Cyanamide of Calcium, Naoto Kameyama. Jl. College of Eng., Tokyo Imperial University, vol. 10, no. 8, July 25, 1920, pp. 173–207. Experimental study of chemical reactions, taking urea and dicyandiamide as amides.

CYLINDERS

Cores. Cylinder Cores Made in Green Sand. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 861–866, 12 figs. Special machines for cores and molds together with accurately fitting flasks and arbors are outstanding features of process.

D

DAMS

Concrete, Gravity. Construction Features of Snow Mountain Dam. Elec. Rev. (Chicago), vol. 77, no. 19, Nov. 6, 1920, pp. 725–726, 1 fig. Methods used in building gravity concrete dam for impounding storage water for Eel River Hydroelectric Plant of the Snow Mountain Water & Power Co. in California.

Spillways. Spillways for Weir Dams, with Special Consideration of Weir Dams on Alluvial Subsoil (Vor- und Sturzbetten an Stauanlagen mit besonderer Berücksichtigung der Wehranlagen auf angeschwemmtem Untergrunde), G. W. Schmidt. Zeitschrift fur Bauwesen, vol. 70, no. 7–9, 1920, pp. 555–595, 29 figs. Gives rules for planning designs of spillways and similar constructions, and new recommendations.

Tilting. Tilting Dams Applied to Water Works Reservoirs, J. F. Springer. Fire & Water Eng., vol. 68, no. 18, Nov. 3, 1920, pp. 915–917, 5 figs. Description of Baltimore elastic dam with sections that tilt as backwater pressure approaches danger point. Sections open automatically at head at which they are set.

DIES

Embossing. Steelstamps. Embossing Dies. Stencils, Ellworth Sheldon. Am. Mach., vol. 53, no. 18, Oct. 28, 1920, pp. 789–794, 2 figs. Description of processes.

DIESEL ENGINES

Cement Mills. Diesel Engines in Cement Mills. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 655–659, 3 figs. Installation at Iola, Kansas, of Lehigh Portland Cement Co. Engines have proven economical.

Compressorless. Diesel Engines Without Compressors (Ueber kompressorlose Dieselmaschinen), Arthur Balog. Der praktische Maschinen-Konstrukteur, vol. 53, no. 31, Aug. 5, 1920, pp. 282–284, 5 figs. It is claimed that Diesel engines can only become perfect when the spraying compressor is eliminated; an auxiliary compressor should suffice for starting; spraying can be effected with or without aid of spraying medium.

Experiments. British Admiralty Experiments with Diesel Engines—II, C. J. Hawkes. Motorship, vol. 5, no. 11, Nov. 1920, pp. 998–1001, 3 figs. Four-stroke vs. 2-stroke opposed-piston types. (Continuation of serial.)

Fuels for. Fuel for Diesel Engines, C. H. Peabody. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 915–917. Characteristics of various fuels.

Marine. New Double-Acting, Two-Cycle Marine Diesel-Engine, M. Goldberg. Motorship, vol. 5, no. 11, Nov. 1920, pp. 993–994, 4 figs. American engine of two-cycle double-acting type. Scavenging-air pump between working cylinders.

The Present Position of the Marine Diesel Engines, James Richardson. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 589–592, 2 figs. Comparative economy of Diesel engines and steam engines for shipbuilders. Paper read before Instn. Engrs. & Shipbuilding in Scotland.

DRILLING

Rock, Dust Produced. Investigations Made with the Konimeter to Ascertain the Amount of Dust Produced in Drilling Holes by Means of Dry Jack Hammer Machines, H. E. Barrett. Jl. Chem., Metallurgical & Min. Soc. of South Africa, vol. 21, no. 1, July 1920, pp. 1–8.

Rock, Sticking of Steel. Stuck Steel, D. E. Dunn. Eng. & Min. Jl., vol. 110, no. 19, Nov. 6, 1920, pp. 903–905, 8 figs. Reasons for sticking of drill steel.

[See also CUTTING METALS, Drilling.]

DRILLING MACHINES

High-Speed Radial. The New Asquith High-Speed Radial. Machy. (Lond.), vol. 17, no. 419, Oct. 7, 1920, pp. 28–29, 1 fig. Radial drilling machines produced to meet demands for medium-sized high-speed machine to deal with holes of moderate size in work.

DRY KILNS

Superheated Steam. Drying Lumber with Superheated Steam. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 111, 1 p. Superheated steam process has been found applicable to Douglas fir, firs of all kinds, western hemlock, white cedars, sugar pine, western yellow pine and southern yellow pine. Process is unsuited for some softwoods on account of collapse.

Water Spray. Manual for Design and Installation of Forest Service Water Spray Dry Kiln, L. V. Teesdale. U. S. Dept. Agriculture, bul. no. 894, Oct. 18, 1920, 47 pp., 18 figs.

E

ELECTRIC CIRCUITS, A. C.

Current Distribution. A Device for the Rapid Determination of the Current Distribution on the Line Side of a Three-Phase Interconnected-Star Static Balancer Operating on a Four-Wire System S. Austen Stigant. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 201–208, 5 figs. Device for determining line currents under different loading conditions.

ELECTRIC FURNACES

Booth Rotating. Booth Rotating Electric Furnace, Carl H. Booth. Metal Industry (N.Y.), vol. 18, no. 10, Oct. 1920, pp. 456–459, 3 figs. Description of furnace. Records of operation as obtained in installations ranging in size from 250 lb. to 2000 lb. per heat.

Greaves-Etchells. An Improved Greaves-Etchells Electric Furnace Installation, Edward T. Moore. Chem. and Metallurgical Eng., vol. 23, no. 17, Oct. 27, 1920, pp. 825–832, 21 figs. Description of Greaves-Etchells electric furnace and of arrangement of electrical equipment as installed at plant of Halcomb Steel Co. Records of operation.

Metal-Melting. Application of Electrical Energy to the Melting of Metals, H. A. Greaves. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 250–253 and (discussion) pp. 276–305, 11 figs. Comparative study of different types of furnaces.

Operating Data. Electric Furnace Operating Data, C. H. Reeder. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 352–355, 4 figs. Present and future prospects of electric furnaces. Figures showing various items of expense involved in melting of steel. Unit costs. Raw materials and finished product.

Refractories for. Electric Furnace Refractories, A. F. Greaves-Walker. Chem. & Metallurgical Eng., vol. 23, no. 19, Nov. 10, 1920, pp. 933–936. Description of raw materials available for highest-grade brick with list showing recommended refractories for melting different metals and alloys, and hints on care, storage and laying of roofs, hearths and linings.

Sahlin. A New Type of Electric Furnace, Axel Sahlin. Jl. Instn. Elec. Engrs., (Supp.), vol. 57, part 2, Oct. 1920, pp. 265–267, 2 figs. Sahlin

furnaces.

Steel Refining. Developments in Electric Iron and Steel Furnaces, J. Bibby. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 23?–246, 24 figs. Electric reduction furnace and steel refining furnace are taken up.

Large Electric Steel-Melting Furnaces, Victor Stobie. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 268–276, 9 figs. Furnace requirements of a large steel plant.

United Kingdom. Electric Furnaces in the United Kingdom, 1918, R. G. Mercer. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 254–264. Records of operation of electric furnaces used in manufacture of steel.

ELECTRIC GENERATORS, A. C.

Slow Speed. 1,750 K. V. A. Slow-Speed Alternator. Eng., vol 110, no. 2857, Oct. 1, 1920, pp. 440–442 and 444, 22 figs. Constructed by General Electric Co., Ltd., Engineers, London. Terminal pressure in tests was 5200 volts between phases and frequency 50 cycles per second at speed of 187.5 r.p.m.

ELECTRIC GENERATORS, D. C.

Axle. Specification for Axle Generators. Ry. Elec. Engr., vol. 11, no. 10, Oct. 1920 pp. 367–370. Specification intended to cover axle-generator equipment for railway service. Committee report of Assn. of Elec. Engrs.

ELECTRIC LAMPS, ARC

Cooper Hewitt. The Cooper Hewitt Lamp—II, L. J. Buttolph. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 858–866, 17 figs. Outlines development and some applications of lamp from 1901 to present time.

ELECTRIC LOCOMOTIVES

Crank Gear, Critical Speeds of. The Critical Speeds of Crank Gears of Electric Locomotives (Die kritischen Drehzahlen der Kurbelgetriebe elektrischer Lokomotiven), W. Kummer. Schweiz. elektrotechnischer Verein Bull., vol. 11, no. 9, Sept. 1920, pp. 237–242, 3 figs. Gives critical numbers of revolutions which can be expected in the case of so-called ideal crank gear; crank gear with deviation of rod lengths from distance of bearing center; and crank gear with play of bearings. It is pointed out that in the construction of large locomotives with parallel crank gears, the occurrence and prevention of critical speeds should be investigated by means of preliminary calculations.

Heavy Electric Traction. Report of the Committee on Heavy Electric Traction. Am. Elec. Ry. Eng. Assn., report no. 305, Oct. 11–15, 1920, 24 pp., 20 figs. Survey of recent developments and progress in design of motors and motor drives for heavy traction, both a.c. and d.c., with comparison of weight, space efficiency, etc.; description and illustrations of recent types of electric locomotives since report of 1916; and comparison of electric switching engines in freight yards with steam engines.

Italian State Railways. Three-Phase Electric Locomotive for the Italian State Railways. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 469–471, 22 fig. partly on 4 supp. plates. Details of six three-phase 4-6-4 type electric locomotives built by Construzioni Meccaniche di Saronno of Milan. Working voltage is 3300. Maximum draw-bar pull is 26,000 lb.

Performance. Data on Electric Locomotive Performance. Elec. World, vol. 76, no. 18, Oct. 30, 1920, pp. 878–880, 1 fig. Advantages claimed for electric locomotive are economy of fuel, increased haulage, low maintenance and general flexibility. Graph showing coal consumption comparison on identical runs by steam and electric locomotives is included.

ELECTRIC METERS

Mean Intensity Indicator. Chromothermic Mean Intensity Indicator (Indicateur chromothermique d'intensité moyenne), Ch. Ed. O'Keenan. Revue générale de l'Electricité, vol. 8, no. 15, Oct. 9, 1920, pp. 493–497, 8 figs. A steel needle is heated by passage of current. Current intensity is determined from nature of coloration assumed by needle.

ELECTRIC MOTORS

Railway. The Ventilation of Railway Motors (Beitrag zur Lüftung von Bahnmotoren), W. Dittrich. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 13, May 4, 1920, pp. 114–115, 1 fig. Describes air vane designed by author in which the air enters motor on the ventilator side and passes out on the commutator side, carrying off carbon dust which otherwise would settle on windings.

Standardization. Motor Features Requiring Standardization, C. W. Starker. Elec. World, vol. 76, no. 19, Nov. 6, 1920, pp. 919–921, 5 figs. Urges standardization of mechanical features of electrical motors.

ELECTRIC MOTORS, D. C.

Crane and Hoist Drive. Direct-Current Motors for Crane and Hoist Work, F. L. Moon. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 532–535, 7 figs. Graphs showing comparative characteristics of enclosed and ventilated motors.

Reversing Pole. The Calculation of the Reversing Pole in Direct-Current Motors (Zur Berechnung der Wendepole bei Gleichstrommaschinen), Wilhelm Oelschläger. Elektrotechnik u. Maschinenbau, vol. 38, no. 23, June 6, 1920, pp. 261–266, 7 figs. For-

Starters. New Motor Starter Embodies Many Interesting Features. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, pp. 1075–1076, 2 figs. Automatic starter designed for general use in controlling series, shunt and compound-wound direct-current motors employed to drive pumps, line-shafts, compressors, blowers, conveyors, etc.

ELECTRIC PLANTS

Inspection. Scheduled Inspection for Power Plants. Elec. World, vol. 76, no. 19, Nov. 6, 1920, pp. 922–924, 2 figs. Forms for keeping records.

Interconnection. Interconnection of Power Systems, Harold W. Smith. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 515–518, 4 figs. Comparative study of the various method of interconnecting generating stations.

Remote Control. Remote Control in Three-Phase Plants (Fernsteuerung in Drehstromanlagen), H. Roth. Elektrotechnische Zeitschrift, vol. 41, no. 35, Sept. 2, 1920, pp. 685–686, 6 figs. Describes system for three-phase plants which permits, without special switch lines, the selective connection or disconnection of a large number of switches, in which use is made of a split-up direct-current superposed on the three-phase current, making use of the resonance between this direct current and the natural vibration of a small direct-current armature serving as a receiver.

ELECTRIC RAILWAYS

Buildings and Structures. Report of the Committee on Buildings and Structures. Am. Elec. Ry. Eng. Assn., report no. 309, Oct. 11–15, 1920, 17 pp., 7 figs. Inspection and maintenance of buildings and structures; lag screws vs. bolts in timber-decked structures; prepayment and postpayment collection of fares at terminals; review of existing standards and recommendations.

Current Standardization. Problems of the Electric Railway, G. Wüthrich. Engr., vol. 130, no. 3377, Sept. 17, 1920, pp. 281–283, 1 fig. It is argued that extra high-tension low periodicity single-phase current system is alone capable of lending itself to immediate and simultaneous standardization for both suburban and main line traction.

Diesel-Electric Motor Cars. Diesel-Electric Motor Cars of the Swedish Railways (Automotrices pétroléo-électriques à moteur Diesel des chemins de fer suedois). Génie Civil, vol. 77, no. 16, Oct. 16, 1920, pp. 305–309, 16 figs. Used in local railways.

Equipment. Report of the Committee on Equipment. Am. Elec. Ry. Eng. Assn., report no. 311, Oct. 11–15, 1920, 39 pp., 33 figs. Standards for brakeshoes, brakeshoe heads, and brakeshoe keys; feasibility of adopting standard cars.

Power Distribution. Report of the Committee on Power Distribution. Am. Elec. Ry. Eng. Assn., report no. 304, Oct. 11–15, 1920, 100 pp., 7 figs. Specifications for overhead line material, electric light, power supply, trolley lines crossing steam and electric railroads, standard thread for pins and insulators, etc.

Power Generation. Report of the Committee on Power Generation. Am. Elec. Ry. Eng. Assn., report no. 308, Oct. 11–15, 1920, 60 pp., 5 figs. Recommended form of power contract for purchase of power; comparative cost of steam production for utilization in electric power plants from using coal, oil, gas or other special fuels; tabulation of costs of power generated by member companies.

Speed-Time Curves. Note on the Drawing of the Speed-Time Curves of Electric Trains, J. Musyck. Bul. Int. Ry. Assn., vol. 2, no. 9, Sept. 1920, pp. 581–590, 7 figs. Graphical method.

Trolley Contact Voltage. What Happens at the Trolley Contact? D. D. Ewing. Elec. Ry. Jl., vol. 56, no. 17, Oct. 23, 1920, pp. 863–865, 3 figs. Results of tests under various operating conditions. Contact voltage graphs for various types of wheels are shown. Average power loss with 5-in. wheel was nearly 1/2 kw.

ELECTRIC RAILWAYS, TRACK

Circuiting. Alternating-Current Track Circuiting, L. H. Peter. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 491–506, 30 figs. Distinction is made between "in phase" and "quadrature" relays, vector diagrams are given of track circuit without impedance bonds and phase displacement is obtained with two types of relays. Vector diagrams of track circuit with non-resonated and with resonated impedance bonds are also constructed. Method of varying the relay track-winding power factor is given and effect on vector diagram discussed.

Insulated Tools. Insulated Tools for Use on the Permanent Way of Electrified Railways. Ry. Gaz., vol. 33, no. 17, Oct. 22, 1920, pp. 541, 2 figs. Newly designed insulated tools, patented and manufactured by British Power Railway Signaling Co.

Track Welding. See ELECTRIC WELDING, Rails.

Trackwork Specifications. Report of the Committee on Way Matters. Am. Elec. Ry. Eng. Assn., report no. 310, Oct. 11–15, 1920, 95 pp., 13 figs. Recommended specifications for track spirals; standard sections for curved-head rails; revision of specifications for plain bolted special trackwork; specifications for wood-block paving; compilation of data on safe limits of wear in rails and special trackwork on life of track construction of various types.

Comparative study of characteristics of various types.

High-Voltage. Notes on the Electrical Calculations of Long-Distance High-Voltage Transmission Lines, A. McKinstry. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 92–117, 8 figs. Fundamental formulæ for transmission lines without branches. Study of constant voltage transmission.

Lightning Protection. See LIGHTNING ARRESTERS.

Long-Distance. Calculation, Diagrams and Regulation of Long Distance Electric Transmission Lines (Calculs, diagrammes et regulation des lignes de transport d'énergie à longue distance), L. Theilemans. Revue générale de l'Electricité, vol. 8, nos. 13, 14 and 15, Sept. 25 and Oct. 2 and 9, 1920, pp. 403–416, 435–443 and 475–482, 39 figs. Methods employed by writer in his practice as engineer of French Thomson-Houston Co. (To be continued.)

Switching and Protection. Switching and Protection of Transmission Circuits—III, S. Q. Hayes. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 521–526, 7 figs. Exemplifies manner of proceeding by determining switching equipment needed in case of generating station containing fifteen 25,000-kva. vertical-shaft waterwheel generators.

Size of Wire. Determining Size of Wire and the Length of Span, D. F. Parrott. Elec. World, vol. 76, no. 19, Nov. 6, 1920, p. 928. No. 6 wire and 250-ft. span are said to be found economical for most cases where voltage lies between 33,000 and 66,000.

ELECTRIC WELDING

Methods. Electric Welding, Fred H. Williams. Jl. Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 514–522, 12 figs. History and survey of electric welding methods. Account of research work by writer.

Rails. Method of Preheating and Reheating of Workpieces in Electric Arc Welding or Autogenous Welding Work (Verfahren zum vor und nachwärmen von Werkstücken bei elektrischer Lichtbogenschweissung oder autogener Schweissung). Autogene Metallbearbeitung, vol. 13, no. 14, July 15, 1920, pp. 162–163. Details of process patented by the Accumulator Works Corp., Berlin, said to be of special value for the electric welding of rails.

ELECTRIC WELDING, ARC

Effect on Eye. Effect of Ultra-Violet Rays on the Eye, C. R. Kindall. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2173, Oct. 1920, 2 pp. Records of effect on eye of electric arc welding.

ELECTRIC WELDING, RESISTANCE

Spot-Welding Machines. Modern Welding and Cutting—XXXI, Ethan Viall. Am. Mach., vol. 53, no. 18, Oct. 28, 1920, pp. 807–821, 39 figs. Spot-welding machines.

ELECTRICAL MACHINERY

Windings. The Maximum Temperature for Windings (Höchsttemperatur an Wicklungen), Kurt Lubowsky. Elektrotechnische Zeitschrift, vol. 41, no. 33, Aug. 19, 1920, pp. 646–647, 2 figs. The Vidmar formula for determination of maximum temperature from the mean and minimum temperature is tested on a long high-voltage stator coil, and results coincide with the observation of Rogowski and Vieweg on round coils according to which the minimum temperature should be measured directly on the conductors. It is concluded that the practicability of formula is limited.

ELECTRICAL SYMBOLS

International Standards. Electrical Symbols Proposed for International Adoption. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 971–972. Complete set adopted by Advisory Committee for consideration of next plenary meeting of international electrotechnical commission.

ELECTRICITY

World's Supply. Development of Rural Electricity Supply. Elecn., vol. 85, no. 2214, Oct. 22, 1920, pp. 472–475, 4 figs. Scheme of rural electricity supply in Hereford, England, a city of 22,000 inhabitants, which is center for commercial side of agricultural trade of surrounding district. Electricity is supplied to surrounding country from municipally owned station.

ELECTRON TUBES

Tungsten-Filament. Some Practical Operating Features of Tungsten Filament Electron Tubes, W. C. White. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 840–846, 2 figs. Curves showing electron emission per watt of energy used to heat pliotron filament.

EMPLOYMENT MANAGEMENT

Bibliography. A Guide and Bibliography for Labor Managers, Leverett S. Lyon and May R. Freedman. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 383–385.

Interviewing Workers. The Art of Interviewing Workers, J. D. Hackett. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 338–340. Qualifications necessary in an interviewer, and essential steps in interviewing.

Vocational Classification of Employees. Making it Easy to Find the Right Technical Men, I. W.

ENGINEERING INDEX (Continued)

Litchfield. Factory, vol. 25, no. 8, Oct. 15, 1920, pp. 1232–1234, 2 figs. Suggests methods of classifying employees by industry and by function.

EMPLOYEES' REPRESENTATION

Shop Committees. The Operation of the Whitley Councils. Metal Industry (N. Y.), vol. 18, no. 10, Oct. 1920, p. 470. History, development and present state of England's experiment in coöperation between employer and employee. (Concluded.)

Workmen's Representation in a Tool Manufacturing Plant. Machy. (Lond.), vol. 17, no. 422, Oct. 28, 1920, pp. 111–115, 1 fig. Shop committee plan of Greenfield Tap & Die Corp. which operates six plants in U. S.

ENGINEERING SOCIETIES

The Federated American Engineering Societies. The Engineering Educator's Opportunity in Engineering Organization, William E. Bullock. Eng. Education, Bul. Soc. Promotion of Eng. Education, vol. 11, no. 2, Oct. 1920, pp. 72–75. Scheme of organization of engineering profession by means of Federated American Engineering Societies is explained. Plan of federation contemplates formation of all-inclusive local societies of engineers in important communities and their organization into federation for action on matters dealing with public service.

ENGINEERS

Fees and Salaries. Recommended Salaries for Manitoba Engineers. Contract Rec., vol. 34, no. 44, Nov. 3, 1920, pp. 1046–1047. Report on remuneration of engineers submitted by Salary Committee of Manitoba Branch of Engineering Institute of Canada.

Various Schedules of Fees for Consulting Engineers, Edmund I. Mitchell. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 941–942. Compiled by Edmund I. Mitchell, Assistant Secretary of Committee on Classification and Compensation of Engineers, Engineering Council, New York City, with aid of Engineering Societies' Library.

Registration. Report of Committee to the Minnesota Joint Engineering Board-Recommended Registration Law. Bul. Affiliated Eng. Soc. of Minnesota, vol. 5, no. 10, Oct. 1920, pp. 18–26. Suggested text of act to regulate practice of architecture, professional engineering and land surveying in Minnesota.

EXCAVATION, EARTH

See SHOVELS, Rotary.

EXCAVATORS

Development of. Recent Excavator Practice, F. H. Livens and W. Barnes. Jl. Instn. Mech. Engrs., no. 6, Oct. 1920, pp. 609–630 and (discussion) pp. 631–637, 16 figs. Survey of progress in development of types, with special reference to the steam-navvy.

Dragline. Storm Sewer Construction with a Dragline Excavator. Excavating Engr., vol. 14, no. 9, Nov. 1920, pp. 295–296. Description of excavation of large storm sewer in Detroit with dragline excavator. Method of handling forms.

EXPLOSIVES

Explosion Point, Determination of. Apparatus for the Safe Determination of the Decomposition or Explosion Point of Explosive Substances (Apparat zur gefahrlosen Bestimmung des Zersetzungs- oder Verpuffungspunktes explosiver Substanzen), A. Langhans. Zeit. für das gesamte Schiess- u. Sprengstoffwesen, vol. 15, no. 15, Aug. 1, 1920, pp. 161–163, 2 figs. Points out that the Wood metal bath usually employed for this purpose has the disadvantage that with the explosion of the substance a part of the melted, red-hot metal is hurled out, whereby either accidents occur to the investigators, or apparatus is soiled; and describes new apparatus with lead or aluminum blocks, designed to mitigate this danger.

EXPORT TRADE

Statistics. Export and Import Statistics Indicate Industrial Trend. O. M. Fox. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 835–836, 1 fig. It is concluded from survey of figures, that imports are rapidly increasing to a point where United States will no longer occupy a favorable trade position.

F

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FARM MACHINERY

Improvements in. Agricultural Machinery, Gustav Fischer. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 301–304, 9 figs. Improvements in thrashing machines, straw presses, chaff cutter and bruising mills.

FATIGUE

Industrial. The Speed of Adaptation of Output to Altered Hours of Work, H. M. Vernon. Eng. and Indus. Management, vol. 4, no. 15, Oct. 7, 1920, pp. 450–451. Data on evidence obtained at British munition factories during war. (Abstract.) Report of British Industrial Fatigue Research Board.

FILTRATION PLANTS

Operation. Filter Underdrain, Sand-Bed and Wash-water Experience. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 934–939. Symposium on current practice and operating success with various details of mechanical or rapid water filtration plants. (To be continued.)

FIRE BOATS

Diesel-Electric vs. Steam. Diesel-Electric Propulsion Versus Steam for Fire-Boats, William H. Easton. Motorship, vol. 5, no. 11, Nov. 1920, p. 997. Diesel electric is found more advantageous.

FIRE PROTECTION

Fire-Alarm Stations. A Central Fire-Alarm Station, C. W. Geiger. Jl. Electricity, vol. 45, no. 9, Nov. 1, 1920, pp. 432–434. San Francisco station.

Underwriters' Laboratories. Underwriters' Laboratories' Protection Department, W. C. Robinson. Nat. Fire Protection Assn., vol. 14, no. 2, Oct. 1920, pp. 141–145. Survey of work of protection Department of Underwriters' Laboratories.

FLIGHT

Soaring. Mechanical Equivalents of Soaring Flight. English Mechanic, vol. 112, no. 2902, Nov. 5, 1920, pp. 172–173. Circular tea-tray with deep rim in which heavy ball is rolled rapidly, motion being kept going by working tea-tray round in small circle. Ball's going round over tray is analogous to bird's gliding round at steady headway through air, friction force opposing bird corresponding to head resistance of opposing bird, and circular movement of tray corresponding to centrifugal propulsive force arising from small circular movement of air.

FLOW OF FLUIDS

Pipe Lines. Effect of Fittings on Flow of Fluids Through Pipe Lines, E. Foster. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 616–618, 11 figs. Graphical solution of Babcock's formula for flow of steam in pipe lines. Tables giving equivalent lengths of standard pipe to allow for various screw fittings in conduits carrying non-viscous liquids, steam, air or gas.

FLOW OF WATER

Drain Tiles. New Formula for Flow of Water in Drain Tile. Eng. and Contracting, vol. 54, no. 15, Oct. 13, 1920, pp. 374–375, 1 fig. Formula derived from experiments in which 824 separate tests were made. From Bulletin 854 of U. S. Dept. of Agriculture.

Manning's Formula. Charts for Solution of Manning's Hydraulic Formula, Elmo G. Harris. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 837–839, 2 figs.

Theory of. On a Theory of Fluid Friction and Its Application to Hydraulics, E. Parry. English Elec. Jl., vol. 1, no. 4, Oct. 1920, pp. 146–164, 4 figs. Generalization of theory of fluid friction employed in aeronautics to flow of water in pipes and conduits. Table giving values of coefficient in Chézy's formula for flow of water in pipes and conduits.

FOREIGN TRADE

Prospects for. Prospects for Foreign Trade, A. H. Holliday. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1106–1107. Statistics show loss of steel production to peaceful arts during war. (Abstract.) Paper read before Am. Iron & Steel Inst.

FORGING

Recording Apparatus. The Solution of Forging Problems, Eugene Schneider. Eng. & Industrial Management, vol. 4, no. 17, Oct. 21, 1920, pp. 520–525, 2 figs. Schneider apparatus for recording times and pressures employed during forging in relation to the stroke.

FOUNDRIES

Accidents in. See ACCIDENTS, Foundries.

Brass. Reclamation of Metal from Brass-Foundry Refuse, F. L. Wolf and G. E. Alderson. Metal Industry (N.Y.), vol. 18, no. 10, Oct. 1920, pp. 452–455, 2 figs. Records of costs and returns obtained in reclaiming plant used at Ohio Brass Co. Paper read before Inst. of Metals Division.

See also RAILWAY SHOPS, Brass Castings for.

British. English Foundry Makes Rail Chairs, H. Cole Estep. Foundry, vol. 48, no. 18, Sept. 15, 1920, pp. 733–740, 13 figs. Quantity production methods employed. Molds are made on roll-over, stripping-plate machines of special design; cupolas melt continuously.

Scrap Utilization in. Utilization of Scrap from Iron and Steel Foundries, with Special Regard to the Recovery of Scrap Iron from Rubbish (Die Verwertung von Abfällen aus Eisen- und Stahlgiessereien insbesondere die Rückgewinnung des Abfalleisens aus dem Schutt), Hubert Hermanns. Dinglers polytechnisches Jl., vol. 335, no. 17, Aug. 21, 1920, pp. 185–188, 7 figs. Notes on the electromagnetic separation of rubbish for the recovery of iron, conditions for which are said to be most favorable in plants where low-voltage direct-current is available as the magnets can be excited only with direct-current. Details of different construction types.

U. S. and Canada. Growth Marks Reconstruction Era. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 853–858, 7 figs. List of foundries in United State and Canada in 1920 and 1918 by States and Provinces.

FUELS

Coal vs. Oil. See COAL, Oil vs.

Diesel-Engine. See DIESEL ENGINES, Fuels.

Purchasing of. Premiums for Dry Fuel (Prämien für trockenen Brennstoff), G. Höhn. Zeit. des Bayerischen Revisions-Vereins, vol. 24, no. 16, Aug. 31, 1920, pp. 125–128, 2 figs. A formula is derived and recommended for calculating gain in value of fuel delivered to purchaser in dryer condition than agreed upon, or loss in value when delivered in more moist condition.

FURNACES, BOILER

Forced Draft. Draft Regulation in Forced-Draft Boiler Furnaces (Windregelung bei Unterwindfeuerungen), H. Pradel. Zeit für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 36, Sept. 3, 1920, pp. 273–275, 5 figs. Details of air-current regulator developed by German Evaporator Co., Ltd., by means of which air admitted into every chamber can be regulated.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEAT-TREATING

Insulation. The Function of Insulation and its Application to Heat Treating Furnaces, E. F. Davis. Trans. Am. Soc. for Steel Treating, vol. 1, no. 1, Oct. 1920, pp. 33–42, 4 figs. Formulæ and graph for designing insulation.

FURNACES, OPEN-HEARTH

Efficiency. Increased Efficiency in the Open Hearth, Philip C. Gunion. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 624–625, and p. 635, 3 figs. Effect roller bearings applied to rolling stock has upon reducing transportation costs. Comparative tests made with cars of plain bearing type.

Port Design. Design of Ports for Open Hearth Furnaces, Herbert F. Miller, Jr., Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 612–614, 3 figs. Circular water cooled ports used by Lackawanna Steel Co.

G

GAGES

Laboratory Standards. Sizes of the N. P. L. End Standards in English Units. Eng. vol. 110, no. 2858, Oct. 8, 1920, p. 474. Changes which have been made in accepted sizes of laboratory end standards at National Physical Laboratory, England.

Lapping. See LAPPING.

Precision. Precision Gages, M. E. Kanek. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 884–886. Methods of accurate measurement, and methods of manufacturing precision gages.

Precision Measuring and Inspection Devices—II, R. J. Whibley. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 242–245, 6 figs. Minimeter and gage comparator used by National Physical Laboratory, England, for inspecting precision gage-blocks. Devices permit readings to accuracy of one millionth of an inch.

Thread. Adjustable Thread Snap Gauge. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 551, 3 figs. Constructed by Coventry Gauge & Tool Co., Ltd., Engineers, Coventry.

GARBAGE DISPOSAL

Methods. Transportation of Garbage with Data on Garbage Disposal in Various Cities, Samuel A. Greeley. Mun. & County Eng., vol. 59, no. 4, Oct. 1920, pp. 132–134. Tables showing method of garbage disposal in 50 of largest cities in U. S.

GAS MAINS

Steel vs. Cast Iron. Steel Versus Cast-Iron for Gas Mains, B. R. Parkinson and Norton H. Humphrys. Gas World, vol. 73, no. 1891, Oct. 16, 1920, pp. 299–300. Opinions of representative engineers.

GAS MANUFACTURE

Regulations in France. New Regulations for the Quality of Illuminating Gas, and New Methods of Manufacture (Nouvelles règles fixant les qualités exigées du gaz d'éclairage, et nouvelles méthodes de fabrication), P. Lauriol. Génie Civil, vol. 77, no. 17, Oct. 23, 1920, pp. 328–329. Suppression of tests of illuminating power and permission to add water gas.

GAS MASKS

Uses in Mines. Danger in Using Army Gas Masks in Mines, George S. Rice. Reports of investigations, Bur. of Mines, Dept. of Interior, serial no. 2175, Oct. 1920, 2 pp. Instances of failure of army gas mask.

GAS PRODUCERS

German. Modern Development of Fuel Gasification, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 617–624, 13 figs. Development of modern gas producers in Germany. Operation of producer and processes by which complete utilization of all constituents are obtained.

Tar Recovery. Gas-Producer Plants Equipped for Recovery of Low-Temperature Tar (Die Gaserzeugungsanlagen mit Gewinnung von Urteer), E. Roser. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 42, Oct. 16, 1920, pp. 857–864, 8 figs. Account of tests carried out by the Thyssen & Co. Machine Factory in Mülheim during years 1916–1918. Notes on yield of by-products; determination of extraction of heat from coal; utilization of by-products; future possibilities of process; the use of cold gas in foundry furnaces and in the generation of power; increase in consumption of coal through recovery of by-products.

deg. cent., W. A. Felsing, H. Odeen and C. B. Petersen. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1063–1065, 4 figs. It was found that decomposition of both process A (original 60 deg.-cent. process) and process B (Levinstein) mustard gas takes place in steel shell at 60 deg. cent., but extent of decomposition is not serious even under severe conditions.

The Precipitation of Sulfur from Crude Mustard Gas by Means of Ammonia, W. A. Felsing and S. B. Arenson. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1065–1066. Addition of moist ammonia caused precipitation of about 40 to 45 per cent of total supposedly free sulphur.

Repelling Poisonous Gases. Repelling Poisonous Gases. Sci. Am. Monthly, vol. 2, no. 3, Nov. 1920, pp. 235–236. Fanning system that was used to clear trenches after gas attack.

GAS WORKS

Motive Power. Notes on Operating a By-Product Producer Gas Plant for Power and Heating, W. H. Patchell. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 417–430 and (discussion) pp. 437–463, 4 figs. Extension of gas works of Hoffmann Manufacturing Co., Ltd., England.

Waste Disposal. Disposal of Waste from Gas Plants. Am. Gas Eng. Jl., vol. 113, no. 19, Nov. 6, 1920, pp. 363–366. Report of American Gas Association 1920 Committee.

GASOLINE

Alcogas Fuel vs. Comparison of Alcogas Aviation Fuel with Export Aviation Gasoline, V. R. Gage, S. W. Sparrow and D. R. Harper, 3d. Nat. Advisory Committee for Aeronautics, report no. 89, 1920, 14 pp. 47 figs. Tests showed at 5.6 compression the same maximum power production at ground level and general average of 4 per cent more power at altitude for alcogas, maximum difference being about 6 per cent at 6400 ft. and 1800 r.p.m. At 7.2 compression alcogas showed average and fairly uniform increase of 4 per cent in power at altitude.

Carburation of. The Carburation of Gasoline, O. C. Berry and C. S. Kegerreis. Purdue University, Publications of Eng. Depts., vol. 4, no. 1, April 1920, 223 pp., 103 figs. Results of tests carried out to determine richness of fuel to air mixture required by engine under different running conditions in order that it may develop either maximum power or maximum efficiency.

Cracking Manufacturing Practice. Gasoline Cracking Processes, Fred W. Padgett. Chem. & Metallurgical Eng., vol. 23, no. 19, Nov. 10, 1920, pp. 908–913. Description of commercial methods for production of gasoline by pyrolytic distillation of heavy hydrocarbons, including Burton, Greenstreet, Hall, Rittman, Aluminum Chloride, Dubbs, Jenkins, and Bacon processes. List of inventors, patent numbers and dates.

GASOLINE ENGINES

Horsepower Diagram. Diagram to Determine Horsepower of Gasoline Engines, C. E. Lounsberg. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 892–893, 1 fig. It is held that Swedish formula is best for purpose.

GASOMETERS

Wind Pressure on. The Effect of Wind Forces on Gasometers. (Windkräfte auf Gasbehälter). Jl. für Gasbeleuchtung u. Wasserversorgung, vol. 63, no. 35, Aug. 28, 1920, pp. 566–567, 3 figs. It is concluded that distribution of pressure on smooth model without limitation of bottom cannot be wholly accepted for actual practice; the total resistance of air on an actual gasometer has probably a different value from that resulting from calculation with the coefficient of a model.

GEARS

Automobile. Fixtures for Testing Automobile Gears. Machy. (N. Y.), vol. 27, no. 3, Nov. 1920, pp. 270–273, 8 figs. Methods used at various plants.

Teeth in Contact. Derivation of a Formula to Determine Number of Teeth in Contact of Two Meshing Gears, A. B. Cox. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 899–902, 10 figs. Formula is derived and graphic representations of results of application of this formula are shown.

GIRDERS

Design. The Stresses in Portals and Similar Structures, Talbot C. Broom. Engr., vol. 130, nos. 3381 and 3382, Oct. 15 and 22, 1920, pp. 368–369, 5 figs., and 393–394, 5 figs. Suggests simplification in design of continuous girders.

GLASS

Expansion at High Temperatures. The Expansion of Glass at High Temperatures, W. B. Pietenpol. Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 876–877, 1 fig. Thermal expansion curves of unannealed light barium crown glass.

GOLD METALLURGY

Recovery from Black Sand Tailings. Recovery of Gold from Black Sand Tailings, John Gross. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2170, Oct. 1920, 2 pp. Tests conducted at Alaska station of Bur. of Mines.

GOLD MINING

Southern U.S. Gold Mining in the Southern States,

GRINDING

Automobile Parts. Cadillac Grinding Practice. Machy. (Lond.), vol. 17, no. 420, Oct. 14, 1920, pp. 33–37, 9 figs. Methods employed in grinding department of plant building Cadillac cars.

GRINDING MACHINES

High-Speed. Grinding at Speed of 100,000 Revolutions per Minute. Can. Machy., vol. 24, no. 16, Oct. 14, 1920, p. 365. Editorial comment on machine produced by British manufacturer which is said to be capable of running safely at 100,000 r.p.m.

H

HARBOR IMPROVEMENTS

Dutch Indies. The Use of Reinforced Concrete for Harbor Construction in the Dutch Indies (Verwendung von bewehrten Beton zu Hafenbauten in Niederländisch-Indien), A. v. Horn. Zentralblatt der Bauverwaltung, vol. 40, no. 72, Sept. 8, 1920, pp. 453–455, 10 figs. Describes extended use of reinforced concrete for piles, caissons for quay walls, storage sheds, loading wharves, etc., including notes abstracted from paper on the technical problems of Indian harbor construction by Wouter Cool (de Ingenieur, no. 8, 1919).

HARMONICS

Analysis. A Practical Method of Harmonic Analysis, Philip Kemp. Jl. Instn. Elec. Engrs. (Supplement), vol. 57, part 2, Oct. 1920, pp. 85–91. Schedule for routine work in analysis of periodic wave forms.

HEAT TRANSMISSION

Radiation. Radiation and Convection from Heated Surface, T. Barratt and A. J. Scott. Physical Soc. of London, Proc., vol. 32, part 5, Aug. 15, 1920, pp. 361–373, 2 figs. Experimental determination was made of amounts of natural convection and radiation from cylindrical and spherical surfaces heated in air at atmospheric temperature and pressure to temperature of about 100 deg. cent. Convection alone was found to be inversely proportional to square root of diameter of cylinder and to cube root of diameter of sphere.

HEATING AND VENTILATION

Humidity Regulator. An Automatic Humidity Regulator (Der selbsttätige Luftfeuchtigkeitsregler "Humidostat"). Gesundheits-Ingenieur, vol. 43, no. 26, June 26, 1920, pp. 306–307, 6 figs. Describes humidostat constructed by the Automatic Temperature Regulation Co., Ltd., Berlin-Friedenau, in which the compressor generates the necessary compressed air and operates in such a manner that when temperature corresponding to 1 atm. above pressure is reached, the movement of compressor ceases and is automatically resumed at lower atmospheric pressure. Points out its many useful possibilities.

Psychrometric Chart. Psychrometric Chart, E. V. Hill. Heating and Vent. Mag., vol. 17, no. 10, Oct. 1920, pp. 50–51, 1 fig. Issued by Chicago Department of Health.

Schools. New Heating and Ventilating System Adopted for Chicago Schools—I. Domestic Eng., vol. 93, nos. 6 and 7, Nov. 6 and 13, 1920, pp. 251–253, 3 figs, and 300–302, 14 figs. Plan recently evolved by chief engineer of Chicago Board of Education.

HEAVY-OIL ENGINES

Reciprocating Parts for. Reciprocating Engine Crosshead Design Applied to Heavy Oil Engines, W. D. Forbes. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 924–925. Service requirements.

HOBS

Worm-Wheel, Standardization of. Standardization of Worm-Wheel Hobs (Ueber die Normung von Schneckenradfräsern), Fr. Woltzendorff. Betrieb, vol. 2, no. 14, Aug. 1920, pp. 347–352, 6 figs. Advantages of standardization are said to be that the cutters can be fabricated in quantities, are cheaper, more accurate in pitch and boring and interchangeable; worms can be forged and cut in quantities, thus effecting a great saving in time and labor.

HOISTING ENGINES

Standardization. Standardization of Hoisting Machines (Normung von Hebezeugen), Karl Engel. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 417–420. Points out its great advantages from economic standpoint and makes recommendations for calibrated load and hand chains and for gage dimensions.

The Standardization of Hoisting Machines (Die Vereinheitlichung der Hebemaschinen), Leopold Feigl. Betrieb., vol. 2, no. 14, Aug. 1920, pp. 377–380. Discusses program submitted by working committee for standardization of hoisting machines of the N D I, and offers suggestions for extending limits in some cases. Recommendations for standardization of trestle bridges and electrically driven traveling crabs.

HOSE

Steam. Steam Hose Construction, John M. Bierer. India-Rubber Jl., vol. 60, no. 15, Oct. 9, 1920, pp. 9–10. Results obtained from tests by B. F. Goodrich Co. Hose constructed according to different processes were compared.

10. and (discussion), pp. 470–490. Cost figures for electrical equipment supply to houses erected under British Government Housing scheme.

HOUSES, CONCRETE

Construction. Concrete Cottage Building. Concrete and Constructional Eng., vol. 15, no. 10, Oct. 1920, pp. 668–673, 7 figs. Patent system of construction approved by British Ministry of Health.

HOUSING

England. English Efforts to Solve the Housing Problem since the War (Englische Bestrebungen zur Behebung der Wohungsnot nach dem Kriege), Stephan Prager. Zeitschrift für Bauwesen, vol. 70, no. 7–9, 1920, pp. 414–499, 87 figs. Notes on government board for building aid; work of government in overcoming the housing shortage; temporary relief measures through use of barracks, framework buildings and rebuilding of single-family houses into renting apartments; building costs, and material and labor supply; recommendations for substitute building materials and new building methods; success up to present time of the housing policy and future prospects. Bibliography.

France. Low-Priced Houses (La construction d'habitations à bon marché), Paul Razous. Génie Civil, vol. 77, no. 16, Oct. 16, 1920, pp. 309–313. Housing projects for Paris and suburbs.

HUMIDITY

See HEATING AND VENTILATION, Humidity Regulator; Psychrometric Chart.

HYDROELECTRIC PLANTS

New Brunswick, Canada. Hydro-Electric Power Development in New Brunswick, C. O. Foss. Jl Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 522–525. Outlines work at Musquash River and Shogomac developments.

Niagara Falls Power Development. Clearing House for Five Stations, J. Allen Johnson. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 961–965, 12 figs. Semi-outdoor substation of Niagara Falls Power Co. Combined output of installations is rated at 400,000 hp.

Norway. Vamma Hydro-Electric Plant. Engr., vol 130, no. 3379, Oct. 1, 1920, pp. 324–326, 3 figs Plant, when completed, will develop 200,000 hp on head of from 80 ft. to 85 ft.

I

IGNITION

Alsop Device. Test of the Alsop All-Spark Ignition Device. Air Service Information Circular, vol. 1, no. 18, Sept. 15, 1920, 4 pp., 1 fig. Device is subsidiary spark gap which is inserted in high-tension circuit of ignition system.

Sparking Performance of System. The Effect of Shunted Resistance, or Plug Leakage, on the Sparking Performance of an Electrical Ignition System, G. E. Bairsto. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 507–522, 22 figs. Tests made at Royal Aircraft Establishment, Farnborough, England, during 1917 to 1918, to determine effect of shunted resistance on spark voltage of most of leading types of electrical ignition systems in use. It was found that the quicker the rate of rise of secondary potential the less is fall of voltage with leakage. Following order of merit of various types was established: (1) rotating armature types with movable pole-shoes, (2) ordinary rotating-armature types, (3) sleeve inductor types, (4) polar inductor types; and (5) battery and coil systems.

Tests. Ignition from the Engineman's Viewpoint, George E. A. Hallett. Jl. Soc. Automotive Engrs., vol. 7, no. 5, Nov. 1920, pp. 475–479, 7 figs. Test results of single and double ignition systems on Liberty engine.

INDUSTRIAL MANAGEMENT

Inspection. Inspection: The Control of Quality—III George S. Radford. Indus. Management, vol 60, no. 5, Nov. 1920, pp. 331–335. Comparative study of various methods of inspection, such as centralized inspection, floor inspection, inspection of work in process, sampling, double inspection, pilot part tests, etc.

Opinions of Workers. What the Workers Think About Management—I, Albert Fry. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 322–327. Views of labor turnover, rate setting and managing men by ironworkers, carpenters, inspectors, blacksmiths, machinists, patternmakers and others.

Payroll Graph. Graphic Planning of Payroll Procedure, W. C. Bober. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 336–337, 1 fig. Chart based on labor routine of Mechanical Rubber Co., Cleveland.

Planning Department. New Department in Detroit Plant, Don F. Kennedy. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1177–1179. Duties of factory planning engineer at Timken-Detroit Axle Co.'s Detroit plant.

Planning Department Systems, John H. Van Deventer. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 373–376, 4 figs. How to visualize methods by mapping routine.

Production Systems. How a Factory Diplomat Aids Production. Factory, vol. 25, no. 9, Nov.

ENGINEERING INDEX (Continued)

1, 1920, pp. 1398–1400, 1 fig. Production methods of foundry in Illinois.

Modern Production Methods, W. R. Basset. Am. Mach., vol. 53, nos. 18 and 20, Oct. 28 and Nov. 11, 1920, pp. 798–802, 3 figs., and 889–891, 2 figs. Fundamental definitions and explanations of cost subdivision. Nov. 11: Method of allotting fixed charges to every department.

Routing Materials. Routing Considered as a Function of Up-to-Date Management—II, H. K. Hathaway. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 353–361, 10 figs. How to proceed when product consists of several parts.

Shipyards. Scientific Management in a Large French Shipyard—I, M. Lavallee. Eng. & Industrial Management, vol. 4, nos. 17 and 18, Oct. 21 and 28, 1920, pp. 515–519, 1 fig., and 547–553, 7 figs. Results obtained in 1914 at Penhoet Shipyard at St. Nazaire, France. From Bulletin de la Société d'Encouragement pour l'Industrie Nationale.

INDUSTRIAL RELATIONS

Employees' Magazines. Making the Plant Paper Pay, Edwin A. Hunger. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 341–344. Suggestions to editors of employees' magazines.

Employers' Control. Italy's Soviet Shows Weakness, Francis Miltoun. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1271–1272. Collapse of short-lived uprising of workers in steel plants and factories is pointed out as illustrating interdependence of capital and labor.

Open-Shop Movement in U. S. Cleveland in Open-Shop Ranks. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1264–1265. It is reported American Plan Association has been organized, with fully 70 per cent of employers coöperating.

Employes Uphold the Open Shop, A. J. Hain. Iron Trade Rev., vol. 67, no. 16, Oct. 14, 1920, pp. 1071–1076, 7 figs. How International Association of Machinists failed to obtain general advance of 25 per cent in wages for which it fought for a year at Cincinnati machine tool plants.

New Open-Shop Movement in Cleveland. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1201–1202. American Plan Association was recently organized. Purpose of organization is to establish open shop principle in industrial relations.

Public Sponsors Open-Shop Associations. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, pp. 1339–1345 and pp. 1348–1350, 5 figs. It is reported that American Federation is to be established soon. Purpose of federation will be to secure and establish open-shop principle in industrial relations.

Open Shops, Arguments in Favor of. The Human Factor in Industry, Alexander Ramsay. Jl. Inst. Mech. Engrs., no. 6, Oct. 1920, pp. 709–715 and (discussion) pp. 716–729. Urges employers to cultivate more open shop policy.

Settlement of Disputes. The Settlement of Labor Disputes, Henry J. Allen. Elec. Ry., Jl., vol. 56, no. 16, Oct. 16, 1920, pp. 751–753. Experience in Kansas cited to illustrate fundamental relations of workers and public welfare.

Unionized Shops. An Example of Putting Friendliness into a Unionized Shop, Harry Tipper. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 882–883. Writer quotes from English employer to show that open shop is not necessary to arrive at complete accord between workers and management.

Whitley Shop Councils. See EMPLOYEES' REPRESENTATION, Shop Committees.

INDUSTRIAL RAILWAYS

Factory Railway System. Conveying in Factories with Special Regard to Works Railway Operation (Das Transportwesen in Fabriken mit besonderer Berucksichtigung des Werkbahnbetriebes), R. Kampe. Betrieb, vol. 2, no. 15, Aug. 1920, pp. 405–407, 2 figs. Gives general fundamental principles and requirements, which should be considered in the organization of a transportation system, especially of a factory railway system.

INDUSTRIAL TRUCKS

Steel Industry. Trucks Win Place in Steel Traffic as Railroads Fail, Myers L. Feiser. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1127–1129, 5 figs. Steel carried in motor trucks from mill to consumer or to car for shipment to consumer is estimated at more than 100,000 tons monthly.

INDUSTRY

Australia. The Industrial Development of Australia, Ernest L. Little. Am. Mach., vol. 53, no. 19, Nov. 4, 1920, pp. 842–843. Statistics showing progress within last ten years.

Mexico. Mexico's Industrial Progress Since Diaz, John E. Kelly. Eng. & Min. Jl., vol. 110, no. 20, Nov. 13, 1920, pp. 941–943. Nearly all railroad construction now under way planned under Carranza. Oil exports tripled in seven years. Metal output during revolutionary period indicative of mining activities.

INSULATORS

European Practice. Features of European Insulator Testing Practice, B. Schapira. Elec. Rev., (Chicago), vol. 77, no. 19, Nov. 6, 1920, pp. 721–724, 8 figs. Two-part insulators of pin type are used for service below 70,000 volts. Tests are made of electrical and mechanical properties of individual parts and complete assembled units. Testing practice as carried on in Schomburg Works at Margarethenhutte, Germany.

High-Voltage. Surface Creepage and High-Voltage Insulation, T. Nishi. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 949–959, 32 figs. Experiments made in Electrical Engineering Laboratory in Tokyo Imperial University and in High-Voltage Laboratory of Leland Stanford Junior University. It is concluded that main cause of erratic surface creepage is accumulation of free charge on surface of dielectric of which bushings insulators, etc., are made.

Testing. Testing Insulators in Factory and Field, Leslie N. Crichton. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 506–509, 10 figs. Methods of Westinghouse Elec. & Mfg. Co.

INTERCHANGEABLE MANUFACTURE

Selective Assembly vs. Manufacturing for Selective Assembly, Earle Buckingham. Machy. (Lond.), vol. 17, no. 421, Oct. 21, 1920, pp. 82–83, 2 figs. Comparison of interchangeable and selective assembly manufacturing methods. Dimensions and tolerances on drawings for manufacturing on selective assembly basis.

Tolerances. Size Tolerances and Allowance Tolerance (Grössentoleranzen und Passungstoleranz), J. Kirner. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 426–427, 4 figs. The preliminary conditions for unlimited interchangeability. Points out that so-called allowance tolerance or inaccuracy of an allowance is result of the algebraic difference between maximum and minimum excess measurement or play of allowance.

INTERNAL-COMBUSTION ENGINES

Compound Type. Pourcel Compound Explosion Motor (Moteur compound à explosion, système Pourcel), Génie Civil, vol. 77, no. 15, Oct. 9, 1920, p. 299, 1 fig. Patented engine with two explosion cylinders and an expansion cylinder where explosion gases expand before being exhausted in atmosphere.

Cooling Devices. New Devices for the Cooling of Internal-Combustion Engines (Neue Luftkühler für Verbrennungsmotoren,) H. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 31 and 34, July 30 and Aug. 20, 1920, pp. 233–234 and 260–262, 17 figs. Details of various new patents.

The Cooling of Internal-Combustion Engine. (Die Kühlung der Verbrennungsmotoren), H. Praetorius. Motorwagen, vol. 23, no. 23, Aug. 20, 1920, pp. 425–429, 12 figs. Review of new patents and devices in the field of engine cooling introduced for the purpose of increasing economy of engines and in view of the frequent necessity of employing heavier fuel.

Valves, Steel for. Steel for Valves of Combustion Motors, G. Gabriel. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1249–1251. Requirements enumerated in light of troubles which experience has discovered in low weight engine. (To be continued.) Translated from La Technique Automobile et Aerienne.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GASOLINE ENGINES; HEAVY-OIL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Electrolytic. Reheating of Electrolytic Iron (Le recuit du fer électrolytique), Jeane Cournot. Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 568–570, 6 figs. Experimental study of best procedure to remove hydrogen remaining in iron when issuing from electrolytic bath.

Soft. Soft Iron (Ueber Weicheisen), P. Goerens and P. Fischer. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 432–436, 20 figs. Account of mechanical and physical investigations of the nearly chemically pure WW soft iron produced in the open-hearth furnaces of the Fried. Krupp Works in Essen-Ruhr, the elasticity and shock resistance of which in cold state is said to exceed that of all kinds of mild steel produced in large quantities, and in many cases is a perfect substitute for copper. Abstracted from the Krupp Monthly Jl. (Jan. 1920).

IRON CASTINGS

Cleaning with Sand Blast. The Sand Blast in the Foundry, O. Bertoya. Metal Industry (Lond.), vol. 17, no. 17, Oct. 22, 1920, pp. 321–323, 9 figs. Comparative tests of time required to clean castings by hand and by sand blasting.

Standardization of. Standardizing of Gray Iron Samples, Edward J. Fowler. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 876–877. It is said that lack of recognized standards which specify method of taking samples of gray iron castings for test purposes greatly impairs work of laboratory.

IRON METALLURGY

Direct Process. A Direct Process for Making Iron and Steel from Ore, James W. Moffat. Iron and Steel of Can., vol. 3, no. 9, Oct. 1920, pp. 271–274, 3 figs. Process patented by writer, in which reduction is accomplished in separate mechanism and melting down of metal and its subsequent refining take place in electric furnace. Blast furnace is eliminated and metal reduced from ores of all types. Process is said to be applicable to certain non-ferrous metals.

IRON ORE

Australian. The Iron Ore Deposits at Yampi Sound, West Australia, A. Montgomery. Min. Mag., vol. 23, no. 4, Oct. 1920, pp. 203–122, 12 figs. Description of iron ore deposits on Koolan and Cockatoo Islands situated in Yampi Sound off northern coast of West Australia.

Canadian. Iron Ores of Commerce with Special Reference to Canadian Deposits, Samuel Groves. Iron and Steel of Can., vol. 3, no. 9, Oct. 1920, pp. 267–270, 1 fig. Classification of commercial iron ores. (To be continued.) Report of Ontario Bureau of Mines.

IRRIGATION

Canada. The Legal Phases of Irrigation Development in Alberta, H. B. Muckleston. Jl. Eng. Inst. Canada, vol. 3, no. 11, Nov. 1920, pp. 510–514. History of irrigation law in general, developments in Alberta, and procedure under present laws.

Washington State. Unprecedented Design Involved in Irrigation Project. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 944–946, 2 figs. To bring water 130 miles to 1,753,000-acre Columbia basin in Washington. Viaduct, siphons and tunnels of unusual size.

L

LABOR

International Action Affecting. Historical Survey of International Action Affecting Labor, U. S. Dept. of Labor, Bur. of Labor Statistics, no. 268, Aug. 1920, 294 pp. Includes brief account of international political labor movement as seen in early International and its later organization as International Socialist Bureau. Describes briefly international trade-union movement, international organizations of "social reformers" interested in labor problems, considering particularly International Association for Labor Legislation, and recounts efforts of Governmental conferences to arrive at agreements as respects control of labor conditions within their respective jurisdictions. Analysis is made of treaties and conventions entered into by various Governments. Survey covers international work up to 1914.

LAPPING

Modern Practice. Modern Lapping Practice, Edward K. Hammond. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 209–217, 19 figs. Review of developments in lapping practice including abrasives used and lap-charging methods, lapping thread gages, snap gages, measuring wires, flat surfaces, ring gages, die-casting dies, T-slots, etc.

LATHES

Turret. Tooling Acme Turret Lathes. Machy. (Lond.), vol. 17, no. 419, Oct. 7, 1920, pp. 1–5, 12 figs. Tooling equipment for performing turret-lathe operations on friction pulleys, aluminum pistons, gear blanks and other machine parts.

Turret Lathe Design and Construction. Mach. (Lond.), vol. 17, no. 420, Oct. 14, 1920, pp. 41–44, 5 figs. Based on examination of four American and one English machines.

LIGNITE

Briquetting. The Briquetting of Lignites, R. A. Ross. Dominion of Canada, report no. 1, 1918, 29 pp. Procedure and equipment are recommended.

Carbozite. The Low-Temperature Carbonization of Low-Grade Fuels, Especially of Lignites (Nochmals: Die Tieftemperaturverkohlung geringwertiger Brennstoff, insbesondere der Braunkohle), H. Bansen. Braunkohle, vol. 19, no. 17, Aug. 7, 1920, pp. 217–220. Refers to article by Theiler in same journal (vol. 18, no. 33, Nov. 15, 1919) on manufacture of carbozite, a lignite product whose heating value is said to be three times that of lignite. Critical discussion of its merits from technical and economical standpoint.

LIGHTING

Bibliography. Illumination Bibliography. Trans. Illuminating Eng. Soc., vol. 15, no. 7, Oct. 9, 1920, pp. 385–391. Prepared by Committee on education of Illuminating Eng. Soc. It covers books published in recent years up to June 1920.

Developments. Report of the Committee on Progress. Trans. Illuminating Eng. Soc., vol. 15, no. 7, Oct. 9, 1920, pp. 425–493. Extensive survey of recent developments in gas and electric light.

Electric Signs. Engineering Features of Electric Sign Lighting. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 15a, March 15, 1916, 35 pp., 20 figs. Engineering features involved in readability of electric signs, wiring of electric signs and cost of their operation.

Industrial. Industrial Lighting, Ward Harrison and H. H. Magdsick. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 20a, Sept. 10, 1919, 95 pp., 79 figs. Requirements which must be fulfilled in design of satisfactory installations. Data on Mazda lamps. Discussion of reflecting and diffusing equipment. Study of lighting of yards and foundries. Cost data of industrial lighting.

Modern Industrial Lighting for Oregon, F. H. Murphy. Elec. World, vol. 76, no. 17, Oct. 23, 1920, pp. 820–823, 5 figs. Features of industrial lighting code adopted by Oregon. Provision is made for raising standards as better lighting practice develops.

Proper Lighting Means Efficiency, James Brakes, Jr. Iron Trade Rev., vol. 67, no. 16, Oct. 14, 1920, pp. 1061–1062 and 1067, 2 figs. Self-cleaning lamp fixtures. (Abstract.) Paper read before Am. Foundrymen's Assn.

Machine Shops. Illumination of Machine Tools, G. Wagschal. Elec. World, vol. 76, no. 19, Nov., 6, 1920, pp. 925–926, 4 figs. Sufficient illumination is said to be obtained over machines with intensity of 15.35 ft. candles in plant of Central Gear Co.

Stores. Store Lighting. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 29, June 5, 1917, 40 pp., 14 figs. Discussion of various types

descent Lamp Circuits. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 25, Sept. 20, 1915, 23 pp. 11 figs. Factors in design and operation of streets series incandescent systems.

Street Series Mazda Lamps. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 11C, Oct. 15, 1915, 10 pp., 6 figs. Characteristic curves of Mazda street series lamp.

LIGHTNING PROTECTION

4000-Volt Circuits. Lightning Protection of 4000-volt lines, Thomas Commerford Martin. Elec. World, vol. 76, no. 20, Nov. 13, 1920, pp. 973–977 5 figs. Experimental investigation showed that density of lightning arresters on an electrical distribution system is far more important than type of arrester.

Studies in Lightning Protection on 4000-Volt Circuits—II, D.W. Roper. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 960–975, 20 figs. Factors which affect lightning-arrester performance. Curves showing relative merits of various types of lightning arresters.

Spark Gaps. Lightning Arrester Spark Gaps—II, Chester T. Allcutt. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 939–943, 12 figs. Data giving discharge characteristics of commercial type of impulse gap under different conditions. Factors that determine degree of protection afforded by lightning-arrester spark gap. Definition of "protection factor" and curves giving protection factor of certain types of gap.

Tests. Life and Performance Tests of O F Lightning Arresters, N. A. Lougee. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 944–948, 5 figs. Performed at laboratories of General Electric Co.

LIME

Manufacture. The Manufacture of Lime for Chemical and Metallurgical Purposes—III, Richard K. Meade. Chem. & Metallurgical Eng., vol. 23, no. 19, Nov. 10, 1920, pp. 929–933, 3 figs. Methods of heating rotary kilns. Description and comparison of pulverized coal and producer gas installations. Boilers in series with kiln. Power consumption. Cost data.

LOCOMOTIVE BOILERS

Welding Flue Points to Boiler Tubes. Welding Flue Points to Boiler Tubes, Charles W. Geiger. Welding Engr., vol. 5, no. 10, Oct. 1920, pp. 44–46, 5 figs. Method developed by Charles S. Coleman of Santa Fe Railroad Co.

LOCOMOTIVES

Boosters. Operating Tests of a Pacific Type Booster Locomotive. Ry. Age, vol. 69, no. 17, Oct. 22, 1920, pp. 699–702, 6 figs. Additional tractive effort of booster has increased tonnage rating for division on New York Central.

Cylinder Parts. Cast Iron for Locomotive-Cylinder Parts, C. H. Strand. Technologic Papers, Bur. of Standards, no. 172, Sept. 11, 1920, 25 pp., 10 figs. Records of investigation of mechanical, chemical and metallographic properties of packing rings of various service mileages, and also of arbitration test bars, chill test blocks, and miscellaneous samples from various makers. It is concluded that existing specifications are insufficiently rigid as to requirements for mechanical tests and specification is proposed with revisions in accordance with results of these tests.

Electric. See ELECTRIC LOCOMOTIVES.

Lubrication of. Lubricator Locomotive Gears (Schmiergefässe am Lokomotiv-Triebwerk), H. Bauer. Verkehrstechnik, vol. 37, no. 21, July 25, 1920, pp. 298–299, 1 fig. Automatic lubricating device called Mobil, which has been used for a number of years for works railway locomotives and is now being used for trunk-line locomotives of German National Ry. Administration.

Mountain Type. Mountain Type Locomotives for the New Haven. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 685–688, 8 figs. Equipment includes feedwater heaters and provision for future application of booster.

No-Load Arrangements. No-Load Arrangements on Locomotives (Leerlaufeinrichtungen an Lokomotiven), F. Meineke. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 39, Sept. 25, 1920, pp. 784–788, 25 figs. Describes typical constructions of air inlet valves, by-pass valves, etc., but states that there is no construction type adaptable to all cases. Aspects governing selection of suitable devices.

Oil-Burning. English Railways Experiment with Fuel Oil. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 692–696. Description of Scarab fuel oil burning apparatus tested on London and Northwestern Ry.

Oil Burning on Locomotives. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 414–418, 7 figs. Tests on London & Northwestern Railway with locomotive of "Precursor" class, equipped with Scarab oil burning apparatus.

Pennsylvania R. R. 2-10-0-Type Locomotive; Pennsylvania Railroad. Eng., vol. 110, nos. 2860 and 2861, Oct. 22 and 29, 1920, pp. 538–539, 23 figs., partly on supp. plates, and 586–587, 28 figs. Characteristics: Total weight in working order, 371,800 lbs.; driving wheels, diameter, 62 in.; cylinders, $30^1/_2$ in x 32 in.; boiler pressure, 250 lb. per sq. in.; total heating surface, 4334 sq. ft.; 22, 1920, pp. 687–696, 8 figs. Locomotive repair shops of Union Pacific Railroad at Cheyenne, Wyo.

Locomotive Repair Shop Organization and Methods. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 410–412. Best method of obtaining maximum output, consistent with good work, from locomotive repair shops.

Wheel Balancing. Calculation of the Counterbalances in Locomotive Driving Wheels (Berechnung der Gegengewichte in Lokomotiv-Triebrädern), H. Igel. Organ für die Fortschritte des Eisenbahnwesens, vol. 57, no. 15, Aug. 1, 1920, pp. 153–156, 15 figs. Gives calculations for different types of locomotives.

Locomotive Wheel Balancing Machine. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 719–720, 5 figs. Device used in British railroad shops tests wheels by rotating them in spring supported bearings.

M

MACHINE GUNS

Pocket Types. A Pocket Machine Gun, E. C. Crossman. Sci. Am., vol. 123, no. 16, Oct. 16, 1920, pp. 405–413–414, 4 figs. Types of pocket machine gun magazines and how gun is used by New York Police Department.

MACHINE-TOOL INDUSTRY

Germany. The German Machine Tool Industry. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, p. 232. It is reported that German manufacturers are no longer able to compute with prices on world's market.

The German Machine-Tool Industry Today. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 923–924. Depression ascribed to overstretching prices.

Sweden. The Swedish Machine Tool Industry, S. E. Osmar. Mach. (N.Y.), vol. 27, no. 3, Nov. 1920, p. 227. Industry is described as very dull at present,a nd it is said that there is not immediate prospect for improvement.

MACHINE TOOLS

Developments. Recent Machine Tool Developments—XVI, Joseph Horner. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 494–498, 16 figs. Milling machines.

Frames. A New Stiffening Construction for Machine Tool Frames (Neue Versteifungsbauart für Werkzeugmaschinenbetten), Ernst Peters. Werkstattstechnik, vol. 14, no. 16, Aug. 15, 1920, pp. 441–442, 5 figs. According to new method, frame of machine tool is provided with diagonal stiffening ribs in place of the rectangular ribs heretofore in use, in order to increase the accuracy of work and resistance against high stresses.

Plants. Service Department in a Machine Tool Plant. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 261–263, 3 figs. Outline of purpose, organization, equipment and methods of service department of Heald Machine Co., Worcester, Mass.

Regulating Motors. Shortening of Working Period and Reduction of Power Consumption through Regulating Motors (Abkürzung der Arbeitzeit und Verminderung des Kraftbedarfs durch Reguliermotoren), O. Pollok. Betrieb, vol. 2, no. 14, Aug. 1920, pp. 341–347, 1 fig. It is shown that machine tools with regulating motors prevent the lower outputs of all mechanically graded machines and, by control of the speeds, effect considerably higher outputs; a very great saving in power is effected by simplification of drive through the regulating motor. Recommendations for standards.

Safety Standards. Safety Standards of the Industrial Board. Commonwealth of Pennsylvania, Dept. of Labor & Industry, vol. 1, no. 5, 7 pp. Rules to safeguard workers in industries in which machine tools are used.

Speed Steps, Standardization of. Standardization of Speed Steps in Machine Tool Construction (Vereinheitlichung der Grösse des Stufensprunges im Werkzeugmaschinenbau), Ernest J. Wild. Der praktische Maschinen-Konstrukteur, vol. 53, no. 36, Sept. 9, 1920, pp. 155–157. Values are developed based on assumption that maximum cutting speed in practically all theoretical working diameters is the same.

MAGNETIC TESTING

Defectoscope. New Magnetic Testing Apparatus. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1125–1128, 7 figs. Defectoscope, a device for magnetic testing of steel.

MALLEABLE CASTINGS

Manufacture in Electric Furnace. Malleable Made by Triplex Process, H. A. Schwartz. Foundry, vol. 48, no. 357, Oct. 15, 1920, pp. 815–817 and 825, 4 figs. Patented process involving use of cupola, side-blow converter and electric furnace. Details of operation and metallurgical reactions are explained. Paper read before Am. Foundrymen's Assn.

MARINE ENGINES

See DIESEL ENGINES, Marine.

MARKETS

Terminal, New York City. $75,000,000 Terminal Market Planned for New York. Manufacturers Rec., vol. 78, no. 19, Nov. 4, 1920, pp. 151–152,

Developments. Precision Instruments in Engineering Works (Le misure di precisione nelle officiene meccaniche), Vernon I. N. Williams. Revista d'Ottica e Meccanica di Precisione, vol. 1, nos. 7–8, Mar.–Apr. 1920, pp. 129–145, 34 figs. Survey of developments throughout the world.

Phosphoroscope. A Special Form of Phosphoroscope, W. S. Andrews. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 856–857, 6 figs. Type developed by writer for visual observation of phosphorescent and fluorescent light emitted by various compounds when excited by ultra-violet light.

METAL INDUSTRY

German. The Metal Supply Problem in German—I, C. A. Heise. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1295–1297. How war shortages were met by substitutions. Effect of latter on present and future consumption of copper and tin.

METALLURGY

Developments in. Recent Progress in the Control of Metallurgical Products (Les progrès récents des méthodes de controle des produits métallurgiques), Leon Guillet. Génie Civil, vol. 77, no. 16, Oct. 16, 1920, pp. 313–316, 7 figs. Industrial uses of equilibrium diagrams of alloys (Concluded).

METALS

Crystal Growth. Crystal Growth and Recrystallisation in Metals, H. C. H. Carpenter and Miss C. F. Elam. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 486–490, 16 figs. Review of theories of crystal growth in light of evidence obtained in experimental research. (Concluded.) (Abstract.) Paper read before Inst. of Metal.

Rust Prevention. Preventing Rust at High Temperatures, Robert June. Sci. Am., vol. 123, no. 16, Oct. 16, 1920, pp. 404 and 412–413, 4 figs. Aluminum-coated metals that will go to melting point without formation of scale.

Supra-Conduction of. The "Supra-Conducting Condition" of Metals (Der "supraleitende Zustand" von Metallen), C. A. Crommelin. Physikalische Zeitschrift, vol. 21, nos. 10, 11 and 12, May 15, June 1 and 15, 1920, pp. 274–280, 300–304 and 331–336, 11 figs. Discussion of a series of investigations on the resistance of metals carried out in Prof. Kamerlingh Onnes' cryogenic laboratory of Leiden at temperatures which can be reached solely with liquid helium, and which led to the discovery of the so-called supra-conducting condition of different metals. Address delivered before Physical Soc. at Leiden in Feb. 1919.

Thermostatic. Thermostatic Metal. Automotive Industries, vol. 43, no. 17, Oct. 21, 1920, p. 819. New thermostatic metal developed by H. A. Wilson Co., and being placed on market under trade name "Wilco."

METRIC SYSTEM

Arguments Against Adoption in U. S. Anti-Metric Resolutions. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 916–917. Resolutions against compulsory adoption of metric system in U. S., passed by Automotive Wood Wheel Manufacturers' Assn., Hickory Products Assn., New Jersey Lumbermen's Assn., Kentucky Manufacturers' Assn., Am. Assn. of Engrs., Hydraulic Soc., Compressed Air Soc. and many other associations and Chambers of Commerce.

The Metric System and International Trade, Harry Alcock. Nature (Lond.), vol. 106, no. 2658, Oct. 7, 1920, pp. 169–170. Comment on Report on Compulsory Adoption of the Metric System in the United Kingdom, submitted by metric committee appointed by Conjoint Board of British Scientific Societies. Recommendations include plea for continued use of British units by Department of State.

The English and the Metric Measuring System A Comparison, C. C. Stutz. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 911–913. It is held that metric units are either too large or too small for every day requirements in industry.

MILLING

Circular Segments. Milling Fixture for Circular Segments. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 229–230, 3 figs. Features of construction of hinged milling fixtures designed for use in performing gang milling operations in circular segments.

Continuous vs. Station. Continuous versus Station Milling. Machy. (Lond.), vol 17, no. 422, Oct. 28, 1920, pp. 106–108, 4 figs. Comparison of results that are obtained by both methods of milling on identical work when using similar machines in interchangeable manufacture.

MILLING CUTTERS

Manufacture. Making "Curvex" Milling Cutters. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 250–258, 17 figs. Methods and equipment employed by Pratt & Whitney Co., Hartford, Conn., in manufacture of formed milling cutters with helical flutes.

MILLING MACHINES

Locomotive Parts. Milling Machines for Crown-Bar Frames of the A. Borsig Locomotive Factory (Barrenrahmenfräsmaschinen der Lokomotivfabrik A. Borsig.) Werkstattstechnik, vol. 14, no. 14, July 15, 1920, pp. 390–395, 16 figs. Details of special machine designed by engineer of Schiess

ENGINEERING INDEX (Continued)

Machine Factory, Ltd., Düsseldorf, in the Borsig works, Specifications: max. length of frames to be cut, 11,000 mm.; max. height, 900 mm.; diam. of cutter spindle, 90 mm.; speed of cutter spindle, 320 r.p.m.; speed of motor, 1250 r.p.m.; etc. Machines are constructed in two types, with two and with three uprights, the latter serving for the simultaneous machining of two locomotive crown-bar frames.

MINE TIMBERING

Preservative Treatment. Saving Mine Timbers from Decay. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 110, 1 p. Three preservatives have been found suitable for mine work: coal-tar creosote, zinc chloride and sodium fluoride.

MINING INDUSTRY

Norway. The Mining and Metallurgical Industry of Norway, Matthew R. Blish. Eng. and Min. Jl., vol. 110, no. 18, Oct. 30, 1920, pp. 856–858. Brief review of resources and past and present production. Iron still most important metal, with copper and molybdenum of secondary interest. Development dependent upon increased application of electric power.

MOLDING MACHINES

European Types. European Equipment Progressive, H. Cole Estep. Foundry, vol. 48, no. 357, Oct. 15, 1920, pp. 818–825, 21 figs. Most of molding-machine manufacturers of Europe are found in Great Britain, France, and Germany. Although war exerted depressing effect upon new molding machines, it served to develop to high efficiency those already in service. Excellence is shown in smaller types. Paper read before Am. Foundrymen's Assn.

MOTOR BUSES

Street Cars vs. Bridgeport Tries the Jitney. Aera, vol. 9, no. 3, Oct. 1920, pp. 239–253, 6 figs. Experiment of eight weeks without trolleys is said to have shown motor bus incapable of furnishing satisfactory transportation.

MOTOR PLOWS

British. Fowler Ploughing Machinery. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 507–508 and 510, 3 figs. Machines built by John Fowler & Co., Ltd. Double steam engine set rated at 8 hp. nominal is used.

Internal Combustion Cable Ploughing Engine. Eng., vol. 100, no. 2859, Oct. 15, 1920, pp. 506–507, 9 figs. Weight is $3^1/_4$ tons for each engine with fuel and spuds, and power developed is 32 b.hp. Four-cylinder Dorman engine arranged to burn paraffin is used.

MOTOR TRUCKS

British. $7^1/_2$-Ton Six-Wheel Commerical Vehicles. Eng., vol. 110, no. 2859, Oct. 15, 1920, pp. 518–520, 5 figs. Engine is of four-cylinder type and develops 47 b.hp. at 1000 r.p.m. It drives through Ferodo-lined cone clutch with aluminium male member.

Olympia Show. Exhibits at the Commercial Motor Exhibition. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 535–536 and 542, 6 figs. Leading features of exhibit at Olympia.

The Commercial Motor Exhibition—I. Engr., vol. 130, no. 3382, Oct. 22, 1920, pp. 400–402 and 404, 13 figs. Details of principal exhibits.

The Commercial Motor Exhibition. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 546–549. Editorial comments on progress as shown by exhibits at Olympia show.

Worm Drives. Tests on Rear-Axle Worm Drives for Trucks, Kalman Heindlhofer. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 613–615, 10 figs. Determination of efficiencies under load variations. Efficiency curves showing results with four sets of gears in mesh are included. Effect of oil temperature in worm thrust bearing, on efficiency of drive is given, high efficiencies being derived at higher oil temperatures.

MOTORSHIPS

European Built. Motorship Building in Europe. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 921–923, 3 figs. Particulars of six new 14,000-ton motor vessels.

Standardization. Standardization of Motor Ships. Times Eng. Supp., vol. 16, no. 552, Oct. 1920, p. 304. Growth of policy.

N

NICKEL STEEL

Classification. The Anomaly of the Nickel-Steels, Charles Edouard Guillaume. Physical Soc. of London, Proc., vol. 32, part 5, Aug. 15, 1920, pp. 374–404, 15 figs. Classification by means of magnetic properties, changes of volume, progressive and transitory variations. Fifth Guthrie lecture.

NOZZLES

Calibration. Calibration of Nozzles for Measurement of Air Flowing into a Vacuum, Wm. L. De Baufre. Mech. Eng., vol. 42, no. 11, Nov. 1920, pp. 607–609 and p. 650, 6 figs. Investigation of flow of elastic fluid through nozzles having well-rounded entrances, effects of frictional resistance and of moisture in atmosphere when fluid is atmospheric air being taken into account. It is shown that rate of flow of dry air decreased with increases of moisture. Investigation was conducted at U. S. Naval Engineering Experiment Station, Annapolis, Md.

Tests. Investigations of Diffusers (Ueber Diffusoruntersuchungen). Der praktische Maschinen-Konstruckteur, vol. 53, no. 31, Aug. 5, 1920, pp. 280–282, 1 fig. Abstract of report on results of measurements on a steam diffuser carried out in the machine-construction laboratory of the Charlottenburg Technical Academy, tests being carried out according to two aspects, namely, variable condition of steam with a given nozzle, and different nozzles with corresponding initial condition.

O

OIL

Crude. Experimental Determination of Evaporation Losses from Crude Oil during Piping and Storage on Oil Leases, A. R. Elliott. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2169, Oct. 1920, 3 pp. Tests made to determine quantities and values lost.

OIL ENGINES

British. Some Lincolnshire Oil-Engines, F. H. Livens. Jl. Instn. Mech. Engrs., no. 6, Oct. 1920, pp. 673–697 and (discussion) pp. 697–707, 18 figs. Survey of most important methods of vaporization and ignition adopted and of increasing economy effected from time to time.

Hot-Bulb. 40-B.HP. Marine Two-Cycle Hot-Bulb Oil Engine. Eng., vol. 110, no. 2861, Oct. 29, 1920, pp. 568–569, 26 figs. partly on supp. plate. Engine is fitted with reversing gear and with bilge circulating air and lubricating pumps. It has 7 in. cylinders by 8 in. stroke and runs at 400 r.p.m. developing 40 b.hp. at that speed. Engine is manufactured by Norris, Henty & Gardners, Ltd., London.

Velocity of Fuel Injection. Determination of the Velocity of Solid Fuel Injection, David Turcott Gas Engine, vol. 22, no. 11, Nov. 1920, pp. 318–319. Experimental study. Velocity of injection in two-stroke cycle 30 hp. oil engines varied from 103 to 109 ft. per sec. with load from 0 to 100 per cent.

[See also HEAVY-OIL ENGINES.]

OIL FUEL

Economics. Fuel Oil as a Means to Increased Capacity, C. C. Lance. Ry. Mech, Engr., vol. 94, no. 11, Nov. 1920, pp. 723–724. Critical boiler plant condition relieved and efficiency improved by use of fuel oil in place of coal.

Measurement Policy. A National Liquid Fuel Policy, R. S. McBride. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 665–669, 2 figs. Possibilities of producing substitutes in liquid fuel supply. Best method for distributing available supplies among various classes of users when total demand exceeds available supplies.

OIL SHALES

Commercial Retorting. Commercial Retorting of Oil Shales, Louis Simpson. Chem. & Metallurgical Eng., vol. 23, no. 16, Oct. 20, 1920, pp. 789–791. Applicability of methods used in Scotland to American oil shales.

Indiana. Oil Shales of Indiana, John R. Reeves. Eng. & Min. Jl., vol. 110, no. 20, Nov. 13, 1920, pp. 954–955. Advantages of location and homogeneous character of raw material warrant expectation of commercial possibilities when experimental data determine satisfactory method of recovery. Results of dry and steam distillation tests.

OIL WELLS

Shutting Off Water. Shutting Off Water in Oil Wells. Petroleum World, vol. 17, no. 242, Nov. 1920, pp. 448–450, 2 figs. Patented process for shutting off water in oil wells by freezing limited area surrounding well casing.

ORES

Classifier. The Mitchell Electric Vibrating Screen, Chas. W. Stimpson. Monthly Jl. Utah Soc. Engrs., vol. 6, no. 4, Sept. 1920, pp. 51–54, 10 figs. partly on 2 supp. plates. Moving force is electric vibrator unit, applied from beneath screen cloth.

OVENS

Core Baking. Core Baking in Electrically Heated Ovens, Jesse L. Jones. Metal Industry (N. Y.), vol. 18, no. 10, Oct. 1920, pp. 450–451, 2 figs. New electric core oven developed by Westinghouse Electric & Mfg. Co. Records of its operation. Paper read before Am. Foundrymen's Assn.

OXY-ACETYLENE CUTTING

Cast Iron. Cutting Cast Iron with the Oxy-Acetylene Flame, Alfred S. Kinsey. Acetylene Jl., vol. 22, no. 5, Nov. 1920, pp. 264–269 and p. 272, 4 figs. Method of procedure. Paper read before Am. Foundryman's Assn.

OXY-ACETYLENE WELDING

Trade School for. An Acetylene Welding and Cutting Institute. Sheet Metal Worker, vol. 11, no. 11, Oct. 29, 1920, pp. 307–310, 4 figs. School established and conducted by equipment manufacturer where sheet metal mechanics and others are given instruction in these branches of industry.

[See also AUTOGENOUS WELDING.]

OXYGEN

Production in Germany. Oxygen and Nitrogen Production in Germany, R. Linde. Eng. Progress, vol. 1, no. 10, Oct. 1920, pp. 297–300, 5 figs. Low temperature processes. Modern installations for production of nitrogen and oxygen. Largest installations of world. Practical use of oxygen and nitrogen.

P

PAINTING

Spray. The Vortex Painter. Commercial America, vol. 17, no. 5, Nov. 1920, p. 51. Nozzle has two openings, a central opening for paint and an annular opening around center from which air is discharged as veritable blast under pressure approximating 60 lb. per sq. in.

PATTERNS

Wheels. Wheel Patterns. Machy. (Lond.), vol. 17, no. 421, Oct. 21, 1920, pp. 91–93, 7 figs. Making of patterns for webbed and flanged wheels as well as for wheels with arms. Methods used for molding wheels without complete patterns.

PETROLEUM

Production. Liquid Fuels—Wanted: A National Policy, R. S. McBride. Eng. and Min. Jl., vol. 110, no. 17, Oct. 23, 1920, pp. 823–825, 1 fig. It is urged that consideration be given to need for securing maximum oil production, reduction of consumption, or finding of new sources, to obtaining of substitutes and to adequate distribution of available supplies.

[See also OIL, Crude.]

PIPE, CONCRETE

Joint for. New Type of Concrete Pipe Joint. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 360–361. Use of machined casting for bell and spigot rings.

PLATINUM

Colombia, S. A. Platinum in Colombia, J. Ovalle. Eng. & Min. Jl., vol. 110, no. 19, Nov. 6, 1920, pp. 907–908. Foreign capital to realize future possibilities of industry. Output of Choco region increasing. That of Urals passed its peak before war. Ordinary methods of production employed.

PNEUMATIC MAIL TUBES

See COMPRESSED AIR, Pneumatic Mail Despatch.

POLES

Preservative Treatment. Preservative Treatment of Wood Poles, R. V. Achatz. Purdue University, Publications Eng. Dept., vol. 4, no. 2, June 1920, 54 pp., 18 figs. Practices in Indiana. Specifications for preservatives adopted by Am. Ry. Eng. Assn., Nat. Elec. Light Assn. and U. S. Shipping Board Emergency Fleet Corporation.

The Kyanizing of Wooden Poles (Beitrag zur Kyanisierung von Holzmasten), Robert Nowotny. Elektrotechnik u. Maschinenbau, vol. 38, no. 22, May 30, 1920, pp. 249–251, 2 figs. Results of experiments on the absorption of liquids in the kyanizing process.

PORTS

Antwerp. The Port of Antwerp, H. E. Cooper Newham and Clifford Atkinson. Shipping, vol. 12, no. 4, Oct. 25, 1920, pp. 19–27 and 32, 6 figs. Cargo handling machinery and equipment.

Layout of. What the Government is Doing to Help Port Layout, F. T. Chambers. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 850–851. Shipping act instructs U. S. Shipping Board and Secretary of War to promote port development and transportation facilities in connection therewith. Extent to which this instruction has been carried out is outlined in article. (Abstract.) Paper read before Am. Assn. of Port Authorities.

POWER FACTOR

Improvement of. The Power Factor Problem (Zur Leistungsfaktorfrage), H. Buchholz. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 24, Aug. 24, 1920, pp. 201–202, 2 figs. Discussion of measures adopted in Germany, France and especially America for increasing power factor in three-phase current. Notes on installation of synchronous in place of asynchronous motors, phase displacers, tariff regulations; enlightenment of consumers concerning phase displacement through an example from commercial practice.

POWER PLANTS

Automatic Regulation. Automatic Hydraulically Operated Regulating System. Iron Age, vol. 106, no. 19, Nov. 4, 1920, pp. 1185–1187, 4 figs. Arca system for automatic regulation of steam, gas, moisture, temperature, electric current, etc., in use in various industries in Sweden, and being introduced in U. S. by American Galco, Inc., New York City.

POWER TRANSMISSION

Carey Oil System. The Carey Oil Transmission System. Engr., vol. 130, no. 3377, Sept. 17, 1920, p. 284, 2 figs. Machines for transmitting power by means of oil under pressure. Two pumps are used which have balls instead of disks as pistons. Balls are giving reciprocating motion in regard to cylinders by being rotated within eccentric rings.

PRESSWORK

Methods. Press Work in an Electric Motor Plant—I, Fred R. Daniels. Machy. (N.Y.), vol. 27, no. 3, Nov. 1920, pp. 264–269, 15 figs. Methods used in power press department of Gen. Elec. Co., Lynn, Mass.

PROSPECTING

Desert. Desert Prospecting, Leroy A. Palmer. Eng. and Min. Jl., vol. 110, no. 18, Oct. 30, 1920,

tions of dry placers. Occurrence of water.

PUBLIC UTILITIES

Rate of Return. Utility Regulation and Rate of Return, Cecil F. Elmes. Elec. Ry. Jl., vol. 56, no. 16, Oct. 16, 1920, pp. 760–764. It is argued that dual standard of commerce regulation which affects utilities, but exempts other industries, has no justification on historical grounds or as matter of public policy. Effect on financing of utilities analyzed. (Abstract.) Paper read before Am. Elec. Ry. Assn.

PUBLIC WORKS

National Department of. The National Department of Public Works Situation. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 834–835. Report of M. O. Leighton to Engineering Council states that moral support is needed now to finish legislative program. Engineers' Corps will control unless civilians act, report says.

PULLEYS

Cone. Machining Cone Pulleys, Ralph E. Flanders. Machy. (Lond.), vol. 17, no. 419, Oct. 7, 1920, pp. 11–12, 4 figs. Tooling equipment and methods employed in the quantity production of three and four-step cone pulleys.

PUMPING STATIONS

Gas-Engine-Driven. Gas-Engine-Driven Pumping Plant at the Tilbury Docks. Eng., vol. 110, no. 2860, Oct. 22, 1920, pp. 532–534, 5 figs. Installation for pumping out dry docks for Port of London Authority.

Pump Selection. Well Tests—The Basis for Pump Selection, George M. Shepard. Mun. & County Eng., vol. 59, no. 4, Oct. 1920, pp. 137–138, 1 fig. Diagram showing results of tests on 12-in. well, 380 ft. deep.

PUMPS, CENTRIFUGAL

Tests. Motor-Driven Pumps Develop High Efficiency. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 358–360, 3 figs. Tests on centrifugal pumps direct connected to synchronous motors at McCarren pumping station, Water Department of City of St. Paul, Minn.

R

RADIO COMMUNICATION

Alexanderson's System. Transoceanic Radio Communication, E. F. W. Alexanderson. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 794–803, 12 figs. Description of Alexanderson's system of telegraphic and telephonic radio.

The Alexanderson System for Radio Communication, Elmer E. Bucher. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 813–839, 41 figs. Description is devoted principally to 200-kw. set.

[See also RADIOTELEGRAPHY; RADIOTELEPHONY.]

RADIOTELEGRAPHY

Antennae. A Rule for Antenna Models (Ein Satz über Modelle von Antennen), Max Abraham. Jahrbuch Zeit. für Telegraphie u. Telephonie, vol. 16, no. 1, July 1920, pp. 67–70. Writer evolves a law which, it is claimed, can be used for the qualitative and eventually for quantitative determination of the earth resistance of antennæ.

Abstractive and Selective Properties of Radio Antenna Circuits, Edward Bennett. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 11, Nov. 1920, pp. 995–1004, 7 figs. Consideration of properties of simple series antenna circuit with object of determining circuit proportions and frequencies which will make circuit most highly responsive to correspondent's signal and unresponsive to interference sources.

Coils vs. Antennae. The Use of Coils in Place of Antennæ in Radiotelegraphic Reception (Ueber die Verwendung von Spulen an Stelle von Antennen beim Empfang in der drahtlosen Telegraphie), Herbert Hoffmann. Jahrbuch Zeit. für Telegraphie u. Telephonie, vol. 16, no. 1, July 1920, pp. 31–66, 22 figs. Points out advantages of a receiving apparatus without antennæ, describes qualities of coils, and gives results of experimental tests of the most feasible connections. Recommendations for use of coils in special cases and for radiotelephony. Report from laboratory of the Torpedo Inspection at Kiel.

High-Speed. Service Tests and Experiences with Wireless High-Speed Telegraph (Ueber Betriebsversuche und Erfahrungen mit drahtloser Schnelltelegraphie), Fritz Banneitz. Telegraphen- u. Fernprech-Technik, vol. 9, no. 5–6 Aug. 1920, pp. 90–93, 5 figs. Describes arrangement adopted in connection with installation of a new high-speed network by the Nat. Telegraph Administration; and gives results of high-speed tests with the Wheatstone system carried out by the Wireless Service Bur., Berlin, between Berlin and Stettin and between Berlin and Königsberg, from which it is concluded that, with use of described apparatus, a serviceable high-speed connection can be maintained.

Research. Recent Experimental Work in Radiotelegraphy (Neuere Arbeiten aus dem Gebiete der Funkentelegraphie), F. Kiebitz. Telegraphen- u. Fernsprech-Technik, vol. 9, no. 5–6, Aug. 1920, pp. 88–90, 2 figs. Notes on investigations of of the periods; wireless telephony; measuring methods and investigations of coils; reception by means of writing apparatus; etc. Preliminary report from the Telegraph Testing Bur.

Signaling. A New Arc Method for Continuous Waves. Wireless Age, vol. 8, no. 2, Nov. 1920, p. 19, 3 figs. Method of signaling with arc transmitter.

RADIOTELEPHONY

Receivers. Duplex Radiophone Receiver on U.S.S. George Washington, Harold H. Beverage. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 807–812, 5 figs. In arranging for duplex communication between George Washington and land stations, one of major difficulties encountered was prevention of each receiver from being affected by powerful interference of its own transmitter. Problem was solved by separating transmitting and receiving stations distance of four miles. How this scheme worked out for land stations, was modified on board George Washington is described.

Transmitters. Radiophone Transmitter on the U.S.S. George Washington, John H. Payne. Gen. Elec. Rev., vol. 23, no. 10, Oct. 1920, pp. 804–806, 2 figs. With chart showing names and positions of ships which reported hearing radiophone messages from U.S.S. George Washington.

RAILS

Creep of. Rail Creep. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 412–413. Summary of views of prominent engineers on bodily movement of rails in longitudinal direction.

Electric Welding of. See ELECTRIC WELDING, Rails.

Rolling of. Steel Rails from Sink-Head and Ordinary Rail Ingots, George K. Burgess. Chem. & Metallurgical Eng., vol. 23, nos. 19 and 20, Nov. 10 and 17, 1920, pp. 921–925 and 969–975, 8 figs. Nov 10: Experimental investigations of Pennsylvania Railway; Nov. 17: Sink-head ingots are shown to give much more uniform metal than common American types.

RAILWAY CONSTRUCTION

Earth Shrinkage in Fills. Density Tests of Earth Shrinkage in Railway Fills. Eng. News-Rec., vol. 85, no. 17, Oct. 21, 1920, pp. 782–783, 1 fig. Density tests of earth samples made by valuation department of Chicago, Burlington & Quincy Railroad. Density was found to vary according to depth in original excavation.

Shrinkage and Swell of Materials in Railway Fill. Eng. World, vol. 17, no. 5, Nov. 1920, pp. 362–363. Actual measurement taken of many fills. Rock swells, earth shrinks. Carriers' report to Interstate Commerce Commission.

RAILWAY ELECTRIFICATION

Belgium. Railway Electrification in Belgium (Elektrification des chemins de fer de l'état Belge), A. Tétrel. L'Électricien, vol. 51, no. 1261, Oct. 1, 1920, pp. 409–413, 1 fig. Proposed plan.

British. The Electrification of British Railways, Albert H. Bridge. Elec. Rev. (Chicago), vol. 77, no. 18, Oct. 30, 1920, pp. 685–686. Points considered and recommendations made by government committee of engineering and railway experts.

The Electrification of Railways. Elecn., vol. 85, no. 2212, Oct. 8, 1920, p. 421; also editorial comment, pp. 412–413; and also in Ry. Engr. vol. 41, no. 490, Nov. 1920, pp. 453–454 and Tramway & Ry. World, vol. 48, no. 19, Oct. 14, 1920, pp. 226–227. Interim report of Committee appointed by British Ministry of Transport to inquire into certain questions connected with electrification of railways. Committee recommend that future standard system of working electric railways shall be direct current at 1500 volts, but existing 600- and 1200-volt railways may continue in use, their extension being subject to approval of Ministry. (Abstract.)

Japan. Electrifying Japan's State Railways, Ivan F. Baker. Trans-Pacific, vol. 3, no. 5, Nov. 1920, pp. 47–51, 8 figs. Account of progress made, with particular reference to recent projects involving electrification of over 400 miles. Also brief survey of railway electrification developments throughout the world.

RAILWAY OPERATION

Divisional Organization. Railway Operation and Maintenance under Divisional Organization, Alfred Price. Central Ry. Club, Official Proc., vol. 28, no. 3, May 1920, pp. 866–873 and (discussion) pp. 873–894, 1 fig. Scheme of organization of Canadian Pacific Railway.

Increasing Car Service. Increasing the Miles Per Car Per Day, A. G. Smart, J. Burnett, E. H. De-Groot, Jr., F. P. Roesch and A. F. Mercier. Ry. Age, vol. 69, no. 20, Nov. 12, 1920, pp. 824–828. Papers received in contest held by Railway Age on means for increasing the average miles per car per day.

Locomotive Schedules. Economical Operation of Railways (De la reduction du prix de revient dans l'exploitation des chemins de fer), Ulysse Lamalle. Revue universelle des Mines, vol. 7, no. 1, Oct. 1, 1920, pp. 1–45, 7 figs. Organization of service schedule for locomotives.

Supervision. The Problems of the Supervising Officers, Samuel O. Dunn. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 689–691. Their duties

RAILWAY SHOPS

Railroad Shops. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 725–726, 2 figs. It is said important savings are possible by operating brass foundries in conjunction with railroad shops.

Car, N. Y. C. N. Y. C. Steel Car Shop at East Buffalo. Ry. Mech. Engr., vol. 94, no. 11, Nov. 1920, pp. 701–703, 7 figs. Capacity of building is 236 cars.

Tools. Tools from a Railroad Blacksmith Shop, Fred H. Colvin. Am. Mach., vol. 53, no. 18, Oct. 28, 1920, pp. 795–797, 10 figs. Methods of punching, shearing and forming metal.

RAILWAY TIES

Reinforced Concrete. Reinforced Concrete Sleepers—I. Indian Eng., vol. 68, no. 13, Sept. 25, 1920, pp. 179–182. Review of their requirements and their advantages.

Timber. Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers, Hermann Von Schrenk. U. S. Dept. of Agriculture, Bur. of Forestry, Bull. no. 50, 1904, 71 pp. Possibilities of using substitutes for wood for railway ties are discussed, methods of cutting timber ties are surveyed, and modifications in them are recommended, and specifications and classification of ties are suggested.

RAILWAY TRACK

Catchpoints. The Relative Utility of Catchpoints and Buffer Stops. Ry. Gaz., vol. 33, no. 16, Oct. 15, 1920, pp. 510–514, 11 figs. Results of some Great Western experiments in connection with derailing efficiency of various types of catchpoints, and utility of buffer stops as compared with soft banks.

Materials. On the Question of Special Steels (Subject III for Discussion at the Ninth Congress of the International Railway Association), Mr. Sand. Bul. Int. Ry. Assn., vol. 2, no. 9, Sept. 1920, pp. 563–570. Report on the kinds of special steel used for tracks, in particular for rails, switches, single and double crossings, expansion devices at ends of bridges and other parts of track. Data are based on experiences of railways in various countries.

Standardizing Work. Methods of Standardizing Track Work, Earl Stimson. Official Proc. St. Louis Ry. Club. vol. 25, no. 5, Sept. 23, 1920, pp. 55–67. Experience of Baltimore & Ohio Railroad.

Ties. See RAILS; RAILWAY TIES.

Work Records. New System of Track Work Records on St. L.-S. F. Ry. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 949–952, 5 figs. Foremen report time and amount of work in detail classification. Figures extended to cover operating divisions.

RAILWAYS

China and the Orient. The Railways of the Orient, Donald F. McLeod. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 952–955, 2 figs. Rolling stock and construction of roadbed are chiefly of European types. Locomotives and dining and freight cars are mostly of American type.

Location of Industries on Rights-of-Way. Hazards Incident to the Location of Industries on Railroad Right-of-way. Ry. Rev., vol. 67, no. 19, Nov. 6, 1920, pp. 713–715, 1 fig. Discussion of relations between railroads and industries, nature of whose operations are conducive to fire hazard, and forms of agreements that should properly exist between such contracting parties. Paper presented at recent convention of Railway Fire Prevention Association at Baltimore, Md.

REFRIGERATING PLANTS

Ammonia Charge. Behavior of Ammonia in Refrigerating Plants, John H. Ryan. Power, vol. 52, no. 16, Oct. 19, 1920, pp. 613–614, 2 figs. How to find quantity of ammonia necessary to add to charge of running plant.

Electrically Operated. Electrical Refrigeration, C. J. Carlsen. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 502–506, 7 figs. Progress in Chicago and suburbs.

Refrigerating Plant at Los Angeles Wholesale Terminal, C. W. Geiger. Power Plant Eng., vol. 24, no. 22, Nov. 15, 1920, pp. 1059–1061, 5 figs. Refrigerating machinery throughout is operated by electric motors, total of 340 hp. of electric motors operating 175 tons of refrigerating machinery.

RELAYS

Reverse-Power Type. Protective Relays-Reverse-Power Type, Victor H. Todd. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 689–692, 10 figs. Conditions produced in system of parallel feeders when short-circuit occurs and types of reverse-power relays that will operate under these conditions. Both single-phase and polyphase relays are treated of.

RESEARCH

Aircraft. The Present Position of Aircraft Research and Contemplated Developments, E. L. Ellington. Flight, vol. 12, no. 44, Oct. 28, 1920, pp. 1130–1132; also in Engineering, vol. 110, nos. 2859 and 2860, Oct. 15 and 22, 1920, pp. 504–505 and 554–555. Directions in which British Air Ministry expect aircraft engines and accessories to develop, and steps they are taking to bring about developments they require. Paper read before Air Conference London, Oct. 13, 1920.

ENGINEERING INDEX (Continued)

is said to effect 27 per cent saving in material and about 40 per cent saving in labor, and to overcome all the defects originating in the welding together of large plate connections.

SHIPS, CONCRETE

Construction. Notes on Concrete Ship Construction, I. B. McDaniel. Tech. Eng. News, vol. 1, no. 7, Nov. 1920, pp. 2–3, 4 figs. Method used at San Francisco Shipbuilding Co. in construction of two 7500-ton tankers for U. S. Shipping Board.

SHOVELS

Rotary. Clère Rotary Shovel (La pelle mécanique rotative Clère), E. Weiss. Nature (Paris), no. 2423, Sept. 11, 1920, pp. 174–176, 5 figs. Shovel resembling paddle wheel operated by steam and provided with accessories for loading loose materials on railway cars and other similar uses.

SILVER METALLURGY

Recovery from Manganese-Silver Ores. Recovery of Silver from Manganese-Silver Ores, Jay A. Carpenter. Eng. & Min. Jl., vol. 110, no. 19, Nov. 6, 1920, pp. 898–902. Chloridizing roasting followed by cyaniding offers considerable promise on material which cannot be treated by less costly processes. Volatilization and recovery by Cottrell process also being developed.

SNOW REMOVAL

Tests. Snow Removal Tests. Public Works, vol. 49, no. 19, Nov. 6, 1920, pp. 427–429, 2 figs. Experimental tests of New York City Street Cleaning Department.

SPARK PLUGS

Sparking Potential. The Sparking Potential of Spark Plugs. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 864–865, 1 fig. Tests made by engine sub-committee of British National Advisory Committee for Aeronautics.

The Sparking Voltages Between Spherical Electrodes, Alexander Russell. Jl. Instn. Elec. Engrs., (Supp.), vol. 57, part 2, Oct. 1920, pp. 223–230. Formulæ for maximum electric stress between equal spherical electrodes.

SPRINGS

Spiral. Spiral Springs, P. H. Parr. Mech. World, vol. 68, no. 1762, Oct. 8, 1920, pp. 256–257. Formulæ and tables for designing them.

STANDARDIZATION

Revolutions per Minute. The Standardization of the Number of Revolutions (Ueber die Normalisierung von Drehzahlen), Reinhold Rüdenberg. Betrieb, vol. 2, no. 14, Aug. 1920, pp. 352–357, 4 figs. Recommends establishment of a certain series of standard revolution numbers to which the future construction of machines should be limited.

STANDARDS

German N. D. I. Report. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 2, no. 15, Aug. 1920, pp. 373–389, 24 figs. Proposals of the Board of Directors for allowances of standard holes and shafts; machining accuracy of limit gages; cylindrical and conical boring bushes; and disk keys. Proposed standards for determination of hardness according to Brinell's method; set screws and counterborings of splines; and machine-tool handles.

The Standardization of Bores, Wheel Widths and Rounding of Teeth on Change Gears (Normung der Bohrungen, Radbreiten und seitlichen Rundungen an Wechselrädern), H. Toussaint. Betrieb, vol. 2, no. 16, Sept. 1920, pp. 410–411, 2 figs. Report of the working committee for pinions.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie), Betrieb, vol. 2, no. 16, Sept. 1920, pp. 401–409, 12 figs. Proposals of Board of Directors for snap gages, and soft steel pipes for gases and liquids. Proposed new standards for binding screws and for wrench openings.

Hollow Brick. Hollow Brick Standards (Normen für Hohlziegel), L. Schmelzer. Zielgelwelt, vol. 51, no. 29, July 24, 1920, pp. 325–327, 1 fig. Writer refers to his own and K. Dümmler's recommendations for standards.

STANDPIPES

Concrete. Concrete Standpipe for 110 ft. Head at Kansas City, T. D. Samuel, Jr. Eng. News-Rec., vol. 85, no. 18, Oct. 28, 1920, pp. 841–843, 5 figs. With 40 ft. diameter has capacity of 1,000,000 gallons. Top is 134 ft. above ground. Has joint at base.

STEAM ENGINES

Uniflow. The Uniflow Steam-Engine, F. B. Perry. Jl. Inst. Mech. Engrs., no. 6, Oct. 1920, pp. 731–743 and (discussion) pp. 743–764, 20 figs. History, principle of work and details of construction.

STEAM PIPES

High-Pressure. High-Pressure Steam Lines (Beitrag zum Kapitel Hochdruckdampfleitungen), Eduard Kaschny. Der praktische Maschinen-Konstrukteur, vol. 53, no. 35–36, Sept. 2, 1920, pp. 305–313, 9 figs. Discusses movement of gases in pipe lines according to results of various experiments and describes fittings for modern plants. Schematic diagrams illustrating how plant should be constructed with regard to economy and safety of operation. Calculation of diameter of pipe lines, pressure and heat losses, and insulation are carried out with aid of graphic charts.

STEEL

Arc-Fused. Metallography of Arc-Fused Steel, Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan. Chem. & Metallurgical Eng., vol. 23, no. 16, Oct. 20, 1920, pp. 777–782, 38 figs. Various lines of investigations are utilized to support idea that microscopic "plates" existing in fusion welds are due to nitrogen; that plates are very persistent, and are not responsible for low ductility of metallic piece.

Bars, Specifications. Specifications for Steel Bars for Other Uses than the Manufacture of Machine Tools (Cahier des charges pour la fourniture de barres en aciers au carbone autres que les aciers à outils), Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 555–560. Adopted by Commission permanente de Standardisation.

Copper, Developments in. A Review of the Development of Copper Steel, D. M. Buck. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1109–1110. Bibliography of subject. Use of product in steel freight cars. (Abstract.) Paper read before Am. Iron & Steel Inst.

Review of the Development of Copper Steel, D. M. Buck. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, p. 593. Discusses results of various researches since 1900 and advises adoption of copper-bearing steel in other sections than sheets. Bibliography of recent literature.

Elastic Strength. Relative Elastic Strengths of Steel. Can. Engr., vol. 39, no. 18, Oct. 28, 1920, pp. 465–468, 1 fig. Relation of elastic strengths in shear, tension and compression. Guest's law is claimed to be erroneous, and it is held that establishment of correct ratios improves design of structural elements subject to combined stresses.

Electric. Electric Steels, C. G. Carlisle. Eng., vol. 110, no. 2857, Oct. 1, 1920, pp. 456–457. Diagram showing relation of cutting speed to durability. (Abstract.) Paper read before Iron & Steel Inst.

Impurities, Detection of. An Electrometric Method for Detecting Segregation of Dissolved Impurities in Steel, E. G. Mahin and R. E. Brewer. Jl. Indus. & Eng. Chem., vol. 12, no 11, Nov. 1920, pp. 1095–1098, 3 figs. Method developed at chemistry laboratory of Purdue University, Lafayette, Ind., for measuring electrode potential of single grain or microscopic point on metal specimen. Application of method to piece of steel containing segregated ring of ferrite, produced by heating in contact with aluminum bronze, developed that average values for ferrite ring were 0.051 volt lower than for ferrite in unaffected body of steel. This was considered indication of different degree of purity for ferrite under two conditions, and theory is advanced to account for ferrite ring.

Inclusions. Inclusions and Ferrite Crystallization in Steel. II—Solubility of Inclusions, E. G. Mahin and E. H. Hartwig. Jl. Indus. & Eng. Chem., vol. 12, no. 11, Nov. 1920, pp. 1090–1095, 3 figs. Alloys and special steels were turned into small rods and driven into holes in carbon steels, and the whole was then heated to temperatures above transformation range for steel. Section of slowly cooled piece showed in nearly all cases, ferrite segregation around insert. Hypothesis to explain phenomenon is advanced and character of influence of nonmetallic inclusions upon ferrite segregation is discussed.

Notched-Bar Tests. Experimental Study on Impact Tests of Notched Bars (Etude expérimentale sur les essais au choc des barreaux entaillés), André Cornu-Thénard. Revue de Métallurgie, vol. 17, no. 8, Aug. 1920, pp. 536–554, 5 figs. Comparative study of machines and processes. (To be continued.)

Open-Hearth, Basic. High Manganese Iron in Basic Open-Hearth Practice, E. A. Wheaton, Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1112–1114. Paper read before Am. Iron & Steel Inst.

Manganese Iron as Desulphurizer, E. A Wheaton. Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1196–1198. Tests indicate that use of high manganese pig iron enables open-hearth operators to maintain low sulphur content in basic steel. Practice does not reduce tonnage. (Abstract.) Paper read before Am. Iron & Steel Inst.

Making Basic Open-Hearth Steel, F. L. Toy, Iron Trade Rev., vol. 67, nos. 18 and 19, Oct. 28, and Nov. 4, 1920, pp. 1199–1201 and 1275–1277 and (discussion) pp. 1277–1278. Oct. 28: Developments in device and methods for preserving and lengthening life of furnace. Merits of various fuels for melting charges. Efficiency of furnaces; Nov. 4: Working high-sulphur pig iron by use of heavy lime burdens results in an excessive slag volume. Importance of manganese in controlling fluidity and basicity of slag. Pouring temperature discussed. Paper read before Am. Iron & Steel Inst. (Abstract.)

The Basic Open-Hearth Process, F. L. Toy. Iron Age, vol. 106, nos. 18 and 19, Oct. 28 and Nov. 4, 1920, pp. 1116–1119 and 1193–1195. Paper read before Am. Iron & Steel Inst.

Use of High Manganese Iron in Basic Open Hearth Practice, E. A. Wheaton. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 596–598. Paper read before Am. Iron & Steel Inst.

Production in Electric Furnace. Producing Acid Steel Electrically, James W. Galvin and Charles N. Ring. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1130–1132. It is held furnace bottoms should be cup instead of saucer shaped. Effect of melting efficiency of degrees of compactness of scrap charged into furnace is studied.

[See also ALLOY STEELS; STEEL, HIGH-SPEED; NICKEL STEEL.]

STEEL CASTINGS

Heat Treatment. Heat Treatment Improves Castings, Fred Grotts. Foundry, vol. 48, no. 21, Nov. 1, 1920, pp. 859–860 and 881, 14 figs. Strength and elongation of cast-steel tractor parts are improved by quench-and-draw treatment. Danger from hardening cracks eliminated by removing castings from water before entirely cool. Paper read before Am. Foundrymen's Assn.

STEEL, HEAT TREATMENT OF

Automobile Steels. The Heat Treatment of Automobile Steels, R. R. Abbott. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1110–1112, 2 figs. Also Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1202–1203, 2 figs. Calculation of critical temperatures. Classification of automobile steels. Paper read before Am. Iron & Steel Inst.

Crystalline Structure Produced. Critical Heat Treatment After Critical Cold Working of Low-Carbon Steel (Kritische Wärmebehandlung nach kritischer Kaltformgebung von kohlenstoffarmen Flusseisen), A. Pomp. Stahl u. Eisen, vol. 40, nos. 38, 41 and 42, Sept. 23, Oct. 14 and 21, 1920, pp. 1261–1269, 1366–1378 and 1403–1415, 47 figs. 13 on supp. plate. Based on review of literature, a summary of conditions is given under which coarsely crystalline structure is produced in cold-worked and annealed material. Gives numerical data concerning the changes in the tensile-strength properties due to critical heat treatment after critical cold working, based on experiments described.

Dendritic Formation. Dendritic Steel, H. G. Carter. Trans. Am. Soc. for Steel Treating, vol. 1, no. 1, Oct. 1920, pp. 56–61, 10 figs. It is concluded from results obtained in experiments and microscopic examinations of bars that dendritic steel cannot be broken up structurally, and, therefore, stripping a casting while very hot gives rise to dendritic steel, while if casting is allowed to cool slowly dendrites will be broken up. Hot stripping is condemned as very bad practice.

Electric-Furnace. Heat Treating Steel Electrically, E. F. Collins. Foundry, vol. 48, no. 357, Oct. 15, 1920, pp. 826–830, 12 figs. Test data showing heat uniformity of electric furnace. Paper read before Am. Foundrymen's Assn.

Gas-Fired Furnaces. Hardening Steel in Gas-Fired Furnaces, W. A. Ehlers. Sci. Am., vol. 124, no. 18, Oct. 30, 1920, pp. 450 and 460, 3 figs. Details of furnaces.

Gas vs. Fuel Oil. Producer Gas for Heat Treating, Geo. H. Trout. Trans. Am. Soc. for Steel Treating, vol. 1, no. 1, Oct. 1920, pp. 51–55. Results of comparative tests using fuel oil and gas.

Hardening. Recent Processes for the Hardening of Steel and Iron (Neuere Verfahren zur Härtung von Stahl und Eisen), W. Hacker. Metall-Technik, vol. 36, no. 33–34, Aug. 23, 1920, pp. 129–131. Review of important patents and processes during last few years.

STEEL, HIGH-SPEED

Chromium Determination. The Influence of Vanadium on the Determination of Chromium in High-Speed Tool Steel Containing Tungsten (Einfluss des Vanadins auf die Chrombestimmung in wolframhaltigen Schnelldrehstählen), P. Slawik. Chemiker-Zeitung, vol. 44, no. 103, Aug. 26, 1920, p. 633. Results of experiments are said to show that if certain given directions are carried out, determination of chromium need not be affected by the reddish brown coloring frequently observed in the titration of chromium with iron sulphate.

STEEL INDUSTRY

Europe. European Iron and Steel in 1920, H. Cole Estep. Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1204–1210, 8 figs. Two years after war England and continental countries with exception of Germany and Russia are regaining prewar capacity. (Abstract.) Paper read before Am. Iron & Steel Inst.

India. India's Steel Industry Expanding, Charles P. Perin. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1273–1274. Extension and improvements to blast furnaces and mills will guarantee output of pig iron and steel greater than domestic needs. Country may soon place products in markets of world. (Abstract.) Paper read before Am. Iron & Steel Inst.

The Iron and Steel Industry in India, Charles Page Perin. Iron Age, vol. 106, no. 18, Oct. 28, 1920, pp. 1119–1122, 1 fig. Paper read before Iron & Steel Inst.

South Africa. South African Iron and Steel. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 478–480. Possibilities of establishing large iron and steel industry.

Status of. Must Help to Stabilize Business, Elbert H. Gary. Iron Trade Rev., vol. 67, no. 18, Oct. 28, 1920, pp. 1192–1193. Optimistic outlook is made of future developments in steel industry. Tendency, writer says, is towards lower, more reasonable and fairer relative basis. (Abstract.) Presidential address before Am. Iron & Steel Inst.

STEEL MANUFACTURE

Basset Process. Will Exploit New Steelmaking Process, Francis Miltoun. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, pp. 1335. Process for making iron and steel direct from ore using an inclined rotating furnace similar to that employed in manufacture of cement. Process was invented by Lucien Basset and is about to be exploited by French company.

Deoxidizers. New Deoxidizers for Steel Manufacture, J. R. Cain. Chem. & Metallurgical Eng., vol. 23, no. 18, Nov. 3, 1920, pp. 879–882. Report

ENGINEERING INDEX (Continued)

of coöperative investigation sponsored by National Research Council on function and action of deoxidizers, together with experimental work to find low-melting mixtures of scavenging oxides.

[See also ELECTRIC FURNACES, Operating Data; Steel Refining; United Kingdom; IRON METALLURGY, Direct Process.]

STEEL WORKS

Africa. Steel Plants of Africa. Iron Age, vol. 106, no. 20, Nov. 11, 1920, p. 1270. Report on present condition of industry and estimate of requirements.

British. Baldwins, Ltd., Adds New Plant, Joseph Horton. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1133–1138, 20 figs. Self contained unit being completed in South Wales district by British steel syndicate. Parent company, capitalized at $35,000,000 controls works in England, Wales and Canada.

Schneider Works, France. The Iron, Steel, and Engineering Works of Messrs. Schneider and Co. Engr. (Supp.), vol. 130, no. 3377, Sept. 17, 1920, 16 pp., 22 figs. Description of chief works of company in France, particularly works at Creusot and Breuil.

The New Steel Works at Breuil (La nouvelle aciérie du Breuil). Génie Civil, vol. 77, no. 15, Oct. 8, 1920, pp. 285–291, 10 figs. partly on supp. plate. Subsidiary to Creusot works. There are eight furnaces, one acid and 7 basic, five of 50- to 60-ton and two of 25- to 30-ton capacities.

Sheet Mills. Material Handling Equipment is Important Factor in New Sheet Mill, E. L. Shaner. Iron Trade Rev., vol. 67, no. 19, Nov. 4, 1920, pp. 1266–1270, 9 figs. Automatic charging machines for sheet and annealing furnaces, crane equipment and electric tractor and trailer system, at works of Newton Steel Co.

STOKERS

Coking. The "Bennis" Patent Coking Stoker. Practical Engr., vol. 62, no. 1755, Oct. 14, 1920, pp. 250–253, 2 figs. Fuel is fed in bulk at front of moving grate, coking taking place and volatile portions being distilled off, while burning mass is gradually conveyed by mechanical means towards rear of grate.

Forced-Draft. Stowe Forced-Draft Stoker. Power, vol. 52, no. 16, Oct. 19, 1920, pp. 624–626, 5 figs. Type developed by Laclede-Christy Clay Products Co., St. Louis, Mo. It consists of traveling chain-grate elements alternating with stationary tuyères.

STREET RAILWAYS

Cars, Safety. One-Man Safety Car Meeting Approval on Many Canadian Systems. Elec. News, vol. 29, no. 21, Nov. 1, 1920, pp. 41–46, 5 figs. Thirteen towns and cities are operating them wholly or in part. It is said that platform expenses have reduced, accidents are almost unknown, schedule is maintained, and service is satisfactory.

Kansas City, Mo. Rerouting Plan to Save $620,000. Elec. Ry. Jl., vol. 56, no. 19, Nov. 6, 1920, pp. 957–961, 6 figs. Report of consulting engineer on Kansas City railways.

Pavement and Construction. Why Street Railways Should Bear Share of Pavement Cost. Eng. News-Rec., vol. 85, no. 17, Oct. 21, 1920, pp. 795–796. Brief of data from 166 cities gives reasons why two-foot strip outside rails should not be diminished.

Regenerative vs. Pneumatic Braking. Street Railway Braking (Beitrag zur Frage der Strassenbahnbremsen), W. Pforr. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 12, Apr. 24, 1920, pp. 105–108. Refers to articles appearing in preceding volume of same journal on the relative merits of the purely electric brake and the pneumatic brake with regard to efficiency, safety and economy; and presents table giving operating data of the Buenos Aires (Argentine) street railway during the years 1911–1918, collected and compiled by author, demonstrating the satisfactory use of the short-circuit brake.

Track Deformations. The Deformation of Street Railway Tracks Under Rolling Loads (Die Formänderungen des Strassenbahngleises unter der rollenden Last), H. Bloss. Elektrische Kraftbetriebe u. Bahnen, vol. 18, nos. 10 and 11, Apr. 4 and 14, 1920, pp. 81–85 and 93–97, 21 figs. Account of measurements carried out by author in 1913, with description of measuring method and apparatus employed. Notes on deflection of rail and coefficient of ballast; and the internal deformations of track.

Zone Fares. How the Zone Fare Has Made Good at San Diego. Elec. Ry. Jl., vol. 56, no. 20, Nov. 13, 1920, pp. 1009–1012, 5 figs. In spite of low density of population, high mileage of track, large number of private automobiles and decrease in military and naval population, company shows 40 per cent more revenue and 12 per cent more passengers for first nine months of 1920 as against same period of 1919.

SUBMARINE WARFARE

Detection of Submarines. Modern Marine Problems in War and Peace, C. V. Drysdale. Eng., vol. 110, nos. 2858, 2859 and 2860, Oct. 8, 15 and 22, 1920, pp. 484–486, 6 figs., 521–523, 9 figs., and 552–554, 4 figs. Eleventh Kelvin lecture delivered before Instn. Elec. Engrs.

SUBMARINES

Periscopes. The Construction of U-Boats at the Germania Shipyards (Der Bau von Unterseebooten auf der Germaniawerft), H. Techel. Zeit. des Vereines deutcher Ingenieure, vol. 64, no. 43, Oct. 23, 1920, pp. 882–888, 36 figs. Notes on periscopes, with details of various types, including the multiocular, the panorama and zenith periscope. Describes latest development by the C. P. Goerz Corp., the upright periscope, which differs from previous models in that it consists of two tubes, the ocular and objective, and can be rolled in and out without the observer having to change his position according to the height. (Continuation of serial.)

SUBWAYS

Berlin. The Construction of the Berlin Elevated and Subway Line Through Built-Up Sections of the City (Führung der Berliner Hoch- und Untergrundbahnen durch bebaute Viertel). Verkehrstechnik, vol. 37, no. 25, Sept. 5, 1920, pp. 345–350, 15 figs. Describes, among other things, the building of tunnels under existing buildings without interrupting or interfering with their use for office or living purposes. Details of new section under construction in which line is constructed partly as elevated, through a row of buildings and courts, not as open track, but entirely enclosed with walls and roof in order to protect neighboring houses from noise and sight of railway. Abstract of book by P. Wittig, Director of Elevated & Subway Co., Berlin.

New York City. Rapid Transit Plan for New York Proposes 830 miles of New Track. Eng. News-Rec., vol. 85, no. 16, Oct. 14, 1920, pp. 754–757, 1 fig. Report of chief engineer of Transit Construction Committee. Twenty-one subaqeous tunnels and three moving platforms are recommended.

Stations. A Study of Rapid Transit Station Design, Olof A. Nilsson. Eng. News-Rec., vol. 85, nos. 18 and 19, Oct. 28 and Nov. 4, 1920, pp. 824–829, 12 figs., and 894–899, 11 figs. Possibilities for great time saving in platform arrangement. Nov. 4: Good and bad features in arrangement of platforms and street approaches. Dimensions and capacities that have been found satisfactory.

SULPHURIC ACID

Addition Compounds. The Formation of Addition Compounds Between 100% Sulfuric Acid and the Neutral Sulfates of the Alkali Metals, James Kendall and Mary Louise Landon. Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2131–2142, 2 figs. Experimental investigations of means of freezing-point method upon compound formation in systems containing sulphuric acid and anhydrous neutral sulphates of potassium, ammonium, sodium and lithium from eutectic point of each system up to temperature of 300 deg. cent.

Concentration. The Concentration of Sulphuric Acid, S. J. Tungay. Chem. Age (Lond.), vol. 3, no. 70, Oct. 16, 1920, pp. 416–417, 2 figs. Describes more important systems of concentration, and discusses their relative merits as regards durability, economy of working, fuel consumption, and general efficiency.

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TAPS

Square and Acme Thread. The Design of Square and Acme Thread Taps of Steep Lead, E. A. Dixie. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 887–888, 7 figs. Methods of manufacture.

TAR

Removal from Coke Gas. Removing Tar from Coke Gas—V, A. Thau. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, pp. 1331–1335, 10 figs. Rotary tar extractors.

TELEGRAPHY

Research. Report on the Activity of the Telegraph Testing Bureau in the Years 1913–1918 (Bericht über die Tätigkeit des Telegraphen-Versuchsamts in den Jahren 1913–1918). Telegraphen- u. Fernsprech-Technik, vol. 9, no. 5–6, Aug. 1920, pp. 69–85, 11 figs. Report of experimental results of investigations of the dielectric properties of different insulating materials, etc.; the closure of currents; lines and wirings; the technique of telegraphy and telephony; wireless telegraphy; disturbances due to strong current; apparatus; problems of illumination; etc.

TELEPHONY

Automatic. Automatic Telephone Progress. Elecn., vol. 85, no. 2214, Oct. 22, 1920, pp. 466–471, 8 figs. Introduction of panel automatic system into City of London.

High-Frequency. High-Frequency Telephony in Long-Distance Stations (Hochfrequenztelephonie in Ueberlandzentralen), H. Gewecke. Elektrotechnische Zeitschrift, vol. 41, no. 34, Aug. 26, 1920, pp. 670–672, 4 figs. Experiments show that even in the case of serious disturbances in the wiring system, the radio communication can be maintained. Description of first radiotelephonic connection constructed by the Radiotelegraphy Co., Ltd., along the 135-km. high-frequency line Golpa-Rummelsburg, and discussion of relative costs of telephone systems with and without wire.

London System. The Telephone Service of Large Cities, with Special Reference to London, E. A. Laidlaw and W. H. Grinsted. Jl. Instn. Elec. Engrs. (Supp.), vol. 57, part 2, Oct. 1920, pp. 158–188 and (discussion) pp. 188–201, 14 figs. Proposal is made for introduction of "unit of telephone service" as basis of charge made to subscriber. Duration of conversation determines charge.

TELESTEREOGRAPHY

Belin System. Sending Photographs Over Wires, Austin C. Lescarboura. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 474–483–484, 3 figs. Belin system for sending actual photographs over ordinary telegraph wire. Photograph is received on sensitized cylinder. Quivering ray of light, originated by electric current from transmitter, operates at receiving end successively upon all parts of a sensitized paper cylinder, intensity of light varying so as to reproduce photograph.

TERMINALS, MARINE

Portland, Ore. Port Terminal Pier Design at Portland, Ore., G. B. Hegardt. Eng. News-Rec., vol. 85, no. 17, Oct. 21, 1920, pp. 796–797, 1 fig. Considerations which led to adoption of wide piers and handling machinery in new municipal docks.

TERMINALS, RAILWAY

Design. The Grouping of the Rail Lines in Terminal Stations with Through Passage for Trains (Ueber die Gruppierung der Geleise bei Kopfbahnhöfen), Rob. Findeis. Schweizerische Bauzeitung, vol. 76, nos. 14 and 15, Oct. 2 and 9, 1920, pp. 153–155 and 165–167, 10 figs. Theoretical study of possible line arrangements, inspired by the expert testimony of Cauer, Moser and Gleim, relative to the proposed extension of the Zürich main railroad station.

TESTING MACHINES

Transverse Tests on Cast Iron. Develops New Machine for Bending Tests. Iron Trade Rev., vol. 67, no. 17, Oct. 21, 1920, pp. 1139–1140, 1 fig. Hand-operated transverse and bend testing machine actuated by oil pressure. Developed by Alfred J. Amsler & Co., Switzerland.

THERMOCOUPLES

Junctions. The Construction of Thermocouples by Electro-Deposition, Wm. Hamilton Wilson and Miss T. D. Epps. Physical Soc. of London, Proc., vol. 32, part 5, Aug. 15, 1920, pp. 326–340, 15 figs. Method devised to overcome difficulty of making satisfactory soldered joints between elements of thermopiles having large number of closely packed junctions, consists in using continuous wire of one of elements and coating those parts of it which have to form other element with electrolytic deposit of another metal.

THERMOMETERS

Mercury, Standardization of. Standardization of Mercury Thermometers (Normalissierung von Quecksilberthermometern), H. Siebert and Karl Scheel. Zeit. für angewandte Chemie, vol. 33, no. 73, Sept. 10, 1920, p. 216. Recommendations for standardization of ordinary thermometers and the Allihn and Anschütz composition thermometers.

TIDAL POWER

Utilization. Utilization of the Tides (Utilisation des marées) Amiral Amet. Revue générale de l'Électricité, vol. 8, nos. 14 and 15, Oct. 2 and 9, 1920, pp. 445–455, and 483–492, 15 figs. General theory. Coördination of available data. (To be continued.)

TOOLS

Steel, High-Speed. High-Speed Cast Steel Tools from the Electric Furnace, Sterling H. Bunnell. Iron Age, vol. 106, no. 20, Nov. 11, 1920, pp. 1258–1259, 3 figs. Practice of United States High-Speed Steel & Tool Corporation in making tools ready for use in any desired shape.

TOWN PLANNING

France. Reconstruction Progress and City Planning in France, George B. Ford. Eng. & Contracting, vol. 54, no. 17, Oct. 27, 1920, pp. 421–422. Compulsory city planning law in France. Paper read before Am. Soc. for Mun. Improvements.

TRACTORS

Castings. Heat Treating Tractor Castings, Fred Grotts. Iron Trade Rev., vol. 67, no. 20, Nov. 11, 1920, pp. 1346–1348, 12 figs. Research work conducted by Holt Mfg. Co., Peoria, Ill. (Abstract.) Paper read before Am. Foundrymen's Assn.

Manufacture. Operations in Building Tractors. Fred H. Colvin. Am. Mach., vol. 53, no. 20, Nov. 11, 1920, pp. 877–883, 25 figs. Methods at works of C. L. Best Gas Traction Co., California.

Tests. Tractors at the Royal Agricultural Society's Trials at Lincoln. Eng., vol. 110, no. 2858, Oct. 8, 1920, pp. 472–474, 476 and 481–482, 10 figs. Particulars of competing tractors and account of trials.

Tractors Perform Effectively in British Trials, M. W. Bourdon. Automotive Industries, vol. 43, no. 18, Oct. 28, 1920, pp. 856–860, 16 figs. Account of 1920 British tractor trials. There were 46 entries all except two of which were powered by internal-combustion engines.

TRAIN CONTROL

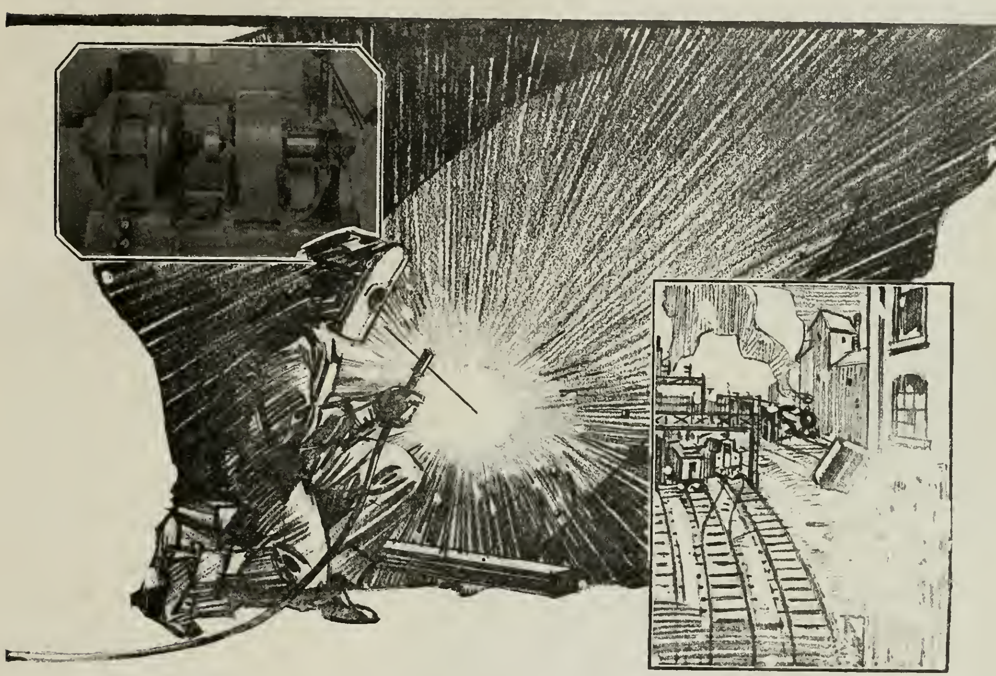
Automatic. Test of Shadle Automatic Train Control. Ry. Signal Engr., vol. 13, no. 10, Oct. 1920, pp. 404–405, 1 fig. Chart showing signal indications for each run as train approaches.

Intermittent-Contact Type. The Bourdette-Brookins Train Control System. Ry. Signal Engr., vol. 13, no. 10, Oct. 1920, pp. 411–413, 7 figs. System is of intermittent electrical contact type.

TRAIN LIGHTING

Lamps for. Essentials of Train Lighting. Bul. Eng. Dept. Nat. Lamp Works, Gen. Elec. Co., bul. no. 10D, Oct. 27, 1919, 16 pp., 13 figs. Sug-

Sometimes the producer is so absorbed with the task of producing, that he overlooks means which might make his plant more productive



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ENGINEERING INDEX (Continued)

gestions as to proper use of Mazda lamps for train lighting. Technical data of lamps.

TRANSPORTATION

Land vs. Water Routes. Comparison of Cargo Transportation by Land and Water Routes, William T. Donnelly. Marine Eng., vol. 25, no. 11, Nov. 1920, pp. 899–803, 5 figs. System for prompt dispatch of cargoes by inland water routes. Fleets of separately propelled vessels travel together in convoy with central electric generating station afloat connected to fleet by cable and with all propellers driven by electric motors. Such a system is found to be more economical than any of land systems.

Steam Vehicles. Road Transportation by Steam-Vehicles, P. W. Robson. Jl. Instn. Mech. Engrs., no. 6, Oct. 1920, pp. 639–661 and (discussion) pp. 661–672, 9 figs. Sees steam motor wagon "as the most economical and reliable form of road transport."

TUBES

Manufacture. Manufacturing Steel and Iron Tubes, H. C. Ebright. Blast Furnace & Steel Plant, vol. 8, no. 11, Nov. 1920, pp. 609–612, 3 figs. Youngstown sheet and Tube Company's method of manufacturing pipe processes used in forming and welding steel tubes. Process of threading, testing and finishing.

Narrow, Riveting. Riveting of Narrow Tubes. Eng. and Indus. Management, vol. 4, no. 15, Oct. 7, 1920, pp. 456–457, 18 figs. Method of riveting narrow tubes from inside. Translated from Luftfahrt, and circulated by British Air Ministry.

TUNNELS

Construction Methods. Tunnels—XXVI. Ry. Engr., vol. 41, no. 489, Oct. 1920, pp. 426–430, 11 figs. Construction methods adopted in Rogers Pass tunnel made by Canadian Pacific Railway in 1913–1915 in British Columbia, and at Twin Peaks tunnel, provided for new highway near San Francisco, Cal.

TURBO-GENERATORS

Small. Small Steam Turbines (Kleindampfturbinen), Werner Bergs. Prometheus, vol. 31, nos. 49 and 50, Sept. 4 and 11, 1920, pp. 385–387 and 395–398, 8 figs. Describes construction by Brown-Boveri & Co. Corp., Mannheim, of small direct-current turbine group for lighting purposes; output: 500 watt, 110 volt, speed 4500 r.p.h.; length, 530 mm.; width, 280 mm.; height, 360 mm.; weight, 75 kg. Details of other BBC small steam turbines for output of 20 to 100 kw., 100 to 500 kw., etc. Points out advantages of small steam turbines in comparison to piston steam engines of the same capacity.

Steel Foundations for. Steel Foundations for 30,000-Kilowatt Horizontal Turbo-Generators, J. R. James. Power, vol. 52, no. 17, Oct. 26, 1920, pp. 646–649, 3 figs. Steel foundations for 30,000-kw. turbo-generators recently installed by Detroit Edison Co. Reduction in weight of about 500 tons was effected, difference in cost was negligible and operation has shown almost no perceptible vibration.

TURPENTINE

Data on. Turpentine: Its Sources, Properties, Uses, Transportation, and Marketing, with Recommended Specifications, F. P. Veitch and V. E. Grotlisch. U. S. Dept. Agriculture, bul. no. 898, Nov. 8, 1920, 51 pp., 7 figs.

V

VACUUM TUBES

See ELECTRON TUBES.

VAPOR PRESSURES

Measurement of. A Method of Measuring Low Vapor Pressures, with Its Application to the Case of Trinitro-Toluene, Alan W. C. Menzies Jl. Am. Chem. Soc., vol. 42, no. 11, Nov. 1920, pp. 2218–2221. Method is outlined by which low vapor pressures may be measured with single McLeod gage.

VENTILATION

Ventilators. Recent Tests on Automatic Ventilators, A. J. Mack. Heat. and Vent. Mag., vol. 17, no. 10, Oct. 1920, pp. 27–29, 3 figs. Results of tests indicated that siphoning ventilators have advantage over non-siphoning types.

[See also HEATING AND VENTILATION.]

VOCATIONAL EDUCATION

Psychotechnical Tests. Fundamental Principles of the Psychotechnical Examination of Industrial Students (Grundsätze der psychotechnischen Lehrlingsprüfung), W. Moede. Werkstattstechnik, vol. 14, no. 16, Aug. 15, 1920, pp. 433–441, 14 figs. Notes on adaptability tests of students and success of such tests at the psychotechnical laboratory of the Charlottenburg High School.

VOLTAGE REGULATION

Step Induction Regulator. The Step Induction Regulator, E. E. Lehr. Elec. Jl., vol. 17, no. 11, Nov. 1920, pp. 510–514, 4 figs. Structural details of apparatus and method of connecting it.

VULCANIZATION

New Process. The New Process for the Vulcanization of Rubber, S. J. Peachy. India Rubber Jl., vol. 60, no. 17, Oct. 23, 1920, pp. 25–26. Cold cure process. It consists in exposing rubber, alone or in admixture with practically any useful filling agent or pigment, successively to action of two gases, sulphur dioxide and hydrogen sulphide. Gases diffuse into rubber and there interacting produce active form of sulphur which is capable of combining with and vulcanizing rubber at ordinary temperature.

W

WAGES

Minimum. Food Requirements and the Minimum Wage. Nature (Lond.), vol. 106, no. 2661, Oct. 28, 1920, pp. 284–286. Based on figures compiled by Food Committee of Royal Society.

WALLS

Concrete. A New System of Hollow Concrete Wall Construction, Charles Alma Byers. Building Age, vol. 42, no. 11, Nov. 1920, pp. 31–32, 3 figs. System designed and patented by Charles B. Harp, construction engineer of Los Angeles, California. Walls are erected with pre-cast concrete slabs which are set edgewise in two tiers to form continuous air space.

WARSHIPS

Cruisers. The Light Cruiser Raleigh. Engr., vol. 130, no. 3381, Oct. 15, 1920, pp. 374–375, 1 fig. Characteristics: Length overall, 605 ft.; extreme breadth, 65 ft.; mean draft, $17^1/_4$ ft.; displacement, 9750 tons; horsepower, 70,000; speed, 31 knots; armament, seven $7^1/_2$-in. and twelve 12-pdr. guns, and six torpedo tubes.

Ex-German. The Ex-German Battleship Baden. Engr., vol. 130, no. 3379, Oct. 1, 1920, pp. 319–322, 13 figs. partly on supp. plate. Structural details.

Superdestroyers. The "Super-Destroyer," Hector C. Bywater. Sci. Am., vol. 123, no. 19, Nov. 6, 1920, pp. 472 and 482, 2 figs. Functions of flotilla leader as contained in recommendations made by General Board of U. S Navy for building program of 1921.

WATER FILTRATION

Research. The Rapid Filtration of Water, Alexander C. Houston. Engr., vol. 130, no. 3375, Sept. 3, 1920, pp. 218–220, 3 figs. Thirteenth Research Report issued by director of Water Examination of Metropolitan Water Board, London. It is principally concerned with question of how far rapid filtration of stored river water is capable of producing supplies which are safe and suitable for human consumption.

WATER HAMMER

Metallic Conduits under Pressure. Study of Water Hammer in Metal Conduits under Pressure (L'étude des coups de bélier dans les canalisations métalliques sous pression), C. Camichel and D. Eydoux. Houille Blanche, vol. 19, no. 43–44, July-Aug. 1920, pp. 127–131, 3 figs. Formulæ for determining velocity of transmission, pressure exerted, etc., and graphs indicating transmission of water hammer. (Continuation of serial.)

WATER GAS

Automatic Controller. Ensuring a Constant Quality of Water Gas. Gas World, vol. 73, no. 1891, Oct. 16, 1920, pp. 297–298, 1 fig. Automatic controller manufactured by Davison and Partner, London, England.

WATER METERS

Design. Defects in Current Meters and a New Design, Samuel Fortier and E. J. Hoff. Eng. News-Rec., vol. 85, no. 20, Nov. 11, 1920, pp. 923–924, 2 figs. Meter developed to meet requirements of relatively low velocities and small channels.

WATER POWER

Federal Power Commission. Commission Drafts Its Rules. Bul. Water Power League of America, vol. 1, no. 2, Aug. 1920, pp. 9–14. Rules and regulations which will govern work of Federal Power Commission created under Federal Water Power Act.

Palestine. Production of Electricity in Palestine by Utilizing Water of Mediterranean Sea (L'elettrificazione della Palestina), A. Gradenwitz. Industria, vol. 34, no. 10, May 31, 1920, pp. 270–271, 2 figs. Level of Mediterranean is 1297 ft. above that of Dead Sea. Their nearest distance apart is less than 43 miles. A tunnel along this line is proposed.

Resources in U. S. Development of National Water-Power Resources, C. D. Wagoner. Elec. Rev. (Chicago), vol. 77, no. 19, Nov. 6, 1920, pp. 717–720, 3 figs. Analysis of developed and undeveloped water powers in U. S.

South America. Electrical Possibilities in South America, Verne Leroy Havens. Elec. World, vol. 76, no. 15, Oct. 9, 1920, pp. 729–730. Opportunities for water power development. Operating difficulties and how they are overcome.

United States. Potential Water Powers. Bul. Water Power League of America, vol. 1, no. 1, July, 1920, pp. 5–6 and 24. Total possible water developments on the 4325 miles of river channels included in present navigation projects over which Federal Government retains jurisdiction for navigation purposes, are estimated to amount to at least 10,200,000 hp.

WATER SUPPLY

Cleveland. Planning the Future of the Cleveland Water Supply, A. V. Ruggles. Eng. News-Rec., vol. 85, no. 19, Nov. 4, 1920, pp. 886–889, 4 figs. Methods followed lead to $30,000,000 program by 1940 delivering 430,000,000 gallons daily from four intakes of which two will be new.

WATER WORKS

Cost-Plus Contracts. Cost-Plus Contracts for Water Works Construction, George W. Fuller. Jl. Am. Water Works Assn., vol. 7, no. 5, Sept. 1920, pp. 683–692. It is held that cost plus contracts, with proper provision for accounting and suprvision, may be satisfactory where conditions are not definitely known and in case of private corporations where well qualified contractors may be selected to work under adequate supervision. Under war conditions, it is said, cost-plus contracts were necessary and even now have many advantages.

WATERWAYS, INLAND

Reconstruction. The Reconstruction of French Inland Waterways (Pour la reconstruction de notre réseau navigable), J. Bondet. Vie Technique & Industrielle, vol. 1, no. 12, Sept. 1920, pp. 463–472, 7 figs. Method of "isolated sections" for reconstructing waterway without interrupting traffic. Special portable dams are firmly placed about 600 ft. apart; water is pumped out from section thus isolated and work required performed over night. Method was invented by Enterprise Fougerolle and is said to have been applied successfully by them in various enterprises.

WAVE POWER

Wave-Motion Turbine. Wave-Motion Turbine, Arthur Palme. Power, vol. 52, no. 18, Nov. 2, 1920, pp. 700–701, 4 figs. Scheme for utilization of wave motion, in operation for some time at Royan, France.

WELDING

Steel, High-Speed. The Welding and Brazing of High-Speed Tool Steel with Carbon-Steel (Verschweissen und Verlöten von Schnelldrehstahl mit Kohlenstoffstahl), Rudolf Schäfer. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 32, Aug. 6, 1920, pp. 241–244, 6 figs. Sets forth relative merits of welding and brazing It is shown by numerous examples that a perfect adhesion of high-speed tool steel points to carbon-steel shanks can be effected by welding or brazing and that the electric welding process is most advantageous.

[See also AUTOGENOUS WELDING; ELECTRIC WELDING; ELECTRIC WELDING, Arc; ELECTRIC WELDING, Resistance; OXY-ACETYLENE WELDING.]

WELDS

Tests. Testing Steel Plate Welds. Iron Age, vol. 106, no. 20, Nov. 11, 1920, p. 1265. Methods for quickly determining general character of work. (Abstract.) Paper read before Am. Welding Soc.

Testing Welds, S. W. Miller. Acetylene Jl., vol. 22, no. 5, Nov. 1920, pp. 258–263 and p. 295, 26 figs. Also Welding Engr., vol. 5, no. 10, Oct. 1920, pp. 26–36, 26 figs. Methods of testing. Paper read before Am. Welding Soc.

WIND TUNNELS

Germany. Report on German Wind Tunnels and Apparatus, Edward P. Warner. Aerial Age, vol. 12, no. 10, Nov. 15, 1920, pp. 275–277, 2 figs. Description of wind tunnels at Göttingen, Aachen, Dessau and Friedrichshafen together with methods of operation and details of apparatus used. (To be continued.) Report of Nat. Advisory Committee for Aeronautics.

Resistance Equation. Air Forces on Circular Cylinders, Axes Normal to the Wind, with Special Reference to Dynamical Similarity, Hugh L. Dryden. Sci. Papers, Bur. of Standards, no. 394, Sept. 4, 1920, pp. 489–519, 10 figs. Experimental study of general wind tunnel resistance equation.

WIRING

Earthing. Earthing. Jl. Instn. Elec. Engrs., vol. 58, no. 292, June 1920, pp. 468–475 and (discussion) pp. 476–490, 4 figs. Report of earthing sub-committee of Wiring Rules Committee, appointed to "consider the whole question of earthing, including the time element of circuit-breakers, the heating of conductors, the current-carrying capacity of the apparatus earthed, the drop of pressure in metal sheathing, and the number of earth wires required."

WOMEN WORKERS

Management of Women. The New Place of Women in Industry—II, Ida M. Tarbell. Indus. Management, vol. 60, no. 5, Nov. 1920, pp. 329–330. Discusses successful utilization of women workers.

WOOD PRESERVATION

Charring. Charring Does not Preserve Wood. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 108, 1 p. Tests showed that charring deep enough to resist decay would undoubtedly weaken post of ordinary size.

Preservative Treatment. Water Solubility a Necessary Property of Wood Preservatives. Forest Products Laboratory, Technical Notes, Oct. 15, 1920, no. 114, 1 p. That any substance to be effective wood preservative must be soluble in water at least to extent of producing toxic water solution is basis of theory now being developed at U. S. Forest Products Laboratory.

WORKMEN'S COMPENSATION

U. S. and Canadian Laws. Comparison of Workmen's Compensation Laws of the United States and Canada up to January 1, 1920, Carl Hookstadt. U. S. Dept. of Labor, Bur. of Labor Statistics, no. 275, Sept. 1920, 140 pp. Covers all laws enacted up to January 1, 1920.

MECHANICAL ENGINEERING

Volume 43 February, 1921 Number 2

Engineering in the Woodworking Industries

A Group of Papers Presented at the Annual Meeting of the A.S.M.E. Dealing with Furniture Manufacture, Freight-Car Construction, Machining of Railroad Cross-Ties, Wood-Block Floors, Wood Preservation, and Electrically Driven Sawmills

ONE of the most enthusiastic sessions held during the last Annual Meeting of The American Society of Mechanical Engineers was that on Forest Products, under the auspices of the newly formed Committee on Woodworking composed of Thomas D. Perry, Chairman, C. E. Paul, and Grant B. Shipley. As a result of the interest aroused by the session a petition was addressed to the A.S.M.E. Committee on Professional Sections requesting the formation of a Forest Products Section which might coöperate with similar organizations to the mutual benefit of the various woodworking industries.

As a general introduction to the session Frederick F. Murray, director of the department of mechanical engineering of the staff of *Lumber*, presented a strikingly interesting photographic study of the methods employed in logging and in the manufacture of lumber. This covered in brief form the various steps in logging and in the production of lumber at the mill. He also touched upon the utilization of wood waste. A selection of the photographs shown by Mr. Murray, tracing the steps of production from the cutting of the tree in the forest to the storing of the finished product in the lumber yard at the mill, ready for shipment, is given on this and succeeding pages in Figs. 1–27.

Following Mr. Murray's study the six papers scheduled for the session were presented. The first of these papers, Engineering in Furniture Factories, by B. A. Parks, pointed out some of the influences which have militated against the development of the woodworking industry and discussed the general principles involved in the design and layout of a new furniture-manufacturing plant. The Use of Wood in Freight-Car Construction, by H. S. Sackett, considered the relative values of steel and wood as materials for the construction of freight cars. Machining Railroad Cross-Ties, by D. W. Edwards, described the machines employed and processes followed in the machining of ties by trimming, adzing, boring and branding. Creosoted Wood-Block Factory Floors, by Lambert T. Ericson, described methods which will permit engineers to specify and build creosoted wood-block floors without entailing any risk of their failure. Processes and Equipment Used in Wood Preservation, by E. S. Park, dealt briefly with the different processes of pressure treatment. Electrically Driven Sawmills, by Allan E. Hall, set forth the advantages of motor-driven mills. Abstracts of all of these papers follow.

Photo by *Lumber*, weekly, St. Louis, Mo

Fig. 1 From Forest to Finished Product—The First Step. No Mechanically Operated Device has yet Superseded the Hand Saw for Felling the Larger Trees

ENGINEERING IN FURNITURE FACTORIES

By B. A. Parks,[1] Grand Rapids, Mich.

THE woodworking industry is one of the oldest industries extant, and yet it has shown the least development and has been the slowest to adopt modern principles of manufacturing of any industry of which the writer has knowledge. There are several causes for this condition, the most important of which are the general lack of accurate cost data and the absence of technically trained men in the executive positions.

In several plants which have come under the writer's notice, only such repairs have been made as were necessary to avoid actual breakdowns, and machinery, power-plant equipment, lighting, heating, drying, sanitary facilities, etc., have been entirely inadequate and inefficient and would not be tolerated in even the average modern plant of most other industries. Also in the several woodworking and furniture-manufacturing plant organizations that have come under the writer's observation, he does not recall a single man with a technical education or training.

This lack of engineering ability in the furniture-manufacturing organization shows its effect throughout the entire plant; in fact, the writer is convinced that the average manager of a furniture plant is more interested in marketing his product than in manufacturing it.

The efficiency of any general plan for a furniture-manufacturing plant, or in fact any industrial plant, may be measured by the degree in which the following requirements are fulfilled:

(*a*) Provision for proper arrangement of the necessary machinery

[1] Mechanical Engineer, Byron E. Parks & Son, Assoc.-Mem.Am.Soc.M.E.

(b) Provision for receiving, handling, storing, and transporting material

(c) Provision for extending the plant and increasing manufacturing facilities without serious disturbance to the original plant or manufacturing routes

(d) Provision for generation and transmission of power, light and heat

(e) Provision for fire protection

(f) Provision for comfort and accommodation of employees.

Location

The importance of the location and arrangement of a furniture factory has not generally received the attention their economic value should dictate. The furniture industry, the same as other industries, has tended to concentrate in given localities, as, for example, Grand Rapids, Mich. This concentration was originally due to nearness to the raw-material supply. As the number of plants multiplied a good supply of skilled labor has accumulated, so that now, even when Grand Rapids is not so well situated as other centers as regards nearness to raw-material supply, the labor market as well as a certain reputation attaching to Grand Rapids product has tended to increase the number of furniture-manufacturing plants in spite of the fact that, theoretically at least, other centers would be more desirable from most standpoints. In general, however, the location of a furniture plant, as for most other types of manufacturing, will be dependent on the following considerations:

(a) Transportation facilities for both raw material and finished product

(b) Availability of raw materials and manufactured parts obtained from other industries

(c) Labor supply

(d) Financial considerations

(e) Civic or municipal aids or restrictions to manufacturing.

Provision for Proper Arrangement of Machinery

Making provision for the proper installation and arrangement of the necessary tools and machinery presupposes that the kind, quantity, and quality of the product have been decided upon and that due and proper care has been given to the selection of the machinery required in the manufacture of this product. Naturally the first consideration is the location of the lumber yard and dry kilns in relation to the incoming lumber to the factory. The location of the lumber yard will of course depend on the arrangement of railroad sidings. Several different plans for location of sidings may be possible for any given site and the most efficient layout can be determined only by close study of the factors entering into any given situation.

After deciding on the location of lumber yard and kilns this will ordinarily determine the point of entrance for the raw lumber into the proposed plant, and the next procedure will be to make a routing chart and thus establish the amount of floor space required for manufacturing purposes.

Having determined the entry point for the raw material, consideration should be given to each factory operation with the sequence required for manufacturing the product. The routing chart should list each separate part entering into the finished product, with the proposed volume of manufacture per unit of time, say, one year, and the sequence of operations required. Such a routing chart giving the sequence of operations will establish in a general way the sequence or arrangement of the various tools and machines throughout the plant.

After a tentative arrangement of the equipment has been completed a careful study should be made of how the product is to be transported from machine to machine, making proper provision for aisleways and location of trucks at machines to allow of efficient handling of material in and out of machines. The final arrangement will determine the amount of floor space required for machine rooms, and careful consideration should then be given to the location and size of store rooms, assembling, finishing, upholstering, crating, and shipping departments, factory offices, toilets, locker rooms, etc. With the approximate total amount of floor space decided upon, a tentative layout of the building may be made. The product of a furniture factory being comparatively light in weight, and consequently easily transported [illegible] ing will in most cases be found the most eco[illegible] points, although four or five stories in height [illegible] the limit. The various departments may [illegible] machine room and shipping department on [illegible] tional machine room if required on the second [illegible] finishing and upholstering departments on [illegible] being exercised to so arrange the various [illegible] flow of product may be as direct and unin[illegible] through each department and then on to the [illegible]

Upon completing the arrangement of the [illegible] the next problem will be one of transportatio[illegible] departments on the different floors, which is ac[illegible] by means of elevators. In connection wit[illegible] problem, thought should be given to the possi[illegible] conveyors, or small elevators from one dep[illegible] thus establishing more direct paths of flow th[illegible] by using the main elevators and also reduci[illegible] amount of handling required.

The floor space and general arrangement of the main manufacturing building having been determined, the next decision to be made is the type of construction to use. This is somewhat limited to materials available, although in most centers where a furniture factory is likely to be built the ordinary forms of construction such as reinforced concrete, slow-burning mill, or steel frame, will be found applicable. Reinforced concrete is rapidly coming into use as one of the most economical types of construction, when all factors are considered, and yet the writer regards the slow-burning, heavy-mill type of construction as particularly adaptable to a furniture factory.

Provision for Handling and Transporting Material

One of the most important problems confronting the furniture manufacturer is the receiving, handling, storing, drying, and transporting of the raw material, namely, lumber. Much thought and study should be placed on the arrangement of sidings, storage yards, dry kilns, cut-off saws, etc., as an efficient layout will pay for its development many times over in decreased labor and saving in time.

The lumber storage yard should be large enough to at least hold a year's supply in order that advantage may be taken of favorable market conditions. The storage yard should also be equipped throughout with industrial trackage laid parallel with the receiving siding. This trackage system should be served by at least two transfer tracks running at right angles to the receiving siding. With this arrangement lumber is unloaded and sorted directly on small lumber trucks or "bunks" of the ordinary kind and then by means of the transfer tracks the truck loads, containing about 4000 ft., are placed in storage ready to be taken to the kilns for drying.

The type of kiln used will depend on the thickness and kind of stock to be used. A dry-storage shed equipped with industrial trackage is also valuable as it allows for an accumulation of dry material and thus avoids delays in receiving lumber at the cut-off saws which might be occasioned by accidents to the kilns, stock spoiled in process of drying, or other delays between the kilns and the mill.

The same system of transfer tracks that serves the storage yard and kilns should be extended to the cut-off saws, where there should be provided hydraulic or screw lifts or elevators to raise the entire load of lumber and keep the top of the pile a few inches above the tops of the saw tables. It will be seen that with the above arrangement the lumber is not handled from the time it leaves the railroad car until it is placed on the table of the cut-off saw, and the consequent decrease in handling costs is at once apparent.

While the receiving and handling of the lumber should probably receive the greatest consideration in laying out the transportation facilities to and from the plant, yet railroad sidings to the power plant, for the delivery of machinery and coal, and to the shipping room for shipping the finished product, should not be overlooked but should receive thoughtful study.

Provision for Generation and Transmission of Power, Light, and Heat

On account of the large amount of refuse from most furniture

Photos by *Lumber*, weekly, St. Louis, Mo.

Figs. 2–7 From Forest to Finished Product—Getting the Logs out of the Forest

Fig. 2—Douglas fir in the State of Washington, showing characteristically rugged surroundings. Fig. 3—Logging railroad penetrating forest in wake of surveyor's transit. Fig. 4—Special construction cars for placing of ties and laying of rails. Fig. 5—Logs being dragged in by overhead cableway system. Note loading boom to left of mast and way in which entire machine to right is jacked up so empty log cars can pass under. The empty cars are run in and the first one is loaded, when the loader itself pulls out the next car, and so on until the load is completed. This is one of the many applications of the "sky line" method. Fig. 6—Crawler-type tractor, capable of doing work of 16 or 18-mule team, and also of working in soft ground. Fig. 7—Heavy-duty truck and two-wheel pole trailer used extensively in western motor-truck logging, showing characteristic load of about 3000 ft., log scale, and weighing from 4½ to 5 tons.

factories, which is available for fuel, it follows without much argument that in by far the majority of cases it will pay to erect an isolated power plant, unless capital is limited or the plant be very small.

The first decision to be made in starting the power-plant design is the method of transmitting power to the various machines in the factory. In by far the majority of cases the most efficient method of transmitting power from the prime mover to the principal machines in small and medium-sized plants is by means of shafting, pulleys, and belts. Electric individual or group driving of machinery is unquestionably the best and most economical where machinery is widely scattered, or where some of the machinery is operated only part time, but where most of the machinery may be arranged in one department and the majority of it is operated at all times, the initial expense and overall efficiency of driving from lineshafting take precedence over those of electric drive.

Upon deciding on the method of transmitting power to the various machines the next step will be to select the proper type and capacity of prime mover. The load factor in most furniture plants will average from 75 to 80 per cent of the connected load. An estimate must then be made of the power consumed by power-transmission equipment, consisting of shafting and belts or electric drives, and by adding the connected load, corrected for load factor, plus an allowance for mechanical efficiency of the prime mover, the indicated-horsepower capacity required to furnish the plant with power may be determined. The electric load and lineshaft load should of course be kept separate in order to determine the generating capacity required, also the electric lighting should be laid out and proper allowance be made both in the generator and prime mover.

The low-pressure steam requirements for dry kilns, heating, etc., should be determined and a curve drawn showing the average demand for low-pressure steam throughout the year. Assuming a steam consumption of 26 or 27 lb. of steam per indicated horsepower per hour for the ordinary Corliss type of engine and that 85 per cent of the exhaust will be available for heating and drying purposes, a curve should next be drawn showing the average available exhaust steam for the various months of the year, and upon comparing the two curves it will be seen at a glance during which periods of the year the heating and drying demands exceed the exhaust from the engine, or vice versa.

In most furniture plants the exhaust from the engine will exceed the requirement for low-pressure steam during the summer time and it therefore becomes a question as to how valuable this excess of exhaust steam is and how great an investment is warranted in cutting it down to the minimum. From a knowledge of the total steam requirements of the plant the amount of fuel required can be calculated, assuming that 20 to 25 per cent of the lumber cut finds its way to the boiler room as refuse or waste, and that the fuel value of the wood is about 20 per cent of that of the average bituminous coal, weight for weight. It is then a simple calculation to determine the cost of evaporating the excess of exhaust steam during such periods of the year as this excess exists. Any saving effected by reducing the amount of the excess exhaust steam, which would go to waste, should not only pay all fixed charges on any investment made to reduce this excess, but should also pay a return of at least 20 per cent per year on this additional investment. The type of engine best suited for driving a lineshaft load where efficiency, economy and continuous operation are permanent considerations is probably the slow- or medium-speed releasing-gear simple Corliss engine or the poppet-valve engine, which latter is similar in most respects to the Corliss except in the valve gear.

In choosing boilers for the plant the capacity required may be determined from the total steam demand, adding an allowance of 10 to 15 per cent for pumps and other incidental uses throughout the plant. By dividing the total maximum boiler capacity required into at least three units it will always be possible to operate the plant on two boilers, for even with a maximum demand for steam two boilers will carry the plant by operating at 150 per cent of rating.

The location and arrangement of the power plant are important as regards the economical transmission of power to the factory and the allowance for increase in capacity. Where lineshaft drive is used the power plant is located in a separate building, preferably near the center of the main lineshaft, though of course within easy driving distance from engine shaft to main recei ing shaft. This location of power plant is also fairly near the cen of distribution for steam and electric current.

The utilization of the factory waste or refuse so as to obtain the maximum fuel value is another problem which should receive its fair share of thought and study. Of course, shavings and sawdust from the various machines will be handled by an exhaust system to a separator on the boiler-house roof and then spouted to the boilers or shavings vault. In most plants the cuttings and culls are collected in push carts by a crew of men and wheeled to the boiler house where they are fed to the furnaces by hand. The above method of handling this part of the refuse is not only expensive from the standpoint of handling cost, but the full value of the refuse as fuel is not realized due to the manner of firing. The installation of a few small "hogs" or chippers, at convenient points in the plant where cuttings collect, discharging into the regular exhaust system will in many cases be found to be a paying investment. The power consumption is considerable and a certain amount of maintenance is required, but these disadvantages will frequently be found to be outweighed by the decreased labor cost and the increased efficiency obtained in burning the fuel.

Another improvement in the handling of refuse is in regard to feeding the excess shavings and sawdust which ordinarily are allowed to collect during the day in a so-called shavings vault. In most plants the contents of the shavings vault must be fed to the furnaces with a shovel, which is not only laborious but prevents the full fuel value being realized. In the design of a power plant for a woodworking factory for which the writer was partly responsible, overhead bins were installed instead of the customary shavings vault. These bins fed by gravity to a short length of screw conveyor discharging into the furnace fronts, a separate conveyor being provided for each boiler. The speed of the conveyors could be varied by means of a friction drive, thus allowing the quantity of shavings and sawdust fed to the furnace to be regulated in accordance with the load on the boiler.

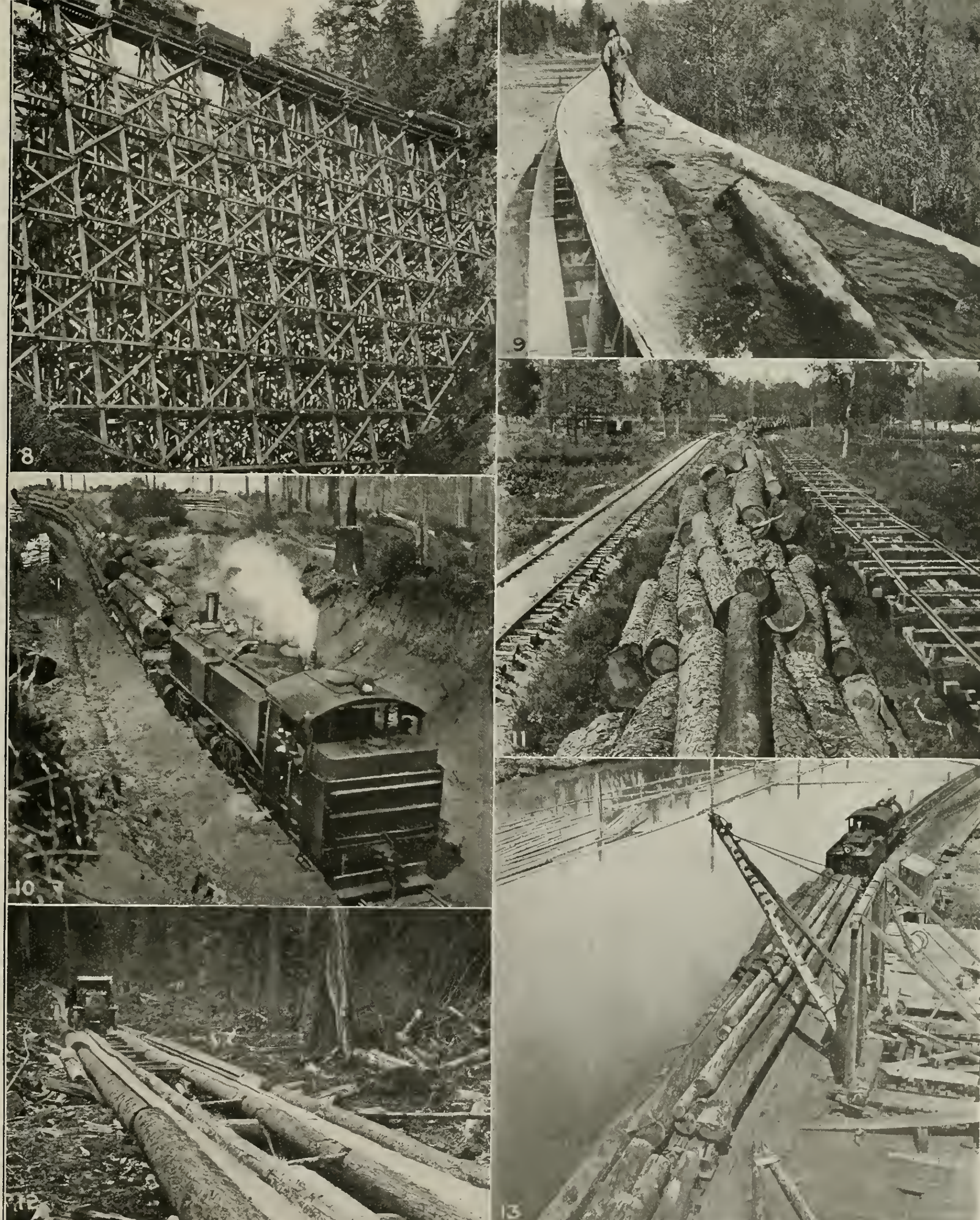
Fire Protection

In a woodworking establishment the fire hazard is naturally much greater than in a metal-working plant, consequently more than ordinary care should be exercised in decreasing the fire hazard to a minimum and preventing the spread of fire in case it does start. Buildings should probably not exceed 250 to 300 ft. in length without dividing them by suitable fire walls at least 17 in. thick, and extending well above the roof line. Finishing and upholstering departments should if possible be isolated from the rest of the plant by fire walls, and if they are on upper floors and any great distance from stairways, outside fire escapes should be provided.

All stair wells and elevator shafts should be enclosed in fireproof towers, and to make fire walls and fireproof towers effective all openings should be fitted with automatic fire doors. It is also well to note that all stairs should be of non-combustible material so they cannot be destroyed in case fire is communicated to the stair well itself. All sash should be steel and the windows opposite adjacent buildings, where buildings are 30 ft. apart or less, should be glazed with wire glass. It almost goes without saying that a good sprinkler system should be installed throughout the entire plant with plenty of yard hydrants and a good supply of fire hose. All motor-control switches should be enclosed in steel boxes so arranged that the box cannot be opened when the switch is closed. All switches for motors driving spray-booth fans, or for motors in other locations where inflammable gas or dust is prevalent, should be of the remote-control type enclosed in tight steel or iron cases, with a push button near the booth or other machine. Spray-booth fires are a constant source of danger and the method above mentioned of controlling the fan motors is well worth the investment required.

Proper Accommodation for Workers

Under accommodations for workers may be included the lighting, heating, toilet, and locker-room arrangements of the plant. The day of the dark, poorly heated and ventilated factory building with inadequate and unsanitary toilet facilities is past, for the simple reason, if for no other, that any self-respecting man will



Photos by *Lumber*, weekly, St. Louis, Mo.

FIGS. 8–13 FROM FOREST TO FINISHED PRODUCT—TRANSPORTING THE LOGS TO THE MILL

Fig. 8—Trestle on logging railroad in Oregon. The structure is 525 ft. long, 160 ft. deep and contains about 800,000 board feet of lumber. The bents are spaced on 15½-ft. centers and supported on some 300 piles driven to a penetration of about 30 ft. Fig. 9—Flume for carrying logs. Flume tender inspecting flume for log jams and leaks. Fig. 10—One of the best examples of modern logging locomotives, privately owned: a 100-ton Mallet with compound cylinders, 12 drivers, and oil burners. Operates over severe sections containing 5½ per cent grade and 26-deg. curves. Fig. 11—A southern log train being made up. The completed train consists of 52 cars for a 20-mile haul to the mills. Fig. 12—A hewn-timber road constituting a logging route for heavy-duty motor trucks, a practice developing for operation where the expense of railroading is not justified. Fig. 13—Logs awaiting unloading at the log dump. The load consists of full-tree-length logs as carried by disconnected log bunks, forward four-wheel truck and rear four-wheel truck having no connection other than the logs themselves.

Photo by *Lumber*, weekly, St. Louis, Mo.

Fig. 14 A City of Lumber and Shingle Mills. Lumber Brought in in Form of Great Log Rafts

not work under such conditions. Bright, cheerful surroundings, comfortably heated and well ventilated, are no longer regarded as an expense by the modern executive but as an investment which pays large returns in increasing production and quality of product, decreasing labor turnover and promoting contentment and loyalty among the employees.

The far-too-usual method of providing a drop cord with a bare lamp over each machine or at each workman's bench with a few thrown in for general illumination should not be tolerated in this day and age when good, efficient fixtures may be had at such reasonable cost. Where walls and ceilings are painted white with some good industrial enamel, efficient lighting may be obtained through a proper selection of reflectors or fixtures at a comparatively small cost in power consumption.

With regard to heating, probably the most ideal system is the hot-blast, for such a system provides adequate ventilation as well as heat and in the summer time may be used to cool the air introduced into the factory by circulating cold water through the heating coils.

The toilet and locker rooms should be centrally located with regard to the building or floors which each serves, and preferably placed in a service wing, as already mentioned. By so locating these features valuable manufacturing space is not taken up and good light and ventilation may be obtained. Washing facilities should preferably consist of enameled roll-rim cast-iron sinks with no stoppers in the waste. Such equipment has the advantage that it is easier to keep clean than individual wash basins and forces the men to wash in running water, an important point in preventing the spread of disease. Every man in the plant should be provided with a pressed-steel locker where he may change his clothes, and the addition of a few showers and a comfortable, well-lighted room where the men can eat their lunches will be found to be not only conveniences provided by a generous management, but features which add still more to the contentment and loyalty of the men.

As mentioned before, these few notes are not intended as a treatise on the design of a furniture factory, but merely as a brief discussion of some points which the writer feels are worthy of serious consideration. The many factors affecting the design and construction of a plant are so important in their bearing on the final overall efficiency of the plant, that the problem is quite properly one for none but an experienced engineer.

Photo by *Lumber*, weekly, St. Louis, Mo.

Fig. 15 An Electrically Operated Mill on the Pacific Coast

Note concrete power house and stack; log-washing device to the left; dome-shaped refuse burner to right of stack.

THE USE OF WOOD IN FREIGHT-CAR CONSTRUCTION

By H. S. Sackett,[1] Chicago, Ill.

The fact that over two billion feet of lumber and timber are used annually in the United States for the maintenance of freight equipment and for the construction of new cars, representing an annual outlay for material alone of over $50,000,000, is ample evidence of the importance of wood in this big industry.

In the construction of the first cars wood was almost universally used for all parts, except of course the running gear. Within the

[1] Asst. Purchasing Agent, Chicago, Milwaukee and St. Paul Railway Company.

Photo by *Lumber*, weekly, St. Louis, Mo.

Fig. 16 Typical Large Sawmill Plant Including Dry Kilns, Planing Mill and Covered Storage

past decade, however, with the introduction of heavy motive power—which spells long and heavy trains—it has been found that wood is no longer capable of withstanding the heavy shocks incident to such operations, and it is generally conceded by all car builders that the freight car of the future must have a steel underframe and steel draft rigging.

This limits the use of wood to unimportant parts of the underframe, such as intermediate sills and cross-beams, and to the superstructure of the car. In the case of open-top cars this means only posts and side and end plank and decking, but in box, stock, and furniture cars, etc., it means also siding, lining and roofing.

Steel vs. Wood for Open-Top Cars

To take up the question of open-top cars first, statistics gathered by operating officials of some of the large railway systems seem to indicate that the cost of maintaining steel gondola cars over a period of years is greater than for composite (wooden and steel) cars of the same type. The data[1] collected show that all-steel gondola cars in their twelfth year of service cost over 36 per cent more to maintain than did the composite gondola. Of course, it is probable that during the first five years of its life the steel gondola cost less to maintain, but it is felt that taking the entire twelve years as an average, the cost would be more for the maintenance of the steel than the composite gondola.

It is furthermore interesting to note that but 60 per cent of the composite gondolas in service required repairs, while 72 per cent of the steel gondolas were obliged to be brought to the shops. The actual time that a car is in service and earning money for the road is an important consideration in determining its general utility.

A table in the complete paper shows that the annual cost of repairing freight cars has increased from $59.30 in 1908 to $80.30 in 1914, an advance of over 35 per cent. This higher cost is due, of course, to a number of factors, but it is felt that no small part of it is due to the use of steel, which requires a greater outlay for material and a higher cost to repair, owing to the fact that it takes longer to make like repairs on a steel car than on a wooden one. It must also be borne in mind that this higher cost is very largely due to the much rougher usage to which freight equipment is now subjected. In recent years the freight business of the railroads has grown enormously, and has necessitated the construction of gravity yards for switching, and the use of fewer switchmen per cars handled than in former years. This has resulted in severe handling of freight equipment, and is probably responsible to a greater degree than any other factor for the increased cost of repairs in recent years.

Steel vs. Wood for Closed-Top Cars

In the case of closed-top cars, such as, for example, stock, box, and furniture cars, there is but little doubt that under present railroading conditions the understructure should be of steel with a wooden superstructure. The steel understructure is required to withstand the shocks of service and to give rigidity and stability to the car, while the wood is desired to give lightness and general utility to the body. Some all-steel box cars are in use today, but

Photo by *Lumber*, weekly, St. Louis, Mo.

Fig. 17 Wire Rope Sling Haul-Up

Device carries log to the mill log deck where sawing operation starts. Medium-sized fir log 4 ft. in diameter shown.

[1] Paper by Wm. Queenan, Asst. Superintendent of Shops, C. B. & Q. R.R.

their heaviness and the fact that nails and cleats cannot be used in them to brace and hold the lading, are strong factors against the use of this material. It has not met with favor with shippers generally and probably will not as long as wood continues to remain available.

Graded Lumber in Car Construction

It seems pertinent to say a word at this time as to the grades of material required for the different parts of the body of the car. In the early days when the supply of wood in this country was thought to be inexhaustible, clear grades of wood were generally demanded by the car builders, and in the construction of new cars this is generally the practice at the present time, especially for car roofing and siding, sound-knotted stock being used for decking and lining. Some of the more progressive railroads, however, have gone a step further in recent years and many are now using sound-knotted stock for siding and roofing for repair and maintenance work. There is no doubt but what such a practice is economical and based on sound judgment, for certainly there is no necessity for using clear material for the repair of many classes of freight equipment, the life of which may not be in excess of seven to ten years. One large railway system which not only constructs its own cars but does repairing on a large scale, has adopted this practice and the saving amounts to over $500,000 per year.

An important feature of car construction which is decidedly in wood's favor, is its general ease of working and adaptability to repair, and this is brought about not only from its qualities which make it easy to cut, saw and shape, but also by its almost universal availability.

It is also rather curious that the salvage value of wooden cars is greater than that of steel cars, and no one doubts this who has seen the two types of cars in a seriously wrecked condition. The wooden car may be quickly and easily repaired, while the steel car is only rehabilitated at a high cost, or for the most part is fit for the junk pile.

The Importance of Well-Seasoned Wood

Before using wood in the building of freight cars it is vitally important that it be well seasoned. When our grandfathers built a house they expected it to last a century, and it usually did, for they took great care to properly season the wood before putting it to use. In the houses nowadays, however, we use wood almost before it is dry from the saw, and the result is that our American frame houses today are old at fifteen or twenty years. Too often today we also see freight cars built of green lumber and timber, with the result that within a few months the bolts are loose, the wood having shrunk away from the original fastenings. This causes rapid deterioration and large timbers often quickly rot, particularly those containing sapwood.

Increasing attention has been given in recent years to the preservative treatment of certain parts of freight cars, and experiments have been made by some of the more important railway systems in the treatment of such items as stock-car decking, side and intermediate sills, roofing, etc. While these experiments have not been conducted for a sufficient length of time to determine actual results, the indications are that the preservative treatment of such car parts as are particularly liable to decay is profitable and will shortly be adopted as standard practice by the more progressive railroads. The conclusion is inevitable that the superstructure of freight cars will continue to be of wood as long as it is available at a reasonable price.

CREOSOTED WOOD-BLOCK FACTORY FLOORS

By LAMBERT T. ERICSON,[1] TOLEDO, OHIO

The use of creosoted wood blocks for factory floors has been so extensive during the past few years that it is hardly necessary to go into details in regard to the advantages of this type of flooring. Most engineers and architects have come in contact with this material at first hand, so that this paper will be confined to a discussion of (1) the material used; (2) the problems encountered; and (3) the field covered.

Southern yellow pine has been employed almost entirely for this work, except on the West Coast, where Douglas fir and tamarack are used. Long-leaf pine is usually specified, but short-leaf pine is also adaptable for the work. The lumber should be thoroughly air-seasoned before being cut into blocks, and then should be given a preservative treatment with coal-tar creosote oil to preserve the wood from decay. Hard woods, such as gum, beech, and maple, can be used, but they are not favored on account of the difficulty in properly seasoning the lumber and the tendency of the blocks to warp and check after they are cut. The coniferous woods are more homogeneous in grain and texture and are consequently more adaptable. Soft wood compacts under service and consequently it is just as serviceable as hard wood, and has the advantage of not becoming slippery under traffic.

It should be understood in the beginning that factory flooring with creosoted wood blocks cannot be grouped under one general heading and specification. The conditions under which the floor is to be used must first be studied and the specifications made to suit. Creosoted wood blocks can be laid to meet practically all factory conditions if the conditions are first properly analyzed. The real reason for most of the trouble encountered with this type of flooring is the fact that wood expands and contracts with various conditions of the atmosphere and the moisture content of the blocks. It is therefore necessary to lay the individual blocks in such a way as to allow for this change in volume, which in extreme cases may be as much as 5 per cent. The individual units in the floor must be bound tightly in place with a binder which will allow this expansion and contraction and which will exclude water from the underside of the floor. As long as the blocks are held tightly and firmly in place and a smooth surface is maintained the floor will wear almost indefinitely, but as soon as they become loose and the surface rough they will break up into sticks very quickly.

Conditions to be Met in a Successful Installation

The three most essential requisites for success are: (1) thoroughly air-seasoned lumber; (2) a smooth, solid foundation base; and (3) a waterproof and elastic binder to hold the units in place. In the majority of cases factory floors are dry most of the time; consequently, the lumber should be thoroughly seasoned, in order to keep the shrinkage to the minimum. Blocks cut from green or semi-dry lumber will shrink in volume to such an extent that they will often have to be taken up and relaid. If it is possible to do so, it is advisable to use a concrete base for the installation of these floors. The base should be strong enough to carry the entire load and should be finished smooth and level so that it will not be necessary to use a cushion between the concrete and the blocks in order to secure a level floor and uniform bearing for the individual units.

Wherever a cushion is necessary between the concrete and the blocks, it is advisable either to use a mixture of portland cement and sand or a bituminous mastic. The latter is preferable in a great many cases on account of being both waterproof and elastic. It is standard practice today to lay the blocks directly upon a smoothly finished concrete without any cushion whatever. It is also customary to give the base a thin, even coating of coal-tar pitch before installing the blocks, so that the underside of the blocks may be thoroughly sealed and made waterproof.

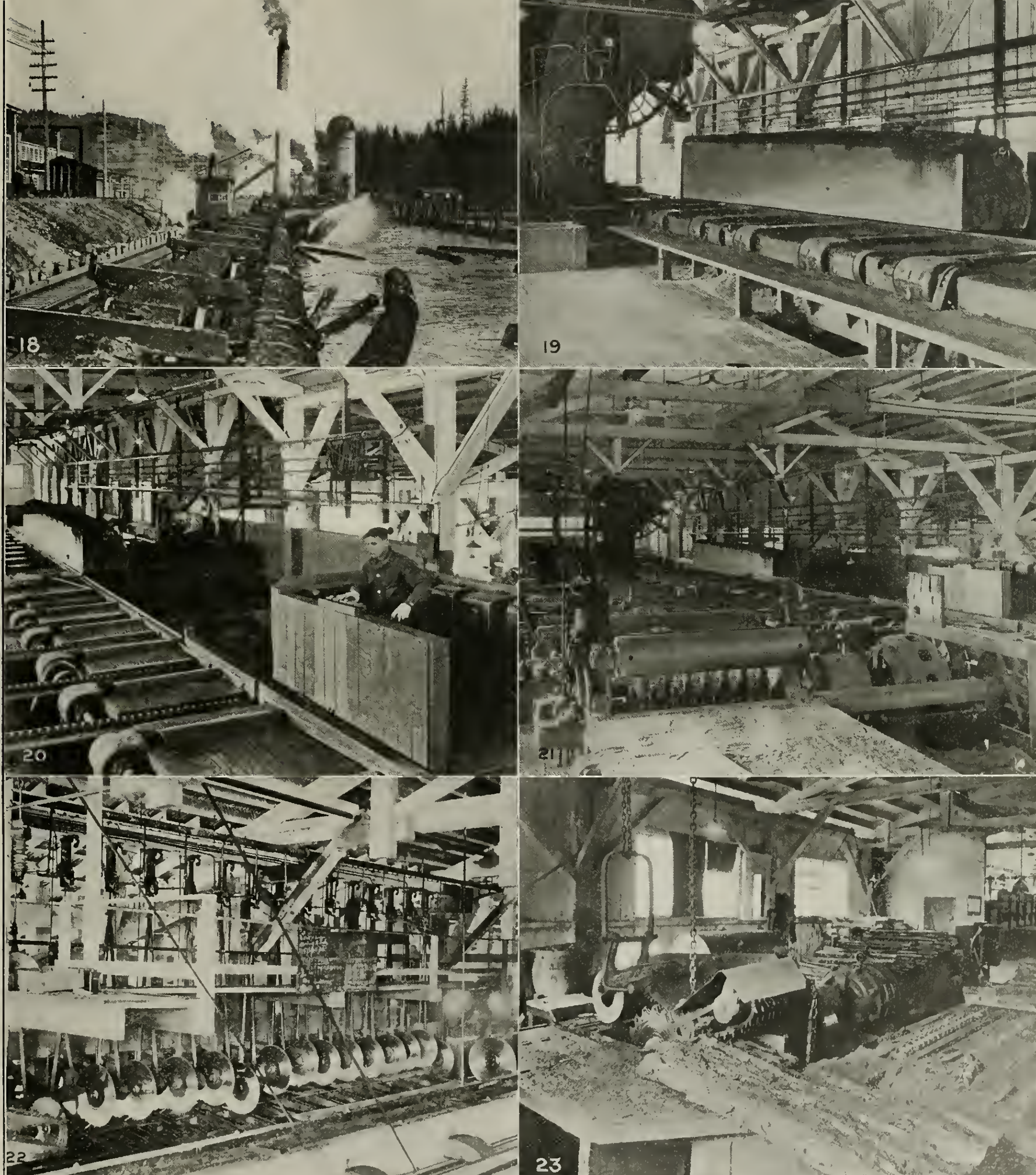
The elimination of cushions and the use of a successful waterproof binder in the joints of the blocks, thereby eliminating the possibility of shifting of the base and a loosening of the units, has permitted a reduction in the depth of the blocks used. Factory floors are now being very successfully installed throughout entire manufacturing plants with blocks as shallow as 2 in. in depth.

Successful installations may be made on timber and plank foundations in mill-type buildings, but care must be taken to see that the timber in the foundation is sound and that the blocks are afforded a firm and even footing. A bituminous-mastic cushion between the planks and the blocks is now being extensively used and is proving very successful.

The Uses of Wood-Block Flooring

Creosoted wood-block floors are being installed in machine shops, forge shops, foundry molding and core rooms, casting cleaning and

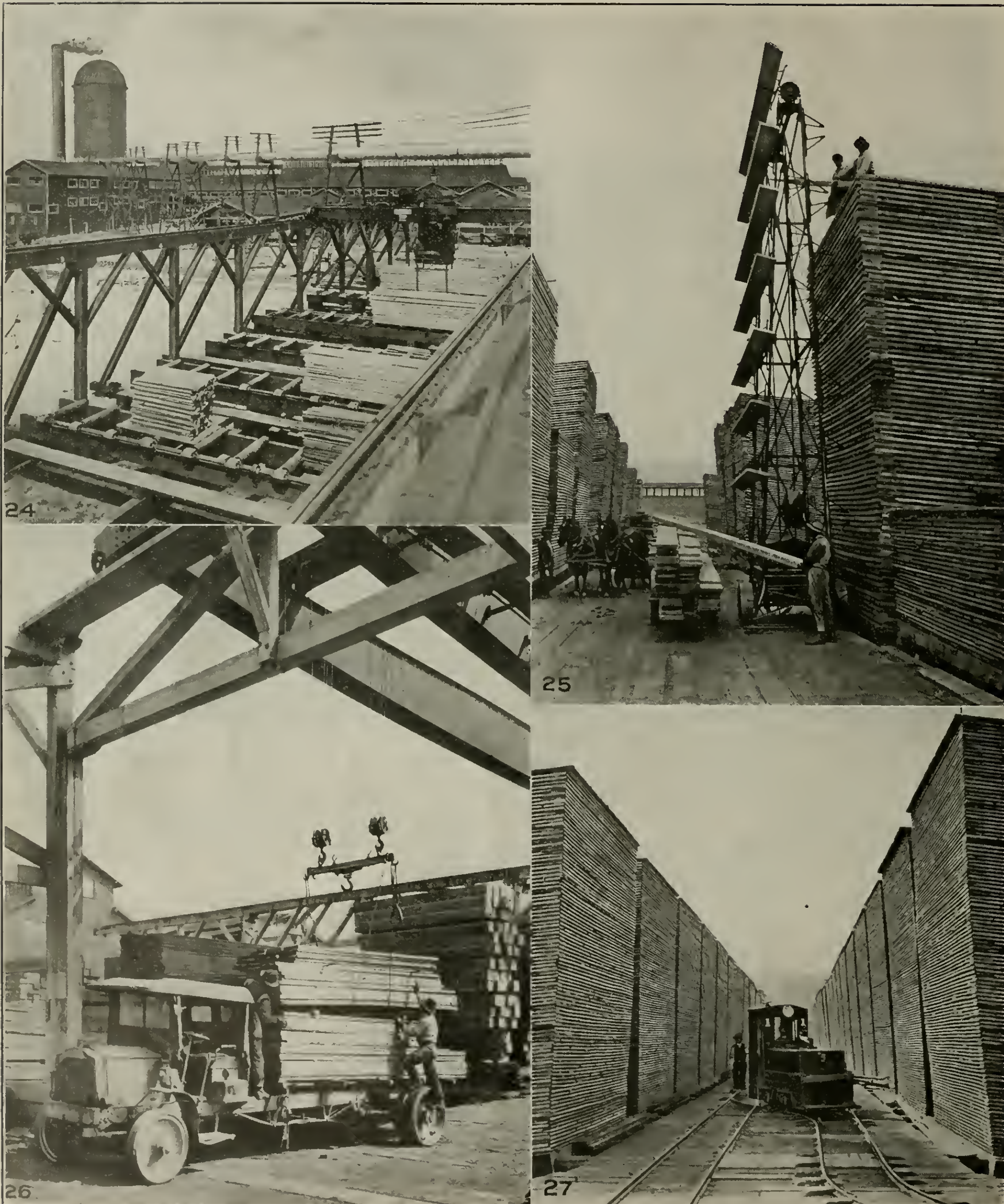
[1] Chief Engineer, The Jennison-Wright Company.



Photos by *Lumber*, weekly, St. Louis, Mo.

FIGS. 18–23 FROM FOREST TO FINISHED PRODUCT—CONVERTING THE LOGS INTO LUMBER

Fig. 18—Dumping fir logs at large plant at Snoqualmie Falls, Wash. Skeleton log cars in foreground from which logs are unloaded by a special type of locomotive crane. Fig. 19—A characteristic band mill and large log. Band-saw wheels 11 ft. in diameter, band saw 14 in. wide, tooth speed about 10,000 ft. per min., maximum cutting rate approximately 800 sq. ft. of wood section per min. A 250–300-hp. motor is used for drive. Fig. 20—Steam-actuated cross-chains for routing material through mill, electrically controlled from a single station. Operator makes necessary changes by pressing buttons. Fig. 21—Edger machine for trimming lumber to width of standard-size plank. Adjustable saws are driven by electric motor. Motors as large as 400 hp. are used in this capacity, though average size is 100 to 150 hp. Fig. 22—Selective trimmer with pneumatic control cylinders and swing saws. Any one (or more) of the saws may be lowered into the cutting position by the compressed-air control to cut a board of required length. These trimmer saws are usually on 2-ft. centers; the lumber is fed into the machine on the carrier chains shown. Fig. 23—Wood conservation. Converting bark slabs into lath. The first machine or set of saws rips the slab into narrow strips, from which the laths are cut in a second machine.



Photos by *Lumber*, weekly, St. Louis, Mo.

FIGS. 24–27 FROM FOREST TO FINISHED PRODUCT—AT THE PLANING MILL AND IN STORAGE FOR SHIPMENT

Fig. 24—Handling lumber at the planing mill on the rough or entrance side. The lumber is brought in in packages by means of a special crane and set upon power-driven rollers which feed directly into the surfacing machine. The monorail system carrying overhead crane and other devices perform this function. Fig. 25—The mechanical lumber piler known as the "Iron Swede" permits higher piles than possible by hand work. The machine is most conveniently electrically driven; some gas-engine applications exist. Fig. 26—Motor truck, used for mill shipment, being loaded by means of an overhead bridge crane at the sawmill plant. Fig. 27—Softwood piles, the lumber being stored for natural drying; served by industrial railroad with storage-battery locomotive.

state. They also vary from low to high temperatures, and in some cases the blocks are submitted to the action of molten metal. The extreme variation in the demands covered by the above list of industries gives a fair idea why it is necessary to study the individual job at hand and draw a specification to meet the particular work.

For ordinary factory purposes the proper treatment for the blocks is 6 lb. of creosote oil per cubic foot of timber. This is injected by the Rueping process and is sufficient to preserve them from decay. When they are to be subjected to considerable moisture or to the weather, they should be treated with 12 lb. of oil per cubic foot of timber by a combination of the empty- and full-cell processes. This extra amount of oil insures better waterproofing of the blocks.

Floors which are to be subjected to considerable moisture, or to weather conditions, should be laid with ample provision for expansion. It is good practice to provide ample space between the individual units to take care of this expansion. These joints should be flushed full of a waterproof, elastic binder, which should preferably be coal-tar pitch of a consistency which will not soften up under atmospheric or room temperatures. Coal-tar pitch has proven the most successful binder and filler for creosoted wood blocks, as it is a derivative of the same base as creosote oil, and thus readily unites with the oil in the blocks.

ELECTRICALLY DRIVEN SAW MILLS

By ALLAN E. HALL,[1] MILWAUKEE, WIS.

THE complete modern plant for the manufacture of lumber includes everything required to transform the growing tree into finished lumber ready for the builder; and this plant naturally divides into forest equipment and mill equipment. The forest equipment, which includes logging machinery and railroad and water transportation of the logs to the mill, is not considered in the present paper.

The capacity of a sawmill is regularly given in thousands of feet board measure per day of 10 hours. The power required for sawmill alone varies from $4^1/_2$ to 8 hp. per 1000 ft. of lumber per day; e.g., a sawmill of 100,000 ft. daily capacity will require from 450 to 800 hp. The lower figure is for mills cutting small and medium pine logs; the higher figure for Pacific Coast mills working the heaviest timber, or mills sawing hardwood. The planing mill will require from 2 to $3^1/_2$ hp. per 1000 ft. on the same basis. The total power for milling is therefore from $6^1/_2$ to $11^1/_2$ hp. per 1000 ft. board measure of lumber sawed per 10 hours.

Two things should be kept in mind in estimating and comparing power used in different sawmills: First, two sawmills rated at 100,000 ft. board measure per day each may deliver this 100,000 ft. in very different forms. The first may be a "board mill" and the entire day's cut may be 1-in. boards. The second may be a "timber mill" making 50 to 60 per cent of the logs it handles into timbers or large dimension pieces. It is obvious that one 12-in. by 12-in. by 16-ft. timber will add just as many board feet to the day's tally as 12 boards 1 in. by 12 in. by 16 ft., but the latter will have consumed much more power. Second, it consumes more power to saw hard, dense wood than to saw soft, light wood. Some mills work hardwood or softwood exclusively; others must cut various kinds just as they come, owing to the timber supply being of mixed varieties.

Conditions of the Problem

In deciding whether to drive a sawmill by lineshaft or motors, the first consideration is the probable life of the plant. Unlike most manufacturing plants, the sawmill must nearly always be built close to the supply of raw material; for it is not commercially possible to transport sawlogs far from where they grow, except in the case of valuable timber like mahogany and other tropical hardwoods. When the supply of accessible timber is sawed, the plant must be abandoned or moved with a very small salvage value.

[1] Allis-Chalmers Manufacturing Company.

wiped out from the profits in a few years—fifteen, ten, or even eight years—without making too great an annual charge.

The size of the sawmill plant is important. It is found that for very small mills the first cost of the electric power plant and motors is greater than for a steam plant and belted drive. For medium-size sawmills the first cost does not differ greatly when everything is considered; and for large plants the first cost may be less for a motor-driven than for a shaft-driven mill.

Accessory or by-product equipment will affect the choice between the two kinds of power transmission. As previously ex-

Fig. 1 Filing Room, with Motor Direct-Connected to Automatic Band Sharpener

plained, the planing mill is considered as a part of the complete installation; but beyond this every intelligent lumberman is constantly trying to make the waste wood from his sawmill into useful products. As an example, a large mill recently built for the manufacture of yellow-pine lumber makes from waste wood (*a*) kiln sticks for spacing lumber in the dry-kiln stacks, (*b*) lath, (*c*) rosin-barrel staves, (*d*) shingles, (*e*) box boards and cleats, (*f*) short stove wood, (*g*) molding strips and (*h*) ground chips for fuel. More-

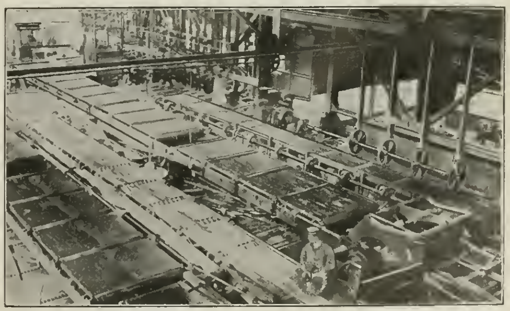


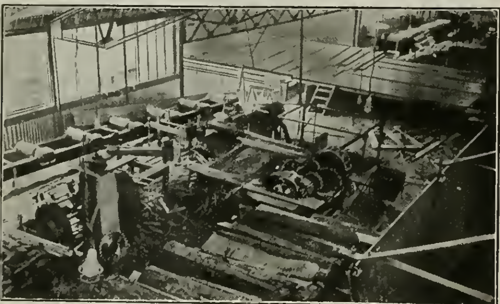
Fig. 2 Interior of Sawmill Showing Motor-Driven Slab Slasher and Trimmer

over sawmills are built today for producing small wood specialties primarily from the log, the output of lumber in the form of boards or other building material being small and incidental. One large plant for instance has recently been built for making oval wood dishes, butter boats and clothes pins. A small sawmill followed by such a remanufacturing plant is usually motor-driven, while the sawmill alone might not justify the investment; for the small specialty machines can be driven electrically with convenience and economy.

A unique condition of sawmill operation is that fuel costs nothing. The waste wood from the mill contains 8500 to 9150 B.t.u. per lb. when dry, the larger values coming from highly resinous wood, although as it falls from the saw it contains from 40 per cent to 50 per cent of moisture, or even more. Generally the mill

roduces more waste wood than can be used for fuel or otherwise, nd this surplus must be sent out in a long conveyor trough and urned in a pit or in a closed iron "burner." Decreased fuel conimption by saving power-transmission losses is therefore of no iterest to the lumberman. The argument has even been made that ecreased fuel consumption under the boilers is poor economy, ecause the saved wood must be conveyed a longer distance to the burner" than to the boiler room, thus using more engine power.

In sawmills, as in other industries, motors give the advantage f unit driving, and the whole mill is not dependent on one line iaft or main belt. But it is to be noted that in the sawmill proper iis advantage is not so great as in most other manufacturing lants. In a machine shop or other factory where one machine r small group of machines is making a finished product independntly of all others, a stoppage of one machine or group will not ffect the others. In a single band mill every piece of lumber from ie log passes through all the machines serially, and a stoppage of ne machine in the chain will soon shut down the mill. In a sawiill with two log-cutting saws there will be two streams of lumber, nd failure of one machine will generally only affect one side. After ie lumber passes the trimmer and reaches remanufacturing and y-product machines, the full advantage of unit driving is gained, or here one machine does not depend on another. With the fore-



ig. 3 Lath Mill Showing Direct-Connected Motor Driving Lath Bolter and Lath Machine

oing conditions in mind, a comparison may be made, first as to lant details and cost, and second as to operating expense.

Comparison of Plant Details and Cost

Sawmill boilers are either ordinary horizontal tubular or of waterabe types. When burning sawdust a large furnace is required, hich is generally of Dutch-oven design. A fuel-storage house is uilt close to the boilers, with the fuel conveyors arranged either to ischarge sawdust from the mill direct to the furnaces or to carry on to the storage house and return it when needed. When the elted mill and non-condensing Corliss engine are replaced by the ondensing steam turbine and motor-driven mill the steam conumption of the prime movers will be cut about one-half, which llows a reduction of boiler capacity to be considered in comparing he cost of the entire plant. The boiler capacity needed for various uxiliary steam cylinders used in the mill will of course remain the ame as before.

The belted sawmill, except in plants too small to be of practical iterest, is generally driven by a simple non-condensing Corliss ngine. It has not been found worth while to install compound r condensing engines when fuel was valueless, simply for the reuction in boiler plant. When motor driving of a proposed plant s in contemplation, the prime mover may be a simple or compound, ondensing or non-condensing steam engine direct-connected to he generator, or else a steam turbo-generator. Fuel cost of course iakes the gas or oil engine out of the question and plant cost liminates hydroelectric power except in rare cases.

It has been said in an earlier paragraph that the standard sawiill plant includes a planing mill. This should be placed 200 ft. r more from the nearest roofed point of the sawmill proper (to ieet insurance rules), which means 300 to 600 ft. from the main power house. Motor driving of new planing mills, except when very small, has become almost universal, so that this is generally assumed at the start. If we belt-drive the sawmill we must then have one prime mover for it and a steam-electric plant for the planing mill. It is obvious that there should be only one boiler plant and one engine room, containing both prime movers. But if the sawmill as well as planing mill is electrically driven, the two prime movers may be combined into one large enough to drive both mills, which is economical in first cost and is often done.

For the same reasons which have brought it into favor in other industries, the condensing steam turbo-generator has become almost universal in motor-driven sawmills; and compound condensing engines are not now running in any mill with which the writer is acquainted. When deciding on the method of power transmission, the choice for large mills is commonly made between (*a*) a sawmill belted from a simple Corliss engine and a planing mill motor-driven by a steam turbo-generator; and (*b*) both mills motor-driven by a turbo-generator. The comparison of costs which follows is on this basis for the larger mill, though for the smaller one both mills are belted from engines.

In a shaft-driven mill the weight and cost of the lineshaft and various countershafts are considerable. The power-receiving section of the lineshaft is about four inches in diameter in a single

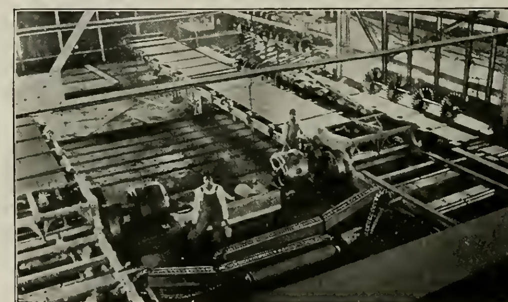


Fig. 4 Interior of Sawmill Showing Two Direct-Connected Motor-Driven Edgers

band mill, and 8 in. to 10 in. in diameter in the largest mills, and the shaft may be 300 ft. long. In large mills countershafts will be required for the log jack, log cut-off saw, log canter, band mill, gang mill, resaws, edgers (this requires a right-angle drive, usually through mortise gears), slasher, trimmer, hog, lumber sorter, timber trim saw, and lath mill. When the individual motor drive is installed all these shafts with their attachments are not required, and the difference in the total of sawmill machinery is almost entirely in these omissions. All the cutting machines, conveyors, and transfer and roll drives will be little changed. The amount of this saving is given below in three cases, the figures covering all sawmill machinery proper, installed, but no power-house equipment.

	Mechanical Drive		Electrical Drive	
	Weight, Lb.	Price	Weight, Lb.	Price
Mill No. 1.......	445,296	$112,345	402,749	$104,410
Mill No. 2.......	701,500	173,5 0	620,000	153,698
Mill No. 3.......	763,150	189,079	674,150	166,789

Sawmill and woodworking machines are almost always driven at constant speed, in one direction, and (except band mills, band resaws, and a few other cases) can be started at light load; so the squirrel-cage induction motor is generally applicable. The direct-current open motor is of course objectionable on account of fire risk from sparking commutators. For driving band mills, heavy band resaws, and in other places where large starting torque is necessary, the wound-rotor motor with starting resistance is used. The current (60-cycle, 3-phase) is commonly generated and used at either 480 or 600 volts, avoiding the use of transformers except for lighting. As all the motors will be probably set within 600 to 800 ft. of the power plant, the saving in wiring does not justify high generator voltage and transformers.

drive. In Table 1, which gives the estimated cost of a single band mill with a daily capacity of 30,000 ft., the figures are about 11 per cent higher for motor drive, but in Table 2, which is for a double band and resaw mill with a daily capacity of 120,000 ft., the first cost is about 8 per cent less for the motor drive.

Comparison of Operating Conditions and Expense

In operating expense the motor-driven sawmill makes a saving in power-transmission loss, upkeep of shafting and belting, use of oil, waste, and supplies, depreciation, fire risk and insurance premium. The complete paper gives a table showing the power consumption of various sawmills for both mechanical drive and electrical drive, the horsepower consumed being less in the case of electric drive.

The average life of belts in a sawmill is not more than four years, which means a running expense of 25 per cent of the total belting cost yearly. The saving in oil, waste, etc., by changing over from shaft drive to motor drive has been estimated at 40 cents per 1000 ft. of lumber per day. No attempt is made to give comparative figures for depreciation, but the lumber manufacturer's accountant should consider the low second-hand value of shafting equipment if it must be moved and refitted for new conditions, as contrasted with the easy interchangeability of motors. One of the lumbermen's mutual insurance associations recognizes motor driving by a reduction of 25 cents in premium. Another association, while not specifically recognizing electric driving, usually makes a 5 per cent deduction from total premium on account of the clear and open condition of the lower floor thus produced.

Separate steam engines are also sometimes used in a belt-driven plant to drive certain large machines (e.g., a gang mill) or groups of machines. These engines proportioned for their average load do not have the peak-carrying capacity of equivalent motors with a large generator behind them. When the mill is driven by several steam engines of small size a reduction of shafting equipment may be made, but each engine must carry its peak load without help. Motors of corresponding horsepower rating connected to one large generator will draw on an ample power reserve during peak loads. Two gang mills have come under the writer's observation, of the same size and make, one driven by a steam engine belted to it individually, the other motor-driven, both machines nominally running at 225 r.p.m. The engine-driven gang ran at 225 r.p.m. light, and 200 r.p.m. fully loaded. The motor-driven gang ran at 225 r.p.m. light, and about 223 r.p.m. loaded. As the rate of lumber feed to the gang is governed by the speed, the steam-driven gang was cutting about 10 per cent less than the other. Cases are on record where mills by simply changing from shaft drive to electric drive have increased their production 15 per cent. This problem of speed maintenance has not been sufficiently studied by sawmill operators.

Details of Motor Application

The equipment for hauling logs into the sawmill and cross-cutting them may be motor-driven. The remaining log-handling equipment is actuated by direct-connected steam cylinders. Sometimes an overhead log "canter" is used for turning logs, supplementary to the "nigger." It turns the logs by a hook attached to a chain wound on a drum and may be motor-driven.

On the other hand jump saws for cross-cutting boards and timbers, hinged transfer skids, the mechanism for raising press rolls on edgers and gangs, and for raising saws on a trimmer, are moved by direct steam or compressed-air cylinders. Also the carriage which holds the log while being sawed is almost always reciprocated by a steam engine through a wire rope or by a steam cylinder directly connected to the carriage itself. All these steam-actuated devices are so simple and positive in action that there is no apparent advantage in developing electrical methods as a substitute.

The other principal machines are connected to the motors through flexible couplings, except band mills, band resaws, and gangs. The band mills may be so driven, but there are certain objections which should be considered: the motor cuts partly through the mill floor, is inconvenient for inspection, and in the way of workmen; and motor speeds do not always match the speeds of the band 8, 9, 10, and 11 ft. in diameter. Irrespective of wheel diameter, the saws, and hence the wheel rims, are run at speeds up to 10,500 ft. per min.—plain cast-iron wheels at twice the ordinary limiting speed of engine flywheel pulleys. Another condition sometimes weighing against connecting a constant-speed motor directly to a band-wheel arbor, is that in northern hardwood mills the saws may be run at different speeds in winter and in summer. If much frozen timber reaches the saw, operators prefer to reduce the speed 1000 or even 2000 ft. per min. below that used when logs are clear of ice.

Gang mills run at such a low speed and require so much power that direct-connected motors of sufficient size would be very expensive, and standard practice up to the present has been to belt from a higher-speed motor.

The lumber-transporting equipment, including live rolls, chain transfers, chain and belt conveyors, is most conveniently and cheaply group-driven, though there is now a tendency to go farther in the use of individual small motors than there was a few years ago.

The filing-room machines for sharpening saws require little power and are arranged for mounting individual motors directly on the frame in most cases.

When specifying sizes for sawmill motors it must be remembered that very great and sudden peak loads are encountered, and the ratings must be larger on this account. In general, it is found that the load factor on an entire sawmill is about 60 per cent of the total nameplate rating of the motors.

A condensed list of the machines found in the ordinary sawmill follows, the sizes of motors suitable therefore being stated in each case.

Machines	Motor sizes
Log jack, for hauling logs into the sawmill	25 to 50 hp.
Circular log cut-off saw, for dividing long logs after being drawn into the mill	25 to 50 hp.
Drag saw, for cutting off logs too large for the circular saw above mentioned	15 to 40 hp.
Overhead log canter, for turning large logs lying on the log storage deck or on the carriage	10 to 20 hp.
Band mill, for ripping the logs which are moved back and forth in front of it on the carriage	100 to 300 hp.
Circular head saw, sometimes used instead of band mill	100 to 400 hp.
Power setting machine, for moving log forward after every cut into position for the next cut. This machine is mounted on the carriage. Two types are used, one direct steam-driven, the other power-driven. The latter is used exclusively for the heaviest work, and motor may be mounted on carriage	5 to 10 hp.
Live rolls, or power-driven rolls, for transporting lumber after being sawed. These are connected and driven together in trains of 6 to 20 or more, according to the mill design; power required per roll	0.4 to 0.6 hp.
Band resaw, for further reduction of large pieces dropped by the head band mill. It may be either vertical or horizontal The latter is used for resawing slabs as well as splitting thick stock from the head band	75 to 200 hp.
Transfer chain tables, for moving lumber sidewise between machines. These are of such varying length and width according to the individual case, that no power requirement can be specified.	
Gang mill, for sawing entire log into boards at one passage through the machine. Two opposite slabs are taken off the log by the head band saw, giving the log two flat faces, after which it is fed to the gang	50 to 400 hp.
Edger, for ripping bark edges from the boards and squaring them	15 to 250 hp.
Slab slasher, for dividing waste stock into short lengths for lath, stovewood, or other by-products	20 to 75 hp.
Trimmer, for cutting ends off boards and making them of standard length	20 to 75 hp.
Swing cut-off saw, for hand-trimming of large timbers, etc.	10 to 25 hp.
Timber sizer, for surfacing two or four sides of timbers at one operation	50 to 60 hp.
Lath bolter, for preparing lath bolts from slabs or other waste wood	30 to 60 hp.
Lath machine, for making lath from bolts	20 to 30 hp.
Hog, a grinder with knives on a revolving disk, for chipping waste wood for fuel or other purposes	25 to 150 hp.
Planers, of great variety in size and type. The largest standard size requires about 75 hp.	
Exhaust fans, for transporting dust and shavings from planers to fuel-storage house	25 to 150 hp.
Chain conveyors, for transporting waste wood and sawdust, the length varying with the mill design up to about 350 ft.	5 to 30 hp.

PROCESSES AND EQUIPMENT USED IN WOOD PRESERVATION

By E. S. Park,[1] Pittsburgh, Pa., and J. M. Weber,[1] Orrville, Ohio

Processes for the use of a preservative agent in the treatment of timber to prevent its decay or its destruction through the boring of insects may be classified into three groups: (1) Surface application: coating the timber with preservative by means of brush or spray; (2) open-tank treatment: immersion of the timber in preservative in open tanks; and (3) pressure treatments: immersion of the timber in closed tanks or cylinders with the application of pressure above atmospheric to force the preservative into the wood. It is only in the treatment of timber under pressure in a closed cylinder that the methods employed are interesting from an engineering standpoint, and this paper is accordingly devoted solely to such plants.

The pressure process has as its prime object, first, the distribution of the preservative throughout the wood as uniformly as possible; and second, the securing of an absorption of a sufficient quantity of the preservative to insure the results desired. The essential feature of all pressure methods is the use of pressure to force the preservative into the wood. This is accomplished in several ways, the kind of wood, the use for which it is intended or the kind of preservative used, making it necessary or advantageous to vary the methods employed. The timber is treated in closed retorts or treating cylinders built to withstand a pressure of 250 lb. per sq. in. and equipped with steam coils for heating the preservative.

The most widely used preservatives and those generally recognized as the most efficient are coal-tar creosote and zinc chloride, the latter being applied in the form of a 2 to 4 per cent aqueous solution. In one process employed in the treatment of cross-ties a mixture of 80 per cent zinc chloride solution and 20 per cent creosote is used. In treating with creosote the amount injected ranges from 4 to 20 lb. per cu. ft., depending on the kind of timber, the process employed, and the proposed use of the treated timber. When zinc chloride is used the aim is to treat the wood to refusal, the strength of the solution being regulated to give an absorption of approximately 1/2 lb. of dry salt per cu. ft. of the wood treated.

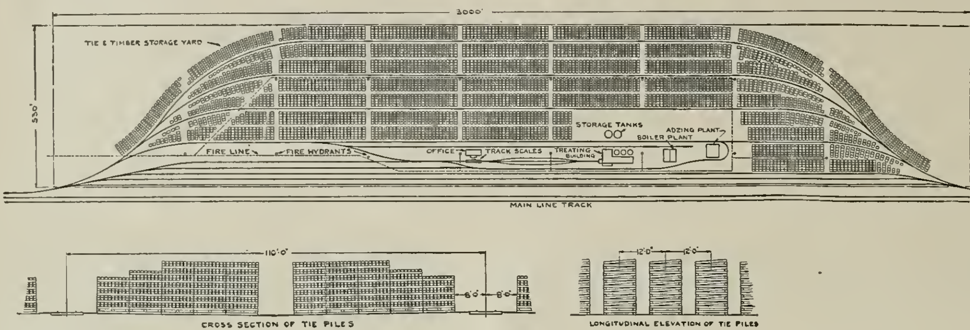


Fig. 1 Plan Showing Layout of Entire Plant

Pressure Treatments

Pressure treatments may be grouped into two classes as follows: (1) Full-cell process, the object of which is to fill the intercellular spaces of the wood as completely as possible with preservative; and (2) empty-cell process, the object of which is to secure as thorough and deep a penetration as possible with the use of a minimum quantity of preservative.

In the full-cell process the timber is placed in the retort, a vacuum is drawn, and, without breaking the vacuum, the retort is completely filled with the preservative fluid. The vacuum not only accelerates the entrance of the preservative into the retort but also makes it possible to force the preservative into the timber more quickly and with less pressure than is the case when the preservative must displace or compress the air in the wood. After the

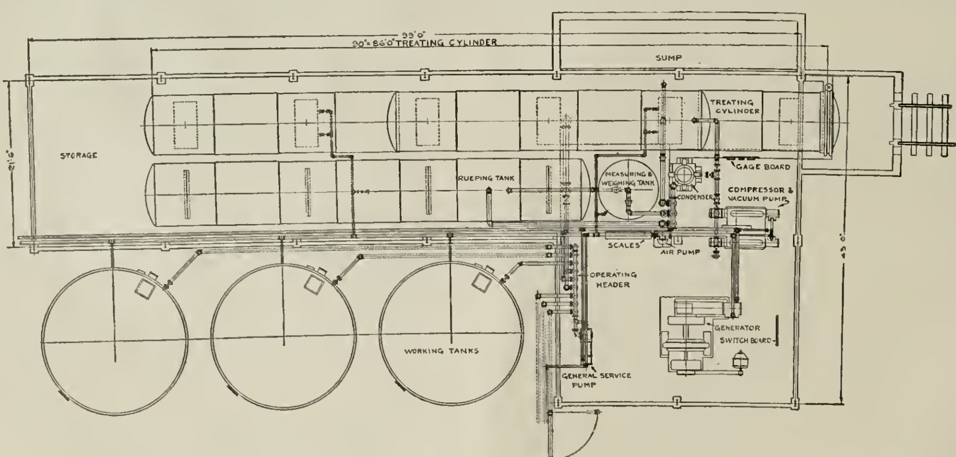


Fig. 2 Equipment Used in Treating Process

[1] Pittsburgh Wood Preserving Company.

and maintained at 125 to 180 lb. per sq. in. until the required amount of preservative has been forced into the wood. The pressure is then released, the preservative drawn from the cylinder, and as a rule, another vacuum is drawn, the object of this final vacuum being to remove the surplus preservative from the surface of the timbers and hasten the dripping of the preservative so that the timber can be removed from the cylinder as soon as possible.

In the empty-cell process no preliminary vacuum is employed and to enter the wood the preservative must therefore displace and, to some extent, compress the air in the wood. Such is the treatment known as the Lowry process. In the more widely used Rueping process the entrance of the preservative into the wood is further retarded by subjecting the timber to an initial air pressure of from 50 to 75 lb. per sq. in., after which the preservative is forced into the cylinder at a higher pressure. After the treating cylinder is filled the procedure in empty-cell processes is practically the same as in full-cell treatments except that the final vacuum is held longer. The results obtained, however, are quite different, as in the empty-cell treatments the release of the pressure and the removal of the preservative from the retort permits the expansion of the air compressed in the wood. The effect of the final vacuum is to cause further expansion and, to some extent, expulsion of the air in the wood and a corresponding expulsion of a portion of the preservative that was forced in during the pressure treatment. The result is a thorough penetration with a minimum amount of preservative. Empty-cell methods are used almost entirely with creosote and in treating timbers which do not require the complete filling of the interstices of the wood. The cost of such a treatment is considerably less than by full-cell processes, as from 25 to 40 per cent less preservative is required.

In some cases, particularly where the preservative used is a solution of zinc chloride, or a mixture of zinc chloride and creosote, and in the treatment of green or partially seasoned timbers with creosote, the timber is first subjected to treatment with live steam in the closed retort, followed by a drawing of the vacuum to remove the steam and vapors. This, to some extent, vaporizes the sap and moisture in the wood and facilitates the entrance of the preservative.

Typical Treating Plant

It will be seen that the essential equipment of a timber-treating plant includes a treating cylinder or retort and facilities for carrying on therein; the application of live steam to the timber, the compression of the air, the application of pressure to the preservative fluid and the drawing of a vacuum, or, more strictly, a partial vacuum. A typical treating plant is shown in Fig. 1. It is a single-cylinder plant with a treating capacity of from 400,000 to 700,000 cross-ties per year, depending on the kind of wood treated and the particular method used. The plant occupies 36 acres of land and is connected at both ends with the railroad on which it is located. Connections with city water mains provide water for plant operation and fire protection.

The storage yard in which timber is seasoned before treatment and which occupies most of the premises has a capacity of 600,000 cross-ties. As the average seasoning period is less than one year the storage facilities make possible the seasoning of sufficient timber to operate the treating plant to maximum capacity. The yard is graded to give thorough drainage and is covered with 6 in. of granulated slag to prevent the growth of weeds.

Ties are unloaded direct from incoming railroad cars to storage piles. When ready for treatment they are loaded on to tram cars which are run into the treating cylinder. Switching cars about the plant and handling trams to and from the treating cylinder is done with a 22-ton fireless steam locomotive that is charged from time to time with steam from the main boiler plant. Its use entirely eliminates all locomotive fire hazard, which is an important advantage, especially if creosote is used as preservative. All tracks are standard gage (4 ft. $8^1/_2$ in.). The use of standard-gage tracks throughout the plant not only simplifies its operation and makes possible the use of larger cylinders, thereby increasing the capacity of the plant, but it also reduces the investment in tracks and the cost of their maintenance.

gives an accurate and positive record of the amount of preservative retained in the treated timber and furnishes a check on similar determinations made during the process of treatment. Track-scale readings cannot be used, however, when treating green or partially seasoned timber on account of the loss of sap and water during treatment.

The tank equipment of the plant illustrated consists of two tanks for the storage of the preservative and smaller working tanks for the mixing, measuring and handling of the preservative during the treating operations. The storage tanks have a combined capacity of 200,000 gal. or sufficient to operate the plant for 45 days when treating with creosote at the maximum rate. In treating with zinc chloride less storage capacity is required as the preservative is received and stored in concentrated form, either as a dry salt or a 50 per cent solution. All tanks are of steel and are equipped with heating coils arranged to use either exhaust or live steam. Such heating facilities are necessary in the working tanks as the preservative, when used, must be at a temperature of from 130 to 200 deg. fahr. In the storage tanks less use is made of heat but it must be available because of the congealing of creosote at low temperatures. The working tanks used to prepare the zinc chloride treating solution are further equipped with steam jets through which live steam can be injected and the solution thereby thoroughly agitated and mixed and at the same time more quickly heated.

Cylinder Building

The cylinder building houses the equipment used in the treating process proper and is shown in plan in Fig. 2. The treating cylinder is $7^1/_2$ ft. in diameter and 86 ft. in length and is built to withstand a pressure of 250 lb. per sq. in. Its capacity is ten tram cars loaded with cross-ties or a total of from 450 to 640 ties per charge, depending on the size of the ties and whether they are hewn or sawn. The treating cylinder is open at one end only and is equipped with a heavy door made by riveting a dished-steel plate on to a cast-steel rim. The door swings on hinges and is equipped with heavy tee bolts which are fastened to and swing from the end of the cylinder and which drop into slotted holes in the rim of the door.

After completion of the treatment the ties are moved on the tram cars to a loading track where they are loaded into gondola cars with a locomotive crane. The crane is equipped with a large grapple which engages and lifts a tram load of ties at one time. At some treating plants the same operation is performed by a gantry crane and at some of the older plants the ties are loaded from trams into cars by hand.

MACHINING RAILROAD CROSS-TIES

By D. W. EDWARDS,[1] WASHINGTON, D. C.

THE cost of railway-track maintenance has vastly increased in recent years and one of the largest single items of expense involved in this work is the cost of cross-ties. Not only is their cost increasing with the diminishing supply of the most suitable timber and the growing scarcity of labor, but their life when unprotected grows shorter because of the greater destructive effects of heavier wheel loads and more frequent trains. Also the labor cost of renewing ties, exclusive of the value of the ties themselves, has advanced.

There are two causes of tie deterioration, decay and mechanical wear, and there is no economy in increasing the resistance to one without also increasing the resistance to the other. In some localities decay proceeds more rapidly than mechanical wear, and in arid sections ties wear out before they decay, but as an average the two destructive agents may be considered of practically equal importance.

It is evident that efficacy of treatment can be realized by doing all cutting before the treatment takes place so that the chemical may present an unbroken barrier to the attacks of decay spores.

[1] Greenlee Bros. & Co.

The majority of all ties are so winding or crooked that they should be adzed to secure proper bearings for the rails, but to do this after treatment is folly as it nullifies the effect of the treatment at the points where it is most needed, around the rail fastenings.

Trimming off the ends of ties by means of cut-off saws exposes internal decay which is not otherwise apparent because of the weather-hardening of the ends. A considerable percentage of ties are so decayed internally as to be of little value, and these may be thrown out before the cost of treatment has been expended upon them. This raises the average grade of the ties put in track and gives more uniform service. Trimming also increases the absorption of the chemical by the removal of the refractory case-hardened end surfaces.

Ties pass through the machines face downward and all operations are performed from below. Provision is made so the regular run of ties, large and small, straight and crooked, pass through as they may come and are automatically machined regardless of their irregularity of size and form.

Description of Machines

The double trim saw (Fig. 1) cuts about $^1/_2$ in. off each end of the ties. This removes the old hardened end wood, thus permitting better penetration of the chemical used for preservation, makes all ties of equal length, which makes for better and neater roadway, presents true surfaces for the brand, and principally discloses the condition of the internal state of preservation.

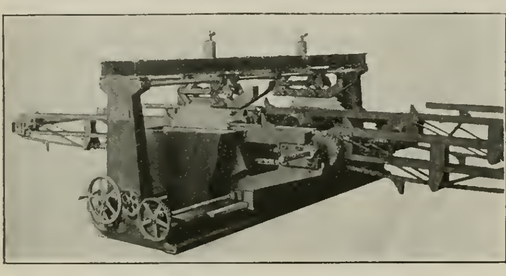


Fig. 1 Tie-Sawing or Trimming Machine

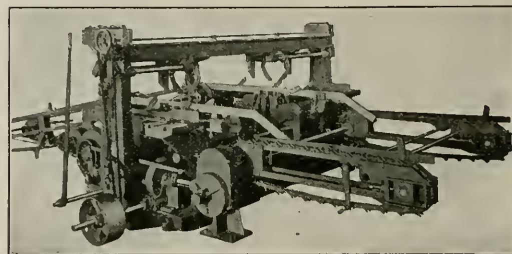


Fig. 2 Automatic Tie-Boring Machine

Briefly, ties are adzed to assure perfect rail-plate bearing; bored to permit chemical penetration, provide correct gage and perfect spike support; and trimmed for appearance and inspection. That the trimming operation is of the utmost importance and worthy of the most serious consideration cannot be too greatly emphasized.

Stationary Installations

For the complete four-unit type of trim saw, adzer, borer and brander, and with in and out tramcar tracks, skidways and conveyors, a building is required 66 ft. 6 in. long by 36 ft. 6 in. wide. The incoming tram track is 2 ft. higher than the outgoing one. This provides the desired elevation for unloading and reloading the trams in the mill and gives a down-grade pitch to the track for moving the empty tram cars around the mill by hand.

Trains of loaded tram cars en route to the treating cylinders are switched up the $1^1/_2$ per cent up-grade ingoing mill track. At the mill the track starts on a $1^1/_2$ per cent downward slope, passes through the mill on a return bend at the rear side and back to connect with the main line. Loaded trams are cut off the train and pushed on the down grade into the mill. When empty they are moved around the return bend to the delivery side.

Ties enter the mill in tram cars that stop in front of the skidways. A tram-car dumping rig removes the load of ties from the car and deposits it on the skidways. This consists of an overhead winch, driven by power, whose double capstans wind up chains securely anchored at their lower ends to heavy cast-iron abutments over which the ties are rolled by the tightening action of the chains. As the winch unwinds the chains lower and rest in slots in the floor, permitting the tram car to pass on.

The bales are removed from the tram cars just before the loads enter the front side of the mill. As the trams are unloaded they are moved around the circular track to the delivery end of the mill. Here they are reloaded and moved out to the front side of the mill where the bales are again applied.

The ties are halted in their fall down the skidways by railroad rails suspended from overhead. Two men, one either side of the skids, place the ties face downward in the correct endwise position on the machine's in-feed conveyors. The passage of the ties from this point through the machine is automatic and the trimming, adzing, boring and branding and delivery to the out-feed conveyors are accomplished mechanically. From the out-feed conveyors the ties drop into the outgoing tram car and are properly laid in place by two laborers. A loading form that outlines the bale circle assists the men in finishing off the load so the bales will fit in place when the loaded tram car leaves the mill.

The design comprises a heavy cast-iron base upon which are mounted housings that carry the saw arbors and feeding mechanism. The housings are gibbed to the base and are movable longitudinally upon it by means of large screws and a back-geared hand wheel. Each carries an independently driven saw arbor. The feed consists of two endless chains driven through speed-reducing gearing from the main countershaft.

The tie-boring machine (Fig. 2) is usually employed in combination with the trim saw and adzer, but there are some cases, such as work on sawed ties, where boring alone may be deemed sufficient. The feed is by means of a set of hinged and counterweighted dogs which are reciprocated by a cam and lever movement through worm and spur gearing. On the backward stroke the dogs pass under the ties, rise behind them and carry them ahead on the forward stroke. This intermittent feed gives time for the boring operation to take place upon the tie which is between the clamps.

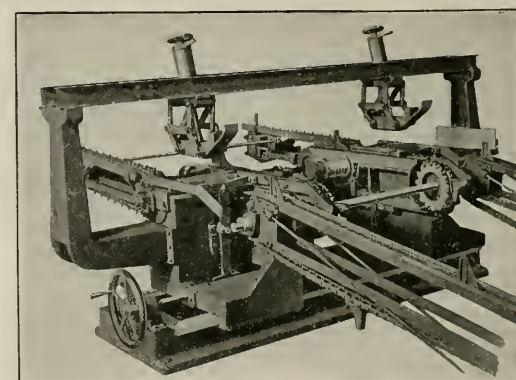


Fig. 3 Automatic Tie-Adzing Machine

A centering and clamping device holds the ties while the bits are boring, and automatically locates the holes so that the plate will rest correctly in the center of the available timber. This device consists of a pair of cam-operated spring-hinged centering and clamping jaws carried by the overhead supports and operated in unison with the bit-spindle feed. The centering jaws are assisted

of the available timber.

The bit spindles are arranged in two groups of two, three or four spindles each with adjustment between the groups for gage, and between the spindles of each group for different widths of rail bases and tie-plate punching. A tie-boring templet having hardened bushings for guiding the tie-boring bits assures correct boring.

The automatic adzing machine (Fig. 3) produces perfect plane surfaces at the points where the rails or tie plates will rest. The heavy cast-iron bedplate carries two housings, one fixed and one adjustable thereon. Each of the housings carries an independent arbor with a shear-cutting, expansion adzing head 11 in. in diameter and cutting up to 14 in. wide. The feed is by endless chains fitted with carrying dogs and driven by gears from the main shaft. A self-adjusting equalizing device which automatically raises or lowers one or both of the ways upon which the ties travel over the cutting heads so functions that the depth of cut is divided equally between the two ends regardless of bends in the tie, instead of the low end being cut much deeper than the other.

In-feed conveyors deliver ties from the skidways to the machine proper. The trim saw is placed first in the train. Saws 30 in. to 36 in. in diameter are used. The adzing machine receives the ties from the trim saw. The boring-machine feed moves them at an accelerated speed to the bits. There they pause, are centered, clamped and bored, and passed on to the brander which is placed to the rear of the borer. Out-feed conveyors pick up the ties at this point and deliver them to trams. These conveyors are fitted with an accumulator which when thrown in causes ties to be retained by the conveyor while the outgoing trams are exchanged. This provides time for the operators to dispose of a loaded and place an empty tram in position without stopping the machine feed; thus constant production is maintained. A shavings-removal system is provided. The machines are built with shaving chutes at each adzing head and group of bits, with flanges for connecting the piping leading to a shaving-exhaust fan. A cyclone dust collector is used where shavings are delivered in the open.

Portable installation is advantageous when plant conditions make it more economical to take the machine to the ties than to bring the ties to the machine. Also where the machine may be required only a part of the year in one plant and can be conveniently moved to another and thus be kept in practically continuous operation throughout the year.

The car which forms the basis of the portable outfit must be of steel underframe construction, 50 ft. long and of the greatest possible width, within standard clearance limits. The power plant is usually a heavy tractor-type internal-combustion engine. When the trim saws are included in the equipment a six-cylinder engine developing 90 hp. is employed. When the saws are not included a four-cylinder engine of 62 hp. is sufficient. Through a suitable transmission with lever control the engine drives directly to the tie machines or to the car axles giving a self-moving speed of about 100 ft. per min. for traveling about the tie yard.

To operate a tie-machining plant a crew of eight men is required, consisting of one foreman mechanic, his assistant, the machine operator and five laborers. Six to seven ties per minute are run and 2500 to 3000 ties per day are machined, or about 500,000 per year.

Discussion at Forest Products Session

Edgar U. Kettle opened the discussion with references to Mr. Park's paper on Engineering in the Furniture Factories. He stated it was his belief that Mr. Park's provisions for the handling and transporting of material would be more applicable to the old-time system of laying out a plant and that if his scheme were followed the comparatively small manufacturer would be obliged to carry a rather heavy overhead. He also referred to the fire risks involved in such a system and gave as his opinion that it would be more advisable to install a modern kiln.

H. C. Dickinson spoke of the large economic loss due to fatalities among workers. He stated that while a few states have passed effort will be made to have it adopted by the various states that there may be some uniformity along these lines. Codes for the logging and sawmill industries can be obtained upon application to the Bureau of Standards, upon which the Bureau is very anxious to obtain criticism from practical men.

Marion Cattermole spoke of the possibilities of applying automatic machinery to the processes involved in furniture manufacture and thus reducing to a very large extent the cost of manufacture. Very little had been done in this direction, he said, and in his opinion the possibilities were enormous.

The chair next called upon Mr. C. P. Winslow, director of the Forest Products Laboratory at Madison, Wis., who spoke of the work of the Laboratory both as regarded its efforts along the lines of conservation of the natural resources and of its value to the industries. Referring particularly to the work the laboratory is doing to assist the industries in solving their problems, Mr. Winslow discussed the question of assigning values for stresses of the various woods in use. This question, he said, depends upon the size and character of the logs and until the consumer realizes this fact and will insist upon securing the material by grades, the problem of safe working stresses cannot be settled upon. He also spoke of the attention that is being given to the question of standardizing the improved grades of lumber and to the work done on structural columns. The boxing and crating for the shipping of goods for domestic and overseas shipment is another problem receiving the attention of the Laboratory, said Mr. Winslow, and this work has varied all the way from the packing of machine guns for shipment to China to the packing of glass and cream separators, and has involved the question of the kind of nail, the type of strapping, the selection of wood, and the thickness for different commodities. Due to faulty packing the losses from this cause amount to as much as $100,000,000 a year. He also mentioned the work of the Laboratory in connection with by-products, particularly their coöperation with the manufacturers of paper and pulp. One of the most important phases of their work, he said, deals with the utilization of small material and there was considerable work being done toward the development of glues which would give joints not only as strong as the wood itself but also as permanent. If this were done he believed it would have an important bearing upon the economics of the woodworking industry.

Herman M. von Schrenk spoke both of the extremely wasteful methods employed in the woodworking industry and of the great need for proper understanding and full application of engineering methods.

Mr. Hall's paper on Electrically Driven Sawmills, brought forth a number of questions dealing with the type and size of motors employed and the power requirements for the various machines in use with the many types of wood encountered. To these Mr. Hall replied that induction motors were almost universally employed and that for a saw not larger than 54 to 60 in., 3-hp. to 4-hp. motors would be necessary. This somewhat indefinite statement was commented upon by Benjamin F. Tillson, who requested that Mr. Hall supply, if possible, more accurate information as to the precise motor sizes which were required for actual operating conditions. Grant B. Shipley also discussed the question of motor sizes and ratings and moved that the question of electrically driven sawmills be referred to the Committee on Woodworking for further study and that they should collect data concerning power requirements of various machines for cutting the different types of wood, not only for large but also for small sawmills. This motion was duly seconded, put to vote, and carried unanimously.

In a written discussion submitted after the meeting, G. B. Muldaur called particular attention to Mr. Winslow's remarks relative to the work done at the Forest Products Laboratory on the strength of wooden columns and the lack of definite data on the subject. Mr. Muldaur wrote that the Underwriters' Laboratories of New York had recently completed a most elaborate set of tests on columns of all classes, including wood, and that the results of these tests were now being compiled in book form and would be ready for distribution in the near future.

Policies for Future Power Development

The Demand for Central-Station Electric Power and How That Demand May be Met Economically—Conservation of Natural Resources and Labor

By COL. JOHN PRICE JACKSON,[1] PHILADELPHIA, PA.

The primary purposes of this paper are (1) to present the problem created in this country by the present acute shortage of central-station electric power, and the large growth of demand for such power; and (2) to set forth the physical, public, and financial relationships that appear essential for relieving the present stress and meeting the continually enlarging demand with reasonable economy and conservation of natural resources and labor. The first purpose is dealt with in the first half of the paper, and includes a comparison with the situation in England. Treatment called for by the second purpose begins with the heading Natural Power Districts, and extends to the end of the paper. The latter is largely an exposition of the possibilities and advantages of unified power systems for supplying the power required by natural power districts.

In a large industrial district with which the writer is familiar there is a large load ready and waiting to be connected with the central-station systems; and were there a wholly adequate and reliable supply of power at the disposal of the power companies in this territory, their present large aggregate load would be greatly increased. Expressed opinions of industrial and central-station men, as well as various statistics, justify the conclusion that an equally pressing situation exists in most or all of our important industrial centers.

The shortage of central power is serious by reason of the fact that it interferes materially with the natural productive growth of our country and with the prosperity of its several communities. Another even more serious element relating to such power shortage is the fact that it continues the use of a large number of isolated steam and electrical plants, most of which are consuming from two to four times the amount of fuel which would be required were the power supplied from efficient central stations. Moreover, the lack of sufficiently adequate central power systems makes impossible the economic utilization of many water powers which would become available if they could pump their power in the form of electrical energy into great electrical distribution systems having heavy demands.

To so develop the central power systems within a reasonably short time that they will meet the present deficiency, absorb the great amount of unconnected or isolated loads, care for the natural growth of demand, and utilize our fuels and water powers most advantageously, represents, in this country, a problem of gigantic dimensions which will require much wisdom to solve.

The English Situation

An even more striking situation affects England, where an acute shortage of fuel and inadequate development of electrical power had placed her, by 1917, in a position in which she was unable to keep up with the increased industrial growth demanded for war purposes. In this regard the situation was somewhat analogous to our own a year later, and is therefore of interest to us. The Board of Trade, a governmental body in England, appointed investigating committees of eminent engineers to study the situation and recommend programs for overcoming the difficulty.

As a result of these investigations it was found that enormous quantities of fuel were being ineffectively consumed by reason of the use of large numbers of comparatively small central stations, and by great numbers of isolated industrial plants.[2] The central stations also were unprepared to act in coöperation, and thus there were found in the area of greater London 70 concerns supplying electricity to the public with 70-odd generating stations, 50 types of systems, 10 different frequencies, and 24 different voltages.

As a result of these findings a bill was introduced in Parliament, which later became a law after modification of some of its compulsory elements. This law provides that there shall be a central body, known as the Electricity Commission, which is given wide powers relating to the national electric-power supply; that the British Isles shall be divided into large power districts in which electric-supply undertakings shall be "unified," the districting to be approved by further action of Parliament; that power boards composed of representatives of the power interests and others, shall be constituted in each of these regions; and these boards shall have charge of the operation of all power plants and transmission lines in their respective territories, including isolated plants, as well as the development and promotion of plans for expansions. It further provides for the transfer of central plants and transmission lines to the boards under certain conditions and gives them large powers of enforcement.

Direction of Development in America

Though the problem is much the same, the conditions in England differ in many ways from those in the United States, for here our commercial power companies have, of their own initiative, progressed far beyond those in England. In this country the growth of large, economical power systems is distinctly and actively under way with but relatively little direct governmental supervision. Furthermore, while English municipal ownership of power utilities has been actively growing, in America the commercial power systems have been developing with enormous rapidity. Again, during the ten years ending with 1917, America increased her central-station output from 123,000 to 241,000 kw-hr. per year per employee, with similar reductions in the use of fuel and other supplies per kw-hr., while in England the coördinate development has been relatively less satisfactory.

However, though the United States is in a better position than England, the demand here is insistent for even more adequate and reliable power systems, for the purposes of reducing at least the rate of increase of depletion of our natural resources, and for better conservation of our labor. To meet this very proper demand requires concerted action. Much has already been done in concert by way of coöperation and unification, but the time has come when more concrete and highly crystallized coöperative policies can be successfully determined upon by privately owned companies. Only by proper policies of this kind can such extensive governmental interference as has occurred in England be obviated.

As the United States is entering into the coming era of peace, indications are that it will face, in its foreign trade end and in its home market, a sharper competition than ever before from the other civilized nations of the world. Such competition is healthy and desirable, for it places us in a position where we must use every endeavor to produce along all lines with the greatest economy. This involves continued development of power production in the way which will most rapidly increase its efficiency in regard to the use of natural resources and labor, and at the same time provide, as far as feasible, a fully adequate and reliable power supply for all those in need of it, particularly for industrial purposes, wherever they may be located.

The Magnitude and Character of our Power Problem

The United States Geological Survey has recently tabulated the use of fuel for power purposes in the United States, based on estimates of 1919 power production and census figures.[1] It is estimated that 333,000,000 tons of coal were utilized in producing energy during 1919. Steam railways produced about 37.5 billion horsepower-hours and used 148 million tons of coal, or about 8 lb. per hp-hr. This includes the fuel for heating and auxiliaries. Manu-

[1] 1414 S. Penn Square., Mem.Am.Soc.M.E.

[2] Report of Electric Power Supply Committee (Cd. 9062), published in April 1919. (English.)

Abstract of a paper presented at the Power Section of the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Files of U. S. Geological Survey, Power Division, Sixth Ave., New York City (Henry Flood, Jr., Executive Secretary, under date of Nov. 1, 1920).

numerous, mostly small, plants at a cost of about 8.4 lb. of coal per hp-hr. In obtaining this figure, fuel used for heating in the manufacturing plants was deducted, but water power was included in the total horsepower-hour output. The fuel rate for the output of the steam apparatus alone was estimated to be about 9.8 lb. of coal per hp-hr. In addition to the above, there was produced by central power stations and electric railways about 53 billion horsepower-hours using 40.5 million tons of coal at a cost of 1.5 lb. of fuel per hp-hr. With water power deducted, this rises to 2.3 lb. for the steam plants alone. With our modern plants this figure is of course much less.

The field for savings in fuel that could be made were the aggregate of the loads named above furnished from efficient central-station systems is evident from these figures. A large part of the unconnected load undoubtedly can and will be rapidly connected for central-station supply, connection of other blocks will probably be delayed for economic or other reasons, and part is probably not of a character for economical central supply. Loads of the character of the last two will therefore delay or prevent obtaining the full savings in fuel which would be possible were our total industrial load supplied from economical central-station systems, but nevertheless possible practical savings are very great. In addition to savings in fuel, very material savings in labor also can be made by the extended use of central power systems.

The equipment, as given by the same reference, required to produce the energies named heretofore, amounts to about 100 million horsepower, including steam-railway locomotion, of which nearly 20 million are installed in central electric power stations and electric railways, and an approximately equal amount in manufactories. Included in this grand total, about seven and three-quarters million horsepower are of water-power equipment. Something less than a third of the central-station equipment is hydraulic, or about five and three-quarters million horsepower. Economic considerations will largely determine the rapidity with which this latter figure can be increased by further development of the available unused water powers of the country.

Census figures show that from 1907 to 1917 the output of central stations grew from less than six billion kilowatt-hours to over 25 billion, or more than doubled each five years. It should be noted, however, that electric railways are not included in these as in the former figures. During the same period the value of the central power properties increased from approximately one to three billion dollars and the annual gross income from about 1.75 to 5.25 hundred million dollars.[1] That this growth has been continuing is borne out by an extensive investigation, made by the writer with Henry Flood, Jr., Frederick Darlington, and others, of a typical American power district where the central power business had just about doubled from 1915 to 1920. It was also found in the same district that there was every reason to predict another doubling of the business in the period from 1920 to 1925 and further substantial increases thereafter. Available information leads to the conclusion that conditions similar to those of this district prevail throughout much of this country.

The above figures referring to the enormous expected central power demand, and other considerations, indicate that the following are among the most important activities to be undertaken in connection with the power situation as it faces the country today:

(1) To so design the construction and direct the operation of central power systems as to make possible the highest practical economy and conservation of natural resources and labor; and also to provide a fully adequate supply of power for all purposes.

(2) To so arrange by interconnection of transmission systems and otherwise that the maximum amount of water power may be developed. The amount of water power utilized can and will greatly increase with the rapidly growing power demands, but in many important industrial sections of the country, where water power is scarce, it will require much wisdom to cause the increase to become a greater percentage of the total power than now exists. Many watersheds having reasonably constant flow, however, but the consumption of fuel.

(3) To place steam plants, as far as possible, close to coal mines or on waterways in order that energy may be transmitted as much as possible in the form of electric power rather than in the form of coal, with resultant reductions of freight charges and relief to railroad traffic.

(4) To supply practically all industries with power from central power systems, which would result not only in an enormous coal saving, but also in a large saving in man power, maintenance supplies, and in transportation.

(5) To largely electrify the railways. This would make possible a great reduction in the fuel used for transportation purposes and relieve the railroads from carrying a large dead weight of coal freight for their own purposes, and also would make available the materially increased duty of railroad trackage and equipment which is possible by electrification.

(6) To not only make the central stations adequate for all of the above purposes and the expected future growth, but fully reliable.[1]

(7) To conserve a larger proportion of the valuable chemical constituents in the coal; such products are now recovered from only a small percentage of the total coal mined. Closely related with this problem is the conservation of our oil and natural-gas supplies. A discussion of these problems is not directly within the sphere of this paper, but it is believed that the suggestions for power development contained herein are along lines to coördinate with their solution. The problems are acute, for our oil and natural gas are showing signs of exhaustion, and though under present rates of consumption our coal may last a few thousand years, if the present increase in the rate of demand continues, it will be exhausted in a very limited time.

(8) To work out programs which will enable the financing of our power systems to be handled with facility. By the census there were three billion dollars invested in 1917 in the central-station industry, not including electric railways. About double that is needed now or as soon as the equipment can be produced, say, in 1922 or soon thereafter, and at least four times the 1917 capital will be required well before 1930 if reasonable progress is made.

The large sums of money indicated as necessary during the next few years for power development will in a large measure be spent even though no concerted effort be made to solve the power problem by a fully coördinated plan. But without concerted action there would be no possibility of such excellent returns, either in the form of earnings for the public and security holders, or in conservation of natural resources and labor. Were we advanced to a point of highly efficient central electrification of all power absorbers, with reasonable use of water power, the saving in fuel alone would amount to vast sums of money per year, with probable total savings of from two to three times as much if labor and all economies were included. The following suggestions with regard to power districts are intended to indicate the lines of a concerted policy of unification which would encourage these savings and at the same time accelerate central power development along the natural lines in which it is now advancing.

Natural Power Districts

The trend of power development during the past few years, and the present tendency, is toward the enlargement and unification of the power systems in large natural power districts. The boundaries of a natural power district are largely determined by the considerations that the region should be sufficiently large and the load of a character to enable it to sustain and properly use generating plants of a size and character necessary to give high economy, and at the same time have a territory sufficiently compact that the exchange of power between the several parts can be carried on conveniently and effectively. Due regard must of course be paid to the location and character of natural power resources. The actual area of a district to fulfil these conditions may vary

[1] United States Census, Central Electric and Power Stations, etc., 1917.

[1] J. W. Lieb set forth emphatically the need of "absolute continuity of service" in the discussion of Electric Supply at the meeting of the American Institute of Electrical Engineers in February, 1920.

widely; thus, the conditions of load, population, and natural resources demand a much larger territory for economical operation in California than is required by a district centering in New England.

A unified central power system supplying the power requirements of a natural power district inherently tends toward highly economical service, because such a system makes it possible to reduce to a minimum the aggregate amount of fuel used in the power plants through the possibility of raising the use of factors of the most economical plants of the region and lowering others, to take advantage of load diversities in the several parts of the district, to maintain a minimum of reserve equipment, to place necessary new plants at the points most effective from the standpoint of natural resources and the load, to more fully utilize water powers, and to permit a higher degree of reliability.

The selection of power sites for accessibility to coal mines, condensing water, water power, etc., has already become difficult with the present large stations and power demands, and with the great expected growth of these demands this problem will become more difficult. Unified action in a power district is of much value in this regard.

Those in charge of operations in a natural power district should design the unified system with the view to obtaining as far as practicable the same efficiency of production and delivery of power to all uses or users of power over the whole district, as is now attained in the big centers of power supply, if reasonably satisfactory conservation of our resources and the best welfare of our country and the power companies is to be obtained. It is evident that such objects require full standardization of voltages, frequencies, systems, etc., throughout the district, or better, throughout the whole country. Such standardization mostly exists in the United States, but it has not reached perfection.

At the present time the growth and unification of power districts is proceeding steadily, as may be noted by the situation in the New England States, the tying together of various companies and successful coöperation in western Pennsylvania and eastern Ohio, the getting together of a number of power companies in a group of the Southern States, in the unified control of the central-station systems of the Pacific Coast, etc. This kind of coöperative development was given a distinct and its most important impetus forward, during the war, by the Power Division of the War Industries Board, headed by Frederick Darlington, which was faced with the problem of relieving an acute shortage of both power and fuel, and the development of additional power to meet the rapidly growing demands caused by war activities. Mr. Darlington, after having examined the subject, concluded that the wisest procedure was to take advantage of and promote the natural tendency toward unification and coöperation of power interests in natural power districts, and with that object in view, dealt with several sections of the country as distinct units, or districts, including those referred to above.[1]

Experience during the war and various results found in peace times are sufficient to lead to the conclusion that both investment and operating costs will usually be so reduced by unification in properly limited districts as to make this kind of power supply attractive from the financial point of view.

UNIFIED POWER SYSTEMS

By the term "unified power system" (or unification) as used heretofore in discussing natural power districts, is meant a system in which the several component parts or companies combine and interconnect to obtain the efficiency and service which would be rendered if the entire district were operated by a single power company. Further, the terms used and discussions of the power problem herein are to be understood as confined to the generation and trunk transmission of power only, and not to include the distribution from the trunk-line load centers and its retail sale unless otherwise indicated.

The purpose and scope of this paper do not warrant entering into a discussion of technical engineering features, but the transmission of the power in quite large unified systems is feasible with existing equipment; thus, in a certain natural power district, a practical transmission system with switching and substations was recently laid out for a future growth to over a million and a half kilowatts. The technical work in laying out this system was largely done and was all approved by some of the best transmission engineers of the country. It is believed that projects which exceed this can be handled safely, though the difficulties to be met and the skill required for their solution should not be minimized.

The most simple method of handling a unified system, covering a natural power district, is by placing the entire generating and transmission apparatus in the hands of a single power company, either by purchase, lease, or the equivalent; where this is the condition no comment is necessary as to methods of operation or construction programs. Where it is not found advisable to arrange such a coalescing of the power companies the several systems of the several companies can be unified and operated as though they were under one ownership by the companies combining in the appointment of a power administrator, who is given full authority to direct the generation and delivery of power as he finds will result in the greatest economy to the entire district.

Where a power administrator is used, arrangements must also be made under which there will be an equitable distribution of earnings among the several companies. An example of a formal plan for accomplishing this is to have each integral company in the district compensated fully, with a reasonable profit, for its facilities in the way of power stations and trunk transmission lines with their substations, etc., which it holds ready for service. In other words, all company expense such as interest, depreciation, amortization, taxes, and insurance, with the addition of reserves and profits, constitutes readiness-to-serve expense for which the power companies are compensated. In addition to this, each company having generating stations or trunk transmission lines will be compensated in full for every operating expense incurred for power generated or transmitted under orders of the power administrator. The companies then pay for the power which they take from the unified system load centers, for retail distribution and sale, at rates per kilowatt-hour which, when applied to the aggregate power generated in the district, pay the combined ready-to-serve and operating charges named above. The price paid by a company for power purchased should, of course, have contained within it adjustments for load and power factors. The greatest difficulty entering into such a formal arrangement is the determination of the value of available facilities, but this need not prove an insurmountable obstacle.

A necessary corollary in this example is that the several integral companies in the district join together in laying out programs of construction in order that, as the load grows and additional stations and facilities are required, they may be developed in the way best to procure the highest economy for the district as a whole, and therefore, under the scheme dealt with, for each of the component parts.

In such programs of construction or in any arrangement of unification involving more than one company, it may readily be found advisable that the component companies join together in the development of a water power or the construction of a large steam power plant, say, at a coal mine, through the medium of a new company, or otherwise, rather than by settling the entire burden upon one of the component companies. A successful case of such joint action is to be found in the modern steam plant at Windsor, W. Va., on the Ohio River, built jointly by the West Penn Power Co. and the American Gas & Electric Co. through the agency of a third company created and owned by them.

Rather than have a single ownership, it may be found more advantageous in a natural power district to form a company which would make the interconnections, handle the interchange of power and settle the intercompany bills, as is done in Switzerland or at Windsor, or to work out other arrangements to meet the special conditions and needs.

It should be noted that the two companies at Windsor operate largely in different states, while the several interconnected companies in the entire power district in which they are located cover parts of Pennsylvania, Ohio, and West Virginia. Little difficulty has been encountered by reason of the crossing of state lines.

The idea of unification with a central power dispatcher, acting jointly for several companies in a district, is not a new one among engineers; as early as 1911 William B. Jackson, as the result of

[1] Report on the Power Situation During the War made by General Charles Keller to the Secretary of War.

and the possibility through it of reaching small communities not otherwise within the range of electrical supply.[1] Further, we have an example of a unified natural power district using a power administrator, which has proven satisfactory to the power companies within it and to its people. This is on the Pacific Coast, where the several companies have worked excellently in coöperation since 1918.[2]

For a recent period of power shortage accentuated by low water, unification arrangements were renewed by a written agreement among 17 power companies in Oregon and California, made last March before the State Railroad Commission, a part of which follows:

> We, the undersigned, hereby pledge that we will obey and carry into effect to the limit of our ability all rules, regulations, and orders of the Railroad Commission concerning diminution of service or taking on of new business, and interchange or delivery of power between the several companies.

The Railroad Commission was voluntarily selected by the companies as their agent and arranged to exercise the full powers, thus delegated, through a power administrator. There seems to have been no vital reason for having selected a public board as power administrator rather than any other person or body in whom the power companies and people have full confidence.

It is altogether to be expected that as unified systems in the natural power districts of the country develop, they also will find it advantageous to make interconnection for emergency and other services. In some cases it may be found that switching arrangements for connecting up the ordinary transmission lines in contiguous districts will be sufficient. In other cases it may be found that several unified districts can, to advantage, join together in the development of a large water power, say, such as on the St. Lawrence and Niagara Rivers in connection with the New England and Middle States, and part of Ohio, and perhaps in the building of a system of plants in the coal regions of Pennsylvania and West Virginia, for supplying more easterly territories.

W. S. Murray has suggested that some such arrangements may be desirable between the Atlantic Seaboard districts which he is at present investigating as the representative of the United States Geological Survey.[3] It should be added here that the investigation being carried out by Mr. Murray and his staff, as a bureau of the United States Geological Survey, is in response to a special act and appropriation of Congress. He has been given wide scope to study the present conditions of power utilization in a belt of territory bordering the northeast Atlantic Seaboard with its enormous industrial and railroad activities and to work out plans for electrical supply which appear advantageous. He has surrounded himself with a group of strong advisers whose joint judgment will be generally accepted. The findings will doubtless give another impetus to the use of central-station power and to unification.

Public Relationships

One of the most important elements which should be considered in bringing about the unification of a power district is that of proper relationship with the public. Effective joint publicity should be inaugurated which would make clear to the people of the district the value of unification, and the ways in which the public can serve to aid in bringing about such a condition of power supply.

The prosperity of every industrial community and of the nation is vitally dependent upon success in properly meeting the present and expected power demands of the country. There is every reason, therefore, to believe that redoubled attention, on the part of the power companies, to the subject of public relations—particularly if activities of this sort are under the direction of joint authorities for entire power districts—will create an adequate popular

[1] Advantages of Unified Electric Systems Covering Large Territories, by William B. Jackson, Proc. A.I.E.E., vol. xxx, 1911, page 131.

[2] Reports of the Railroad Commission of California for July 1, 1917, to June 30, 1918, and for July 1, 1918, to June 30, 1920.

[3] Economical Supply of Electric Power, by W. S. Murray et al, Midwinter Convention of the A.I.E.E., February 1920.

Special attention should be given to the development of laws whereby capital invested in power systems would be reasonably assured by law as to stability and return, instead of being subject to a modified status with every change of administration or public-service commission. One of our most capable and experienced financiers and industrialists in emphasizing this, recently said that, "Public-utility commission actions should be governed by definite laws". . . . "They should be bound to respect and recompense capital invested in public utilities according to plans definitely set out by enacted laws, so that the security to investors in railroads, electric power properties, gas plants, etc., would not be dependent on the personal attitude or judgment of transient commissions." Another man, also of high national standing, makes the statement that: "This is a government of laws and not of men, but there seems an increasing disposition to establish commissions not guided by any fixed or determined principles of law, but which have wide powers and whose decisions are frequently governed by expediency or opinion."

Laws should be enacted which would be as liberal in the matter of rights of way for power plants, transmission lines, and other needs of the power companies, as is the case for railroads or in various states with regard to water-power plants. It is particularly desirable also that the law be so drawn as to enable the power interests to share economies brought about by the ingenuity, energy, and capacity of their personnel.

With regard to this latter item it is well to call attention to the classical example of the South Metropolitan Gas Company of London, which is acting under a sliding-scale law. As the law stood in 1899, when the selling price of gas was not above 3s. 6d. per 1000 cu. ft., the return on the capital invested in the gas companies might be 10 per cent. (These figures have been modified, but the method is still in force.)[1] When the gas companies were able to reduce the price of gas, through economical operation, by a penny a thousand cubic feet, the return on the capital invested might be increased by $^1/_4$ of 1 per cent; increase of interest on the capital investment continued with each penny lowering of price, while raising of the price lowered the permissible dividend. It may be of interest to note that the returns on the capital gained under this sytem are so distributed as to give an incentive to the management and employees to make economies. A somewhat similar scheme is used by the Boston Gas Company of this country. The arrangement has the advantage of rewarding good service and at the same time bringing financial profits to the community. In the case of light and power companies the application of these methods is more complicated by reason of the varying rates charged for electric power, but the obstacles are not insurmountable and the principle is well worth considering.

The people of each power district should be brought into a closer relationship with the power companies by the distribution of securities to a maximum number of holders. If arrangements are made for payment in small installments and the stability and returns of the securities of most of our power companies are made known, there should be no difficulty in obtaining their wide distribution. Indeed, it is doubtful if there are many building and loan or savings bank associations which can show such excellent returns with reasonable safety as can our best organized electric-light and power companies. This, and obtaining financial support from large consumers, may not secure a major part of the necessary capital, but it will bring excellent returns in the nature of public support.

Financial Considerations

In order to procure the large amount of money necessary for obtaining adequate and reliable power in the United States, it is essential not only that the best plan be adopted from the engineering and business standpoints, but that it shall be one which is acceptable to the public and to public-service commissions. The plan must be one which will gain the definite approval of the latter, and the securities offered by power companies in obtaining neces-

[1] Report on Profit Sharing and Labour Co-Partnership in the United Kingdom, 1912. (English.)

sary funds should, as said, not only have the approval of the commissions, but be practically safeguarded as to earnings through stable action of the Government. The financial situation, under a properly designed unified plan for power districts with proper interdistrict connections, such as have been suggested, would better command the support of the public and protect their investments than would be the case were the necessary facilities installed and operated by several independent companies; in other words, there is undoubtedly better opportunity for such safety of investments and support by the public and the public-service commissions for a single well-worked-out plan covering a whole district, which would be clearly the right way of performing the work economically, than there would be for three or four different plans put on foot by several independent companies operating in one natural power district.

Since the success of the electrical power business in meeting industrial needs depends upon securing the necessary capital, this feature with regard to financing may easily be a controlling factor in the results. The power companies are practically obligated by their franchises and other contracts to supply the facilities needed to provide an economical and sufficient supply of electrical power. If they should not do this through failure to make the necessary financial arrangements, or for any other reason, the results which would naturally follow would be most unfortunate, and would probably lead to undesirable and in the end nationally injurious curtailment by the Government of the advantages of the strong personal initiative and incentive which now exist in the power industry of this country.

Discussion

Following the presentation of Colonel Jackson's paper at the Power Session of the Annual Meeting of The American Society of Mechanical Engineers, there was general discussion, the substance of which is presented below:

T. Kennard Thompson, who was the first to discuss Colonel Jackson's paper, stated that, as everyone knew, the greatest source of power in this country, and probably the most unified source of power in the world, was the Niagara River, and that by placing a dam four miles below the Falls nearly 200,000 hp. could be developed at a cost of not more than five dollars per horsepower. He exhibited some slides showing the site of this proposed dam and stated that power could be transmitted at 60,000 volts with a loss of only 10 per cent. According to W. S. Murray, he said, this voltage could be raised to 220,000 so as to transmit the power at least 500 miles, which would then take in both the Lake Superior and Quebec districts. It would thus reach 19 states of the Union and two provinces of Ontario, or 60 per cent of the entire population of the United States and 80 per cent of the entire population of Canada. Mr. Thompson also stated that it would be possible to develop other plants on the St. Lawrence and to obtain several millions of horsepower. If this were done, he said, Montreal would be one of the greatest seaports in the world.

E. H. De Lany suggested the founding of a Federal Bureau of Engineering and Research. "I think," he said, "that every technical bureau that has ever been inaugurated by the Federal Government has proved itself worthy, and has the support of the people." He urged the creation of the Federal Bureau on the grounds that no private corporation or society could afford to advance the funds necessary for experimental purposes and that such a Bureau could do a great deal more than either corporations or societies in the way of securing the legislation necessary to carry on its work.

John W. Lieb, in referring to Colonel Jackson's statements of the conditions in London where there are a number of plants with various frequencies and voltages, said that we face no such difficulties in this country because the systems in our great cities are fairly thoroughly consolidated. He called attention to the fact that the British Commission assumes control, not merely of "linking in," as the general term is there, but also assumes to say what type of installation an industry should use and also whether the industry ought to be allowed to instal such a plant or whether it should be made a part of a system which already exists. Furthermore, they assume the right to say what shall be the voltage and frequency in order that the proposed plant may form a part of the future prospective original system. Referring to capital expenditures and the availability of capital, Mr. Lieb said: "What the public wants is service, and the American public is willing to pay a reasonable and proper price for that service. But to obtain it, it must be possible to have adequate rates under proper supervision and regulation." Mr. Lieb also stressed the importance of the reliability of service, saying that it is absolutely essential in our great metropolitan centers to have absolutely reliable service, and that from an engineering standpoint a complete reliance on a transmission line alone, without an adequate steam stand-by, was not a safe and proper thing. The usual method of tying in and linking up of systems was also commented upon by Mr. Lieb. He urged the carrying of a joint reserve instead of each power company carrying its own reserve and meeting the capital charges thereon. "There is an important economic advantage," he said, "in having a joint reserve that is common to all." As to the tying in of systems, Mr. Lieb stated that what was necessary was not merely to have two original systems and then incorporate them by tying them together at the ends, but that the tie line should be of large capacity and should connect the systems at important generating points so that the load could be shifted back and forth at the points where it was needed. Mr. Lieb also referred to the work being done by the Superpower Survey and stated that if we wished as a nation to be leaders in industry we must go ahead with such comprehensive plans, which are essential to our economic national life.

Walter N. Polakov urged that the coal supply be conserved by utilizing distillation processes for the recovery of products now lost. We should put our coal, he said, through a low-temperature distillation process and thus obtain not only a smokeless, dustless, and odorless coal, but also certain gases valuable for domestic purposes and a residue valuable for fertilizers. Benzol, which can be used as a substitute for gasoline, as well as coal tar could also be obtained.

Harold L. Doolittle spoke of the systems now employed in California for the interchange of power. The scheme functions through the Railroad Commission and practically all of the companies in the state have agreed that future transmission lines shall be so constructed that ultimately a 220,000-volt bus line will run from one end of the state to the other and that in this way it will be possible to take advantage of any diversity in the load. Experiments have already been made on the line, he said, and there is no question as to the practicability of the scheme. In regard to economy of operation, he pointed out that there should be some method adopted which would reward public-service corporations for increased efficiency. To accomplish this in California, he said, the Southern California Edison Company had placed before the Railroad Commission the proposition of establishing some standard of operation, so that if any saving were made the corporation would be allowed to put that money in a fund. In other words, create a surplus, so that at the end of the year rebates could be made, 50 per cent to the consumer, 25 per cent to the stockholders in the company and 25 per cent to the employees. Mr. Doolittle stated that this proposition, however, had not as yet been acted upon.

W. S. Murray referred to the waste of power through the use of isolated plants and also by the railroads, and stated that the whole object and incentive of the Superpower Survey is to see that this may be corrected. Regarding the development of our waterpower, he said that the waterpower available in the superpower zone represents but a possible 15 per cent of the whole, and that therefore we must confine ourselves to a most careful consideration of the highest economic development of steam power. Mr. Murray also contributed a written discussion of Colonel Jackson's paper, extracts from which follow:

In connection with the railroads, the fuel consumption by steam engines against electric engines, respectively, in the passenger, freight, and switching service, has been shown to be 2, $2^1/_2$, and 3 to 1, and this with a thermal efficiency of the central stations driving them not greater than 8 per cent. Today the efficiency can be made to be 18 per cent, and this means that those ratios will be in excess of 4, 5, and 6 to 1. The best steam freight locomotive when burning 5 tons throws 3 tons away.

Mr. Henry Flood, Engineer-Secretary for the Superpower Survey, has placed in my hands a collaborated statement which shows that had the

coal, and as of 1930 the conservation that can be effected is estimated at 59,000,000 tons per annum.

These preliminary estimates of the savings possible through the centralization of power supply do not consider the complete electrification of the railroads in the district, nor the complete electrification of industry; for instance, on the heavy-traction railroads it is estimated that 6000 miles can be economically justified for electrification in 1920 of the total 30,000 miles within the region, and it is further estimated that the increase in electrification would grow only at a rate of traffic growth for this region up to the 1930 period, so that it considers the electrification in total by 1930 of only about 20 per cent of the total track mileage. In industry these estimates consider taking over to central power-supply sources only 50 per cent of the total power in the manufacturing industry, so that it is reasonable to state that these estimates are conservative and that they do not carry out the electrification of industry to the point of saturation.

Colonel Jackson points out the difficult situation in England with its innumerable small stations and varying frequencies. It is a lesson to us what we should avoid. Our plants are larger; our main frequencies are but two, and yet it is amazing to know that the capacity of the average-size plant in the United States is not greater than 3400 kw., and its consumption of coal per kilowatt-hour is 3 lb. The superpower stations projected will be on the order of 300,000 kw.; their economy should touch 1.5 lb. of coal per kw-hr. Again, a load factor of 40 per cent carried by a central station requires that station to burn 85 per cent of its coal before its kilowatt capacity has been taxed 35 per cent, and the remaining 65 per cent of its kilowatt capacity is used while burning the remaining 15 per cent of the coal. I think this visualizes what I have just said regarding the employment of the present large stations, which, if they are not in a position to furnish large blocks of kilowatt-hours, stand ready, however, as peak-load plants to furnish the capacity with which a very small amount of energy (kw-hr.) is involved.

Colonel Jackson says, "The time has come when more concrete and highly crystallized coöperative policies can be successfully determined upon by privately owned companies." I am in perfect accord with this statement, and I wish to emphasize at this point that the Superpower System as proposed stands alien to none, helpful to all, and that its construction will not be upon a competitive basis. The entity and franchise rights of the present central stations must be respected. The Superpower System through delivery and exchange will place energy upon the distributing mains of the present public utilities, and there its functions cease. Its duty will be the generation of a maximum amount of power for a minimum consumption of coal. It is to be purely a power and transmission company and will have no relations with the customers of power, except that those customers be public utilities.

Through the uneconomical production of power, coal is in the yards, on the sidings, and on the main lines of the railroads. It is competing with the raw and finished commodities for cargo space. Think what a saving of 59,000,000 tons of coal per annum in 1930 within a district between Boston and Washington, inland 150 miles, means! If that amount of coal is not required to be mined, first we have conserved nature's storehouse; second, we have relieved the railroads of its transportation and created cargo space for our other high-priced commodities which industry and expansion demand; and third, through the new process of power production as recommended in the Superpower System we will put a very large percentage of the remaining coal required for power and lighting in the form of electricity and thus create an overhead carrier system and automatically release cargo space for other important commodities.

Colonel Jackson's summation in the paragraphs of his paper numbered (1) to (8) is splendid, and the integration of these indeed furnishes an epitome of the specifications of the work undertaken by the Superpower Survey, viz.:

(*a*) Allocation of wastes and their amount, due to the present improper form of power production and distribution, and

(*b*) The recommendation of the regional plant through the means of which these wastes may be eliminated.

I am struck by his reference in Par. (7) to the average cost of a kilowatt installed by central stations up to 1917. This is $333, including the distribution system. In the past we have been required to build, due to the lack of interconnection, a plant and a quarter, the additional quarter being necessary for spare capacity. Through the proposed interconnection offered by the Superpower System, not only will this additional quarter capacity disappear, but through diversity the plant's capacity may be run below the 100 per cent line, and instead of our small plants (averaging but 3400 kw.) at a cost of possible $200 per kilowatt, the larger plants may be built at probably less than half that amount. Indeed, we have arrived at the period for the construction of enormous plants to carry the great base loads. The present unassociated load factor (and by unassociated is meant the independent operation of the industries and the railroads) now existing at 15 per cent will be lifted to 50, and thus it will not be difficult to visualize a 4,000,000,000-kw-hr. base load in a pool of power aggregating 36,000,000,000 kw-hr.

Colonel Jackson has said that special attention would be given to the development of laws whereby capital invested in power systems should be assured of a reasonable return, and in this statement he strikes a note of insistant requirement. Finance and engineering go together. It is indeed a case of E Pluribus Unum. Viewing the Superpower System from a commercial aspect and entirely apart from its basic and national importance, namely, the conservation of the millions of tons of coal pre-

The functioning of the Superpower System is within the limits of power generation and transmission. It ends where distribution begins. If it can furnish a kilowatt-hour to a local company by the expenditure of two pounds of coal where the company has been burning three pounds, it is reasonable to expect that such a company would take the power so delivered to its distributing lines, particularly when it can obtain such power with a relatively small investment, smaller than it would have been in providing its own facilities to produce the power at such a low coal consumption. In fact, there are many distributing companies so located that it is absolutely impossible for them under any condition at the present time to reduce their coal consumption much below their present figure.

Wm. B. Jackson called attention to the fact that by the development of interconnections and of network transmission circuits it would be possible to utilize many water-power sites which might otherwise remain undeveloped. Furthermore, with a reliable transmission system it would be possible to reduce the investment in steam-power stations because of the fact that the maximum capacity of the water-power plant will always be available and consequently can always be operated at maximum capacity. Mr. Jackson also discussed other factors in the development of hydraulic stations, touching upon such points as more effectual operation of the existing steam plants, coal savings, load factors, and capacity of transmission lines.

Charles W. Thomas referred to the newly created Federal Power Commission and its duty of granting preliminary and permanent licenses for the exploration and final development of water powers. He said that in his opinion influence should be brought to bear upon the Commission so that permanent permits would not be issued to those who might finally develop important water-power sites in an incompetent way.

Henry Harrison Suplee, referring to flood control of great rivers, particularly the Mississippi, the Ohio and its tributaries, stated that it had been suggested that by controlling the run-off rainfall much nearer the source and by supplying proper catchment basins, power could be developed, while at the same time losses due to floods could be entirely avoided. Mr. Suplee also spoke of the difficulty of securing local interest in one part of the country for the benefit of another and suggested that it would probably require a Federal bureau with appropriations from Congress to develop such a scheme.

H. P. Quick contributed a written discussion in which he reviewed the method of financing hydroelectric enterprises that have been built in this country, Canada, Mexico, Brazil and Spain, by money furnished partly by bankers, partly by capitalists, and partly by small investors. The promoters of these enterprises secured their money, he said, by first getting a majority control of existing going enterprises and future consumers of their power, and then issuing bonds and selling stock in new development companies, or railway, light and power companies organized for the purpose of hydroelectric development and power distribution in the various municipalities. These bonds and stock were sold as the reconstruction or improvement of the going concerns or as the new construction demanded and the revenues increased with which to pay interest on the bonds. Of course the purchase of stock or the gift of stock having great prospective value increased the income of the concerns, and the ability, standing and character of the managing engineer-president-financier and his associates furnished the additional incentive to investors to open up.

As to the attitude of American bankers toward such enterprises Mr. Quick wrote as follows:

Did American bankers assist to any great extent in these developments of foreign enterprises? Not a bit of it, and perhaps they were wise in view of the revolutionary possibilities and actualities in some of these countries in recent years. But plenty of foreigners—Canadian, Englishmen, Frenchmen, Belgian bankers and others invested in them, as they saw a large profit and thought the countries stable and were accustomed to such investments.

Now, if those same developments had been undertaken by the foreigners' own nationals, how would the undertakings have been financed? Why, by their governments, by securing control of going enterprises, or by special taxation of utilities or communities to be benefited; and this revenue or taxation, or perhaps the revenue from imports and exports, or the income from foreign stocks and bonds as collateral, would be used or set aside periodically to pay the interest on new government bonds issued

(*Continued on page 110*)

Effect of Load Factor on Steam-Station Costs

By PETER JUNKERSFELD,[1] BOSTON, MASS.

The following paper discusses the factors affecting steam-station costs, particularly the load factor. Financial loss, the author states, will result whenever it becomes necessary to operate a power station at a substantially higher or at a substantially lower annual load factor than that for which the station was properly designed. The load factor should be carefully considered in locating a central station as well as in the selection of equipment. Fuel, usually an item of great expense, is dependent upon the load factor, the efficiency in the use of fuel being greater at the higher load factors. Curves are given to show relative generating costs and boiler rating as affected by load factor, typical week-day load curves and load factors, and the load factor as it occurs from day to day and month to month.

The annual load factor is an indication of the number of hours per year that the dollar of capital expenditure in a steam station can be kept at work. The expense of using this dollar is just as great when it is working 100 hr. as when working the full 8760 hr. of the year. The returns are, however, in direct proportion to the number of hours per year that this dollar is kept at work, or in other words, to the annual load factor. For example,

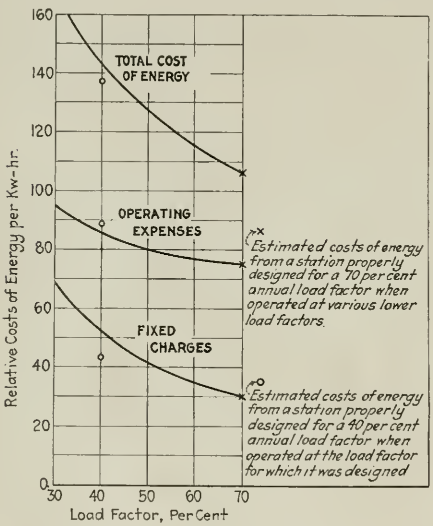


Fig. 1 Relative Generating Costs, Showing the Effect of Designing a Station for Too High a Load Factor

if the annual load factor of a power station is increased from 30 per cent to 60 per cent the fixed charges per kilowatt-hour are cut in half.

Load factor is the ratio of the average to the maximum output during any definite period of time. It is usually based upon an average demand for, say, 15 min., and upon output for a day, week, month, or year. It may apply to a system having many generating stations and serving many communities, or merely to one power station or even one unit in a power station.

The annual load factor of a central-station system nearly always changes very slowly. Special effort to secure a well-diversified business together with the new uses of electricity which are constantly arising contributes substantially to improvement in load factor.

The ordinary factory, working a 44-hr. week with the usual lay-offs for holidays, keeps a power station busy for only one-quarter of the 8760 hr. per year. Residence and street lighting tend to improve load factor in the summer, but are less and less of a help as the days grow shorter, until they finally change from a blessing to a burden upon the plant, during the months when the lighting peak overlaps the end of the factory or business day.

Investment as Affected by Load Factor

The cost of energy is made up of two principal elements, the fixed charges and the operating and maintenance expenses. In the case of the fixed charges we must use annual load factor because fixed charges run on year after year. Suppose that one power station has cost \$100 per kilowatt. At 15 per cent per annum the fixed charge per kilowatt would be \$15 each year. With an annual load factor of 30 per cent, the fixed charge per kilowatt-hour would be 0.57 cent. If the load factor is increased to 70 per cent, we find this fixed charge per kilowatt-hour cut to 0.24 cent.

This comparison of course is not wholly a fair one, because a station properly designed to operate at a 70 per cent load factor would cost more to build, although less per kilowatt-hour to operate, than one of equal capacity but properly designed for a 30 per cent load factor. Its boilers would have been rated differently, turbines of different individual capacities and perhaps different efficiencies might have been selected, the condensers would have been designed more liberally and higher-efficiency equipment would have been selected wherever economical with the higher load factor. Even supposing that those features boosted the first cost \$20 per kilowatt, we would still save probably one-tenth of a cent per kilowatt-hour in the combined fixed charges and operating expenses in comparison with an attempt to impose a 70 per cent load factor on a plant properly designed for one of 30 per cent.

The curves in Fig. 1 show the relative costs of energy from a power station designed for a 70 per cent annual load factor when operated at various other load factors. Note at 40 per cent annual load factor the lower cost of energy obtained from a station designed for a 40 per cent annual load factor. The lower fixed charges on the 40 per cent station more than offset its higher operating expenses.

Financial loss will result whenever it becomes necessary to operate a power station at a substantially higher or at a substantially lower annual load factor than the annual load factor for which the station was properly designed. Suppose that the station mentioned previously were one of several stations supplying a light and power system. Assume that at the time of its construction it were intended to operate it on a base load at a 70 per cent annual load factor, whereas the other stations supplying the system were to be operated only to carry peak loads on account of their inferior efficiency. Assume also that within a few years on account of rapid growth of load another larger station, not previously contemplated, were built having greater efficiency and that the station first mentioned no longer were operated on the base load but were operated at a 30 per cent annual load factor. We at once see that we are then using an unnecessarily expensive tool where one costing \$20 less per kilowatt would do the work just as well and at less total cost per kilowatt-hour.

Similar financial losses may occur in a single power station supplying a rapidly growing load. When a new unit is installed in a power station it is important to know approximately how soon another will be required. Each succeeding unit is frequently larger than the preceding ones, up to the practical limit of size available for the particular purpose. The increased size is usually accompanied by increased efficiency. The units of highest efficiency carry the bulk of the load. The extra price paid for extra efficiency in a power-station unit sometimes results uneconomically due to another larger unit being installed earlier than anticipated.

The cost of an error of judgment or the extra expense due to an unexpected change in the annual load factor at which a station or unit is operated may therefore be considerable.

[1] Stone & Webster, Inc., Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 7 to 10, 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

The location of a central station relative to its raw material supply and to the point of delivery of its finished product should be influenced greatly by load factor. In the selection of a site, condensing water is usually given first consideration. Transporting it adds greatly to the station fixed charges, while cooling it artificially causes inefficient operation. A very low annual load factor, likely to prevail over a long period of years, sometimes justifies artificial cooling of condensing water if the station may thereby be located near the load with a minimum investment in transmission lines or cable. With a large annual load factor the additional operating expense due to cooling the condensing water might be so large as to entirely outweigh the fixed charge on the transmission line so that the plant would be located where condensing water is available. In weighing the relative costs, the operating expense at either location must be added to the fixed charge before the more advantageous site can be determined.

Selection of Equipment

Load factor determines the quantity of fuel consumed by a power station and has considerable influence upon the efficiency with which it is burned. Starting, stopping and standing by as well as operating equipment only partly loaded, as is required at low daily load factors, inevitably result in a high coal rate.

One of the first problems, if the station be a new one, is to determine the boiler pressure. High efficiencies can be obtained with high boiler pressure. Construction cost, on the other hand, increases rapidly with increases in pressure. The economical pressure should usually be determined by the extent of the use of the equipment, that is, by the annual load factor.

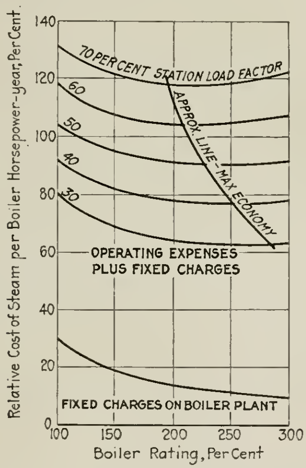


Fig. 2 Boiler Rating as Affected by Annual Load Factor on the Station

An arbitrary assumption of steam pressure or an arbitrary selection of certain principal items of equipment may so definitely restrict the design that the full financial benefits of a consideration of load factor in the later selection of additional equipment may not be realized. The most far-reaching power-station engineering is done during the conception of the project, and it is at this time, when fundamental decisions are being made which will either help or hinder the engineering construction and operation of the station, that load factor should be given the greatest consideration. This means not only the immediate load factors but also the load factors that could reasonably be expected during the probable life of the equipment.

Reference has been previously made to the differences in boiler rating for which central-station boiler plants would be designed for operation at different annual load factors. This depends upon the cost of the boilers and combustion equipment, their efficiencies at various loads, the cost of labor and maintenance at various load factor on the most economical rating at which boilers should be operated to carry the station peak load. Note the manner in which this economical rating increases as the load factor diminishes.

The rating is only one of a number of boiler-plant problems that arise which must be solved on the basis of load factor. The type and design of the boiler, the length of its tubes, the number of rows of tubes wide and the number of rows high, the combustion equipment, the location of the bridge wall and the baffles, and the size and shape of the furnace, should all be determined by reference to the total load factor on the station as well as the anticipated load factor on the individual boilers. The use of economizers even in large stations cannot be justified at very low load factors.

The economic selection of turbo-generator units may be made upon the basis of size, speed and other factors. The speed influences both the cost and the efficiency of the unit, and is very important in relation to the average annual load factor at which the machine will operate over a period of years.

The selection of a surface condenser should be made largely from the point of view of the annual load factor. A high load factor anticipated for a unit for a long period of time would justify

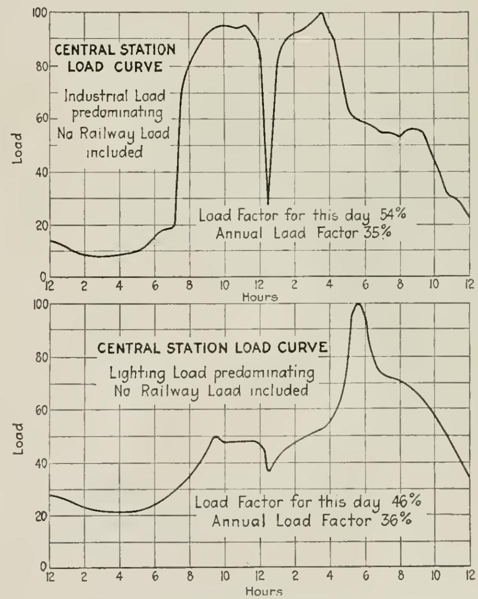


Fig. 3 Typical Week-Day Load Curves and Load Factors

a condenser of large surface so as to obtain a high efficiency in operation.

The foregoing does not attempt to mention the many power-station appurtenances contributing to higher efficiency which should be omitted from the station designed to operate at low annual load factor, but which might be justified if the station annual load factor were higher. On the other hand, it should not be overlooked that there are some instances in which it is more economical to buy more expensive equipment for low load-factor conditions than for higher load-factor conditions.

The engineers who design a power station fix the upper limit of its operating efficiency by the selection and arrangement of equipment. If this is properly done for the particular load and load factor, the total cost of power from that station, including the fixed charges upon the investment, will be a minimum if the station is properly operated and maintained. If the selection and arrangement are not made wisely the station thereafter will be handicapped either by excessive fixed charges or excessive operating expenses.

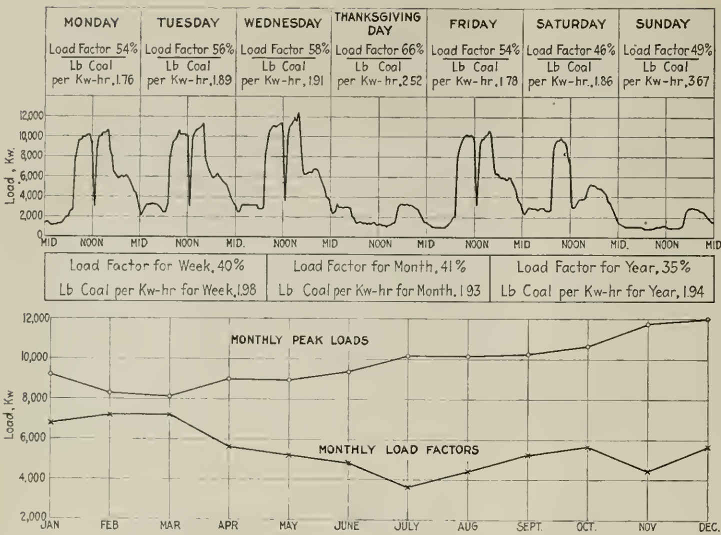


Fig. 4 Load Factor as it Occurs from Day to Day and Month to Month

Operating Expenses

The expense of superintendence and station administration is more or less fixed for a given size of station so that a change of load factor would not influence it in total amount. Boiler labor may be considered as composed of two parts, one of which depends upon the capacity of the station alone, and the other of which, for a station of given capacity, would vary with the daily load factor upon the station. Mechanical labor would be influenced by daily load factor to a less degree but would depend upon the number and size of the main generator units. The electrical labor would be influenced more by the number of feeders or the number of kinds of current distributed than anything else.

Fuel is usually an item of greater expense than all others and, as pointed out previously, it is dependent upon load factor. Efficiency in the use of fuel is greater at the higher load factors. As an example of the effect of load factor upon station operating expenses, a hypothetical case may be taken of a station containing units of various sizes which might have operating expenses as shown in Table 1. Note the fuel expense as compared with the total.

Load factor alone does not by any means determine the amount of fuel which a central station of a given size should consume. The shape of the daily load curve is of almost equal importance in its effect upon the efficiency with which the fuel is burned. The shape of the load curve is in turn dependent upon the character of the business served by the central station. This is illustrated by the two examples of central-station load curve given in Fig. 3. In both instances the lighting peak overlaps the day load, but on account of the predominance of factory load in the business of one of these stations an exceptionally favorable shape of load curve is obtained as well as a relatively high load factor for the day.

Table 1 Operating Expenses as Affected by Load Factor

	Operating Expenses, Cents per kw-hr.		
Annual Load Factor, per cent	30	50	70
Fuel	0.91	0.85	0.71
Labor for Operation	0.10	0.07	0.06
Maintenance, Material and Labor	0.08	0.05	0.04
Miscellaneous, Material and Labor	0.04	0.03	0.03
Total	$1.13	$1.00	$0.84

It is interesting to note, however, that the load factor for the year is practically the same in these two cases. This is due to the effect of the extremely low loads which obtain on Sundays and holidays. For these two conditions, illustrated by Fig. 3, having practically the same annual load factors, the better annual coal rate would be obtained with the one having the more favorable shape of load curve, that is, with the one in which the factory load predominates.

Fig. 4 shows how the load and load factor vary from day to day and month to month for a business in which factory load predominates. The beneficial effect of high load factor on Thanksgiving Day, for example, is much more than offset by the relatively small load on the station on that day. Note how the load factors for the week and for the month are practically the same. The load factor for the year is somewhat lower due to the variation in maximum demand throughout the various seasons. In general the better coal rates are obtained with the higher load factors, although this is greatly influenced by peak load, quality of fuel, and skill in operation, all of which are interesting subjects but beyond the scope of this discussion.

Discussion

In the extended discussion at the Power Session of the Annual Meeting, those whose remarks dealt more particularly with Mr. Junkersfeld's paper were Messrs. Charles Penrose and James T. Enes. Mr. Penrose stated that it is perhaps the foremost duty of the engineer to act as conserver of the natural resources and to obtain the greatest possible economy in power-station design. If this is true, he said, then instead of designing a power plant for existing loads it should be designed for abnormally high loads and then the load should be developed. This could be secured by a combination of circumstances and loads, including railroad electrification, street-railway load and industrial uses. There has been secured, he said, within a short radius from New York City a load factor which at the present time, exclusive of Saturday, Sunday and holidays, has the high figure of 78 per cent.

Mr. Enes referred to the relation between the investment and load factor, which in turn depends upon fixed charges and operating expenses. Since we are now entering a new era of increasing prices, he said, it will be very difficult and perhaps impossible to determine such charges. We have in mind prices and the actual value based on the entire life of the plant. The problem is thus complicated because of the fact that we are now entering upon a period of increasing prices.

POLICIES FOR FUTURE POWER DEVELOPMENT

(Continued from page 107)

to bankers of other nations who would take them and sell them to their customers, clients, stockholders, etc., or they would be taken by the construction companies and sold in the same way.

Now that fact of government-issued bonds with guaranteed income at high rates of interest from the start is the inducement that leads the United States bankers to take the securities of foreign stable governments, as they have been doing recently, which funds are to be used for hydroelectric developments that will enable electrification of railroads and industries, and make great savings in fuel. For, what bankers are as a rule looking for is securities that they can take at a profit and recommend to constituents as a profitable investment, either from their own investigation or that of the governments or municipalities they represent.

I believe the United States Government or its Federal Power Commission must do as the foreign governments are doing in order that the funds may be raised for these enterprises. In other words, having sanctioned the enterprises, issued licenses, fixed the rates for interest and for power, guaranteed the efficiency and caused the cost or value to be filed with it, they must go further and find the funds to develop by first finding or arranging for the money to pay the interest, then issuing the securities to be sold to bankers, and they in turn to investors, on the strength of Government backing and guaranteed interest from the start.

Those who provide the money for interest, through taxes or assessments, must expect to get it back in some way, either through enhanced values of property, or improvements, lower rates, cheaper power, etc. The Commission will then have to regulate the use of funds during construction by the engineers and contractors, and lease the enterprises to operating companies for the term of years, specified in the Act.

By E. B. Rosa,[1] Washington, D. C.

The United States Government is carrying on a very considerable amount of scientific and engineering work through a large number of bureaus located in several different departments. The Agricultural Department is sometimes spoken of as the greatest scientific institution in the world. The Geological Survey, the Bureau of Mines, the Reclamation Service, the Bureau of Standards and other bureaus are well and favorably known for their scientific and engineering work. The importance and economic value of such work is only appreciated by engineers and others who have been brought into intimate contact with such work. Our industries and our civilization are largely based on science and its manifold applications, realized in practice through the various branches of engineering. That the Government should foster science and engineering and cooperate with and develop the industries by means of scientific and engineering research is very generally admitted. There is, however, in the mind of the general public a feeling that this work is not carried on as successfully or as efficiently as it should be, that its distribution and its management could be improved, and that it probably costs too much. This feeling finds expression in the press quite frequently these days, and in terms which lead one to believe that there is a good deal of misunderstanding and misconception regarding the scientific work of the Government, its scope and value and cost. The author has therefore thought it worth while to make a rapid survey of what the Government is doing in the way of scientific and engineering work, how and why it is doing it, what it costs to do it, and, if possible, to answer the question, does it pay?

SOME months ago the writer made a study of the appropriations for all branches of the Government service for the fiscal year 1920. These appropriations were analyzed and classified into six groups.[2] The result showed that for the fiscal year 1920, 3 per cent of the total budget was appropriated for general governmental purposes (legislative, executive, and judicial), 3 per cent for public works, 1 per cent for research, education, and development, and 93 per cent for the army and navy, railroad deficit, shipping board, pensions, war-risk insurance and interest on the public debt, all of which are either obligations arising from the war or for preparation for possible future wars.

In order to get a more accurate knowledge of Government expenditures, and to ascertain how they have increased in recent years, the receipts and expenditures of all departments for the past ten years were analyzed, using the official published records of the Treasury Department for the purpose, but following a somewhat different and more detailed classification. Appropriation bills do not show the earnings or credits to bureaus and departments and hence in many cases are misleading as to the real cost of a given branch of the service. In some cases the whole cost, and in other cases a large part of the cost, is covered by fees or earnings. Examples are the Consular Service, the Patent Office, the Land Office, the Reclamation Service, the Bureau of Navigation, the Forest Service, National Bank examinations, the Federal Reserve Board and notably the Post Office. A "billion dollar Congress" was a familiar phrase in prewar days, but this did not mean that the National Government cost the taxpayers a billion dollars a year. It meant merely that the gross annual disbursements of the Government, including the entire business of the Post Office Department, amounted to a billion dollars per annum. In no single year prior to our entry into the Great War were the net expenses of the Government as much as seven hundred millions of dollars. The important distinction between gross disbursements and net expenses is too obvious perhaps to be emphasized, but it is often overlooked. This study has yielded results of very great interest and value, and throws much light on the question of the cost of government, and whether the civil side of the Federal Government is overdeveloped, and to what extent it is a burden upon the taxpayer.

The Classification Adopted

In order to obtain the relation between the scientific and engineering work of the Government and other Government activities, both as to distribution and expenditures, we may review briefly the organization of the Government, which for the present purpose may be divided into two parts, the civil and the non-civil. The civil side of the Government may be divided into three groups of departments or activities as follows:

I Primary Governmental Functions
II Research, Educational, and Developmental Work
III Public Works (New Construction).

The remaining activities may be grouped as follows:

IV Army and Navy
V Pensions and Care of Soldiers
VI Obligations Arising from the Recent War
VII Interest
VIII Public Debt, Loans, and Trust Funds.

Lastly, Group IX includes all revenues of the Government which are derived from direct or indirect taxation.[1]

Disbursements, Receipts and Net Expenses for Ten Years

In order to obtain a correct idea of the actual expenses of the various departments and bureaus of the Government, it is necessary to take account of their earnings and of credits for the sale of Government property, trust funds received and disbursed and of unexpended appropriations turned back into the Treasury. The Treasury Department publishes each year a Combined Statement of Receipts, Disbursements, Balances, etc., of all departments for which appropriations are made, as well as of revenues collected, and these official publications have been used in this study. The ten fiscal years, 1910–1919, inclusive, have been taken, the report for 1920 not being available as yet.

In some cases appropriations greatly exceed actual net expenses, and, on the other hand, certain continuing and indefinite appropriations do not appear explicitly in current appropriations. Fees and fines, proceeds from the sale of Government property and other collections are turned into the Treasury and recorded under miscellaneous receipts, and cannot be expended by the department or bureau collecting them. During the fiscal years 1910 to 1917, inclusive, the amounts of these miscellaneous receipts ranged from forty-five to eighty million dollars each year. In the two war years, 1918 and 1919 taken together, they amounted to over nine hundred million dollars, including several hundred millions for interest on loans to European governments. Expenditures and receipts are distributed among the 106 items of the eight groups, and net revenues and net expenses determined for each item and each group, and the whole added and balanced and checked against the figures given in the summaries published by the Treasury Department. For each year a summary statement was also made for Group IX showing the revenues collected through the customs, internal-revenue taxes, and taxation of national-bank circulation. These are the only revenues resulting from taxation; fees and fines and the proceeds of sales of Government property being credited to departments, as stated above, as an offset to expenses. For example, the fees collected by the State Department or the Patent Office or the Land Office, or the Bureau of Navigation, or a federal court are not intended as taxes for governmental revenue, but rather as fees to cover in part or in whole the expense incurred in rendering a special service or adjudicating a specific case, or as an administrative measure, and are properly credited against the expenses of the given agency. Most, if not all, of these agencies perform public functions and thus render a service to the public as a whole apart from the service to individuals for which a fee is collected. It is thus proper that the public as a

[1] Chief Physicist, Bureau of Standards.

[2] The Economic Importance of the Scientific Work of the Government, *Journal of the Washington Academy of Sciences* vol. 10, no. 12, pp. 341–382. Copies of this paper may be had by addressing the author.

Presented at a Meeting of the Washington Section of The American Society of Mechanical Engineers, December 2, 1920.

[1] The detailed classification adopted is given in the Appendix.

whole should pay for the general service to the public if the individuals served pay for the individual service which they receive. But it is obviously unfair and misleading to charge against a department or bureau the entire expense, and not credit to that department or bureau fees and other earnings or receipts from Government property sold, all of which have caused the expense to be greater than otherwise.

An extreme case of the kind is the Post Office. The Postal Service account is kept separate from the General Fund of the Treasury, and includes all the receipts of post-office business and all expenses other than salaries for the central administration of the Post Office Department, and certain items of a general character. In addition to these overhead items paid from the Treasury, which amount on the average to less than 1 per cent of the postal revenues, the net deficiency or net surplus is transferred over to the General Fund of the Treasury in a single item each year. During the last ten years the total of the surplus transferred amounted to $26,033,448, and the total of deficiencies amounted to $30,890,619. This is in addition to $110,000,000 special war revenue collected while 3-cent letter postage was in vogue. The excess revenue resulting from the extra cent charged, which was regarded as a war tax, was transferred to the General Fund.

The expenditures on the Panama Canal while under construction were included in the Public Works group, but after its opening the cost of routine operation and maintenance together with tolls collected were placed in Group I, while the cost of additions and betterments was included in Group III. The cost of the fortifications of the Panama Canal, however, has been charged in this study to the War Department as a military expenditure. On the other hand, the large sums spent for river and harbor improvements, which are expended by the Army and charged to the War Department in the Treasury account, have been charged in this study to Public Works, on the ground that these improvements are for civil rather than military purposes.

The Reclamation Service has annual appropriations of about nine million dollars, bu it is provided that it cannot expend any more money than is received annually through the sale of public lands and by collections from settlers for lands they occupy or for water received by them for irrigation purposes. Thus the nine-million-dollar appropriation to the Reclamation Service is only an authorization to use the money which they annually collect, or which has been turned into the Treasury by the Land Office, and hence the Reclamation Service costs the taxpayers very little. Some years ago $20,000,000 was, indeed, advanced to the Reclamation Service as a loan, in addition to the receipts from land sales and collections from irrigation projects. This has all been expended and this year a first installment of one million dollars will be paid into the Treasury toward the liquidation of the loan.

The Treasury Department maintains a large force of national-bank examiners, and expended in 1919 more than a million dollars for their salaries and expenses, but it collects and reimburses the Treasury for every dollar of it through assessments upon the banks. It also collects nearly a half a million dollars a year from national banking associations on account of salaries and contingent expenses of the Treasurer of the United States and

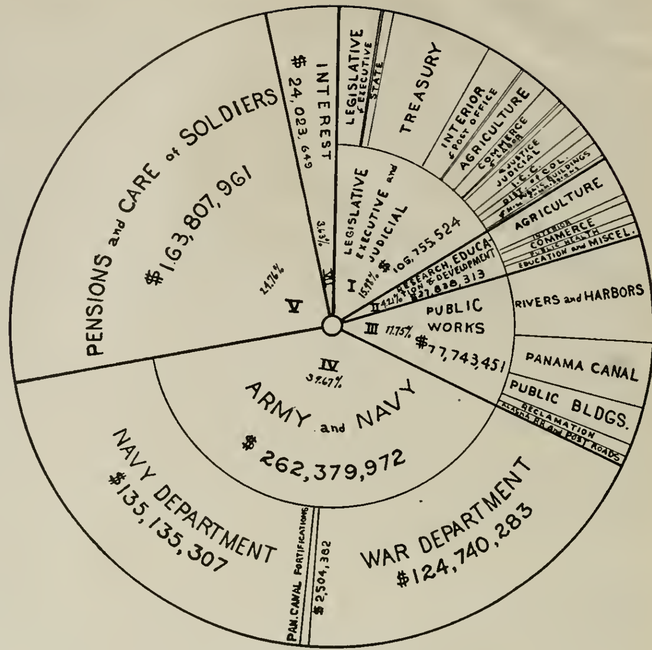


Fig. 1 Average Net Expenditure of Federal Government, 1910 to 1919, Exclusive of War Cost

Average Yearly Total.......................... $661,548,870
Average Yearly Civil.......................... $211,337,288

Fig. 2 Average Annual Net Expenditure of Federal Goverment During the Period 1910 to 1919, for Groups I, II and III—Civil Activities, $211,337,288

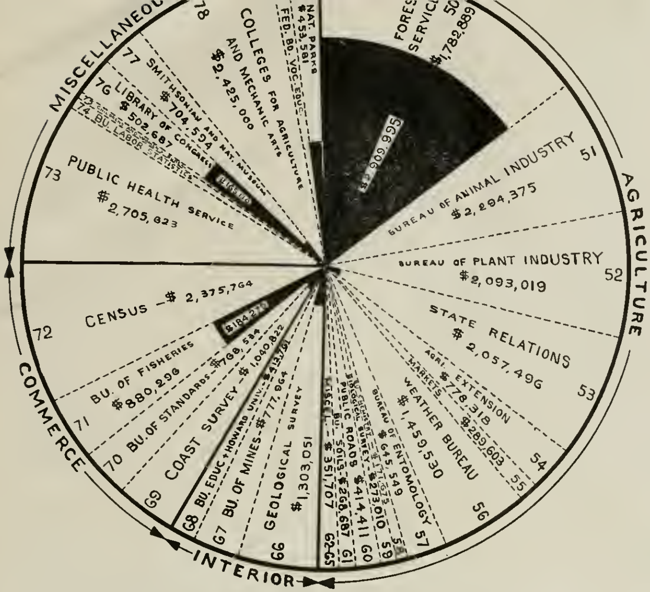


FIG. 3 AVERAGE ANNUAL EXPENDITURES AND EARNINGS FROM 1910 TO 1919 FOR GROUP II—RESEARCH, EDUCATION, AND DEVELOPMENT

Total area of each sector represents gross disbursement; black area represents receipts; white area represents net expenditure.

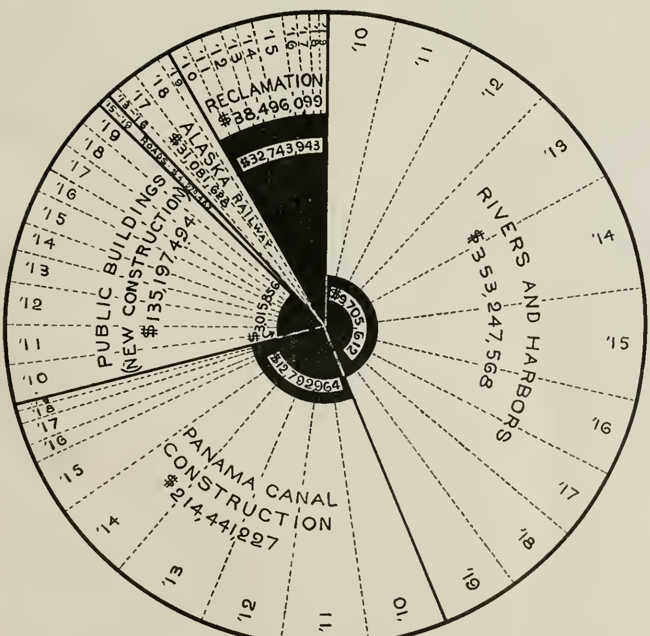


FIG. 4 AGGREGATE EXPENDITURES AND EARNINGS FROM 1910 TO 1919 FOR GROUP III—PUBLIC WORKS

Total area of each sector represents gross disbursement; black area represents receipts; white area represents net expenditure.

this sum was the Indians' own money, which the Government handled as trustee for the Indians. Only $10,500,000 was borne out of taxation as an actual expense to the Government. These examples are given to illustrate the important distinction between gross disbursements and net expenses of the various departments of the Government.

RESULTS OF THE STUDY

The results of this study have been collected in the form of numerous tables which have furnished the data necessary for the preparation of a number of charts, which graphically illustrate the results obtained. A few of these charts are reproduced here. This study covers the fiscal years, 1910 to 1919, inclusive, but for the present we are not considering the cost of the war. It was necessary, therefore, in order to show the normal relation between the net expenses of the various groups on a peace-time basis, to exclude *in the non-civil groups all* expenditures arising from the Great War; that is, the expenses for the non-civil groups for the war years 1917 to 1919 were estimated as what they probably would have been if the war had not come, the prewar rate of change being taken into consideration.

The normal relation, on a peace-time basis, between the net expenses of the various groups can best be shown by the average calculated on the above basis for the ten years. The results are shown in Fig. 1. The net annual expenses for the three civil groups, including the legislative, executive, and judicial activities, all the research, educational and developmental work, as well as public works, amounted to $211,337,288—less than one-third of the whole. If we divide this sum by the population of the country at the middle of the 10-year period, 98,000,000, we have the average per capita cost of the civil activities of the Government. This average annual cost to the taxpayer of the civil activities of the Government amounted to approximately $2.15 per capita, divided as follows:

For Primary Governmental Functions (Group I)......	$1.08
For Research, Education and Development (Group II).	0.28
For Public Works—New Construction (Group III)....	0.79
Total for Civil Activities........................	$2.15

Since the war the expenses of the Government have increased enormously, and it seems to have been assumed by some that the civil bureaus and departments have increased their activities and expenses in the same proportion as the total has increased. Much has been said and written about the great expansion of the bureaus, and this means or, at least, includes, the civil bureaus; and the need for curbing their growth and cutting their estimates is often emphasized. Some writers, while saying little of their usefulness or the increased need of their services, say much of their inefficiency, extravagance and overdevelopment, and of the duplication of work by different bureaus or departments. These statements are usually made in general terms and without proof or particulars, but they appear to be made in good faith and apparently with the belief that bureau officers are more anxious to expand their functions and spend money than to increase the efficiency and usefulness of their respective bureaus This opinion is so seriously at variance with what one should expect that it appears worth while to examine the facts in the case.

Fig. 2 shows in more detail the cost of the separate civil activities than is shown in Fig. 1. It will be noted that the legislative, executive, and judicial group absorbed almost exactly one-half of the total for the civil groups, public works represented 36.8 per cent, while 13.2 per cent was devoted to research, educational and developmental work. Expressed in terms of the whole these percentages are:

	Per cent
Legislative, Executive, and Judicial	16.0
Research, Education, and Development	4.2
Public Works	11.7
Total for Civil Groups	31.9

The actual expenditures for all the civil activities are shown for each year in Fig. 5. The variation of the total for any year from

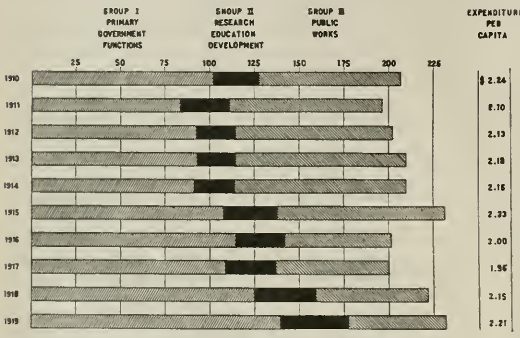


Fig. 5 Allocation of Civil Expenditures of U. S. Government from 1910 to 1919 in Millions of Dollars

the average does not exceed 10 per cent, notwithstanding the fact that general price levels for commodities have more than doubled in recent years and wages outside of the Government service have, in general, risen correspondingly. Particular attention is directed to the fact that no deductions have been made in the expenditures of these civil departments, such as the State and Treasury Departments, which necessarily had to be expanded on account of the war. The per capita net civil expenses are shown in the last column. Attention is also called to the fact that the trend of the per capita costs of the civil activities of the Government was slightly *downward* before the war, with the exception of 1915, which was largely attributable to increases in the net cost of the postal service and immigration service and to a special appropriation of $4,000,000 for eradication of the foot and mouth disease. It is proper to add that there was an appreciable increase in Groups I and II, counterbalanced by a decrease in Group III during the 10-year period.

The relationship between changing wholesale price levels, which largely represent the cost of doing business, and the per capita civil cost is graphically illustrated in Fig. 6. If the cost of the latter were reduced in proportion to the reduction in the purchasing power of the dollar in 1919 as compared with 1910, it would be found that instead of an increase in the cost of the civil government an effective reduction of nearly 50 per cent actually occurred. This largely explains the huge labor turnover in the government service and the reduced efficiency resulting therefrom, as more fully discussed later.

The sources of the revenue of the Federal Government will be of interest. It will be seen from Table 1, the data for which have been taken from the report of the Bureau of Internal Revenue, that while the principal sources of revenue are the income and excess-profits taxes, large amounts are realized from miscellaneous taxes and from customs.

The average net cost for the ten years of the civil activities, including all the research, educational and developmental activities as well as public works, was previously stated as $211,337,288. This is considerably less than the internal-revenue tax for 1920 on cigars and tobacco alone.

TABLE 1 ANALYSIS OF TOTAL U. S. TAXES FOR FISCAL YEAR 1920

Internal Revenue	Net Amount	Per Capita
Income and Excess Profits	$3,957,699,871	$37.20
Cigars and Tobacco	294,813,073	2.77
Transportation and Other Utilities	289,386,302	2.72
Autos, Candy, Furs, Jewelry, etc.	268,480,355	2.53
Beverages	197,353,439	1.86
Special Taxes on Capital Stock, etc.	105,508,052	0.99
Estate Inheritance	103,628,105	0.97
Stamps on Legal Papers, etc.	84,349,027	0.79
Admissions to Amusements, etc.	81,931,781	0.77
Insurance and Miscellaneous	24,925,468	0.23
Customs	307,253,787	2.89
Total	$5,715,329,260	$53.72

Group II The Scientific and Engineering Work of the Government

The members of the engineering profession are, however, more especially interested in the constructive activities, all included in Groups II and III. Figs. 3 and 4 have accordingly been prepared to show in detail the nature of the work and wide range of scientific and industrial research and engineering construction. Gross disbursements, receipts and net expenses are shown on these charts. While Fig. 3 is based on the *average* for the fiscal years 1910 to 1919, Fig. 4 shows the *aggregate* expenditures and earnings during the entire period, together with the relative amount for each year.

The fifteen bureaus of the Agricultural Department constitute the first half of Group II. This work is of fundamental importance not only to farmers and agricultural communities but to the entire population, for an abundant supply of food is essential to the welfare and even existence of the nation and as the urban

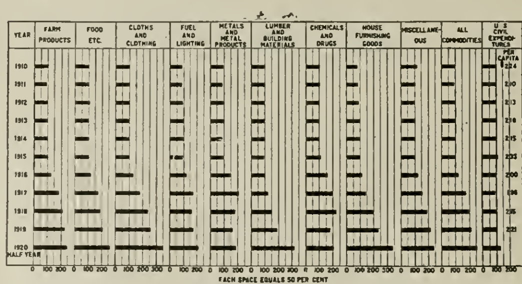


Fig. 6 Wholesale Prices for 1910 to 1920 Compared with U. S. Civil Expenditures
1913 = 100 Per Cent

population increases more rapidly than the rural, the food problem becomes more serious. The total cost of these investigations is not one-tenth of 1 per cent of the value of the agricultural products produced, and there can be no question that the value of the work done far exceeds its cost.

The Geological Survey is one of the oldest of our scientific bureaus and has done notable work of the greatest scientific and economic value. It includes, besides structural and economic geology, topographic surveys and studies of water supply and water power. The Bureau of Mines is an outgrowth of the Geological Survey, and is concerned with all the problems of mining and quarrying and the handling and treatment of their products, and also many phases of the petroleum and natural-gas industry, and the use of fuels. These materials are fundamental to the industries, and work which helps the production of fuels and such important raw materials as metals and minerals is of prime importance.

The Bureau of Education has done important and useful work, but has never been developed on a scale commensurate with the importance of its field. It is believed by many that the Bureau of Education should take a leading part in studying the science of education, and coöperate effectively with the educational institutions of the country in setting standards of education. It would not and could not dominate or control education, and there would be no danger of such a result. But it should be able to coöperate effectively and worthily, and to assist in raising educational standards where they are too low. The Federal Government is now assisting the states to the extent of a hundred million dollars

the supremely important work of education by taking a leading part in studying the problems of education?

Four bureaus of the Department of Commerce a e included in Group II. The Coast and Geodetic Survey does fundamental work upon which all other surveys are based, and also does the valuable work of charting the coasts and locating obstructions to navigation. The Bureau of Standards maintains the fundamental standards of physical measurement. It coöperates with foreign governmental institutions in maintaining international uniformity in such measurements. It provides or calibrates copies of standards for states and manufacturers so as to insure uniformity in physical measurements. It develops instruments and methods to secure the highest possible accuracy in measurement and the greatest permanence and reliability in standards. It coöperates with engineering and trade organizations in standardization work, and carries out investigations on the properties of materials to secure data for such standardization. It furnishes information to the various branches of the Federal Government, to state commissions and officers of state and municipal governments, and to the industries of the country and the general public.

Much other valuable work of an educational and developmental character is shown on the Group II chart. The average cost of all this work for the 10-year period was *28 cents per year per capita of the country's population*, certainly a very small sum in proportion to the importance of the interests represented, and also in proportion to the aggregate of the federal taxes collected.

Group III New Construction

The Panama Canal was opened to navigation in 1914. Its total cost for construction and equipment to date is $367,000,000. During the past six years its revenues have amounted to about $34,000,000 and its expenditures for operation and maintenance to $36,000,000, a net deficit of $2,000,000 for the entire period. Had it not been for the slides in 1916, which closed the canal for seven months and greatly reduced the revenue that year, there would have been a surplus of $2,000,000 for the entire period instead of a deficit. The surplus in the fiscal year 1920, amounted to more than $2,000,000, and this should increase year by year. More than $210,000,000 out of the total cost of $367,000,000 was provided out of current revenues of the Government from 1910 to 1915, and hence was included in the $2.15 per capita of civil governmental cost during these years. This is one of the engineering triumphs of the present century, and is another illustration of the successful handling of large public undertakings by the people coöperatively, that is, by the Government.

Another large undertaking of an engineering character is the river and harbor improvements, carried out by the engineers of the army but charged in this study to Public Works. During the ten years, 1910 to 1919, inclusive, more than $350,000,000 was expended in this very important work. From Hell Gate to the Golden Gate, and from Duluth to the delta of the Mississippi, this work has been carried on for many years and is of great aggregate importance.

A third important item in this group is the construction of new public buildings, and during the ten-year period in question $135,197,494 was expended in the construction of post offices, custom houses, hospitals and other Government buildings, about one hundred twenty new buildings per year being erected. The work is done by the office of the supervising architect of the Treasury Department, which for many years has handled this work. This also comes within the total of $2.15 per capita of civil governmental cost, about 79 cents of which was expended in the public-works group. In addition to the construction of new buildings the supervising architect's office has charge of the operation and maintenance of 1300 public buildings in all parts of the country.

The fourth item in this group is the construction of rural post roads, by coöperation with state highway departments. This work has been greatly expanded recently. During the ten years, 1910 to 1919, inclusive, $4,970,489 was expended in the aggregate. But the appropriation for 1920 was $99,000,000, and for 1921, $104,000,000. This is more than the annual expenditure previous to 1920 for the entire range of engineering work included in Group the country is now well understood, and there can be no doubt that the coöperation of the Federal Government will be to the advantage of the people as a whole. The building of roads is an engineering matter in which technical information and experience are of very great importance. The aid of the Federal Government not only stimulates and aids the states, which must pay at least half the cost, but tends to secure the best engineering service and to standardize road construction. It cannot fail to have a great educational influence upon engineers and road builders throughout the country, and to give the users of roads better roads and the taxpayers more for their money than if it is left to individual states. Moreover, in planning and building national highways it is very advantageous to have the Federal Government an active participant, in order to secure a better coördination of effort. As a measure of military precaution and preparedness the realization of a system of good roads on a national scale is of enormous advantage. As a help in getting food to market and supplies to farmers, it is of enormous economic value. As supplementing and in some cases supplanting railroads, such a system of highways is of great significance.

The fifth item is the Alaskan Railway, from Seward to Fairbanks. During the years 1913 to 1919, inclusive, $31,081,628 was expended on this important railway, which, when completed, will be 540 miles long. As with the Panama Canal, this is not an undertaking which private capital would care to undertake. But its ultimate success and its value in the development of Alaska can hardly be doubted.

The sixth item is the Reclamation Service, one of the most profitable and most interesting of the engineering projects of the Government. To reclaim the deserts and to create farms and homes and villages where before was waste and desolation is an inspiring undertaking; and to be able to create wealth far in excess of the cost of the work furnishes a double incentive. Since 1902 the Reclamation Service has constructed irrigation systems to supply 1,780,000 acres of land with water, and storage reservoirs sufficient to supply an additional million of acres. On this reclaimed land 40,000 families are living, and the population of the towns and villages within these projects had increased by as many more. It is estimated that the increased value of the land due to the work of the Reclamation Service is $200 per acre, or a total of more than $350,000,000. The annual value of the crops raised on these lands is estimated at $90,000,000. Most of the money expended on this work is derived from the sale of public lands and the money collected from settlers for the improvements made and the water service rendered.

The Forest Service is akin to the Reclamation Service in that it is developing the public domain. It has been included in Group II, but may be mentioned in this connection. The national forests are located in 29 states in all parts of the country, although the larger portion is in the Far West. There are 152 different forest tracts, with a total area of 156,000,000 acres. The Forest Service has the responsibility of protecting and managing these vast tracts of land; studying how to develop the land best and make its resources most useful to the public. It yields a large revenue each year from timber cut (last year 800,000,000 board feet), and affords on its grazing ranges pasturage for 15,000,000 head of sheep, cattle, horses, goats, and swine. Watching the forests for the outbreak of fire, and fighting fires when they gain headway, is one of the important duties of the Forest Service. Another duty is applying scientific forestry to the development of the forests. Still another is studying the properties of woods and methods of treating and using woods. The Forest Products Laboratory of the Forest Service has done a great deal of valuable scientific and engineering work on a wide range of subjects. In planning its work and in developing the forests the Forest Service takes a long look ahead. Obviously, no commercial company could undertake such a work. The question of early dividends is not paramount with the Government We have drawn lavishly, even recklessly in some cases, upon our natural resources, and it is well that we should be taking some thought for the future, and should be able to hand down to the next generation our public forest areas in better, rather than worse, condition than they are at present.

18 Independent Treasury, Mint and Assay Offices
19 Fiscal: Comptroller of Currency, Public Moneys, Loans and Currency, Farm Loans, etc.

Interior Department:

20 Office of Secretary and Miscellaneous
21 Land Office and Land Service
22 Patent Office
23 Hospitals and Relief
24 Territorial Governments
25 Indian Office and Indian Service.

Post Office Department:

26 Post Office Department Proper
27 Postal Service Miscellaneous
28 Postal Service Deficiency or Surplus.

Department of Agriculture:

29 Statutory Salaries and Miscellaneous Expenses
30 Meat Inspection Service
31 Acquisition of Land to Protect Water Sheds
32 Enforcement of Grain Standards, the Pure Food Law, and Animal and Plant Quarantine, etc.

Department of Commerce:

33 Office of Secretary and Miscellaneous
34 Bureau of Navigation
35 Steamboat Inspection Service
36 Bureau of Lighthouses
37 Bureau of Foreign and Domestic Commerce.

Department of Labor:

38 Office of Secretary and Miscellaneous
39 Immigration and Naturalization.

Department of Justice:

40 Salaries, Expenses, and Sundries.

Judicial:

41 Federal Courts and Penal Establishments.

Independent Commissions, Etc.:

42 Interstate Commerce Commission
43 Federal Trade Commission
44 Employees' Compensation and Retirement Commissions
45 Miscellaneous Commissions
46 District of Columbia
47 Panama Canal—Maintenance and Operation
48 Public Buildings and Grounds—Maintenance and Operation
49 Extraordinary Expenses.

Group II Research, Educational and Development Work

Department of Agriculture:

50 Forest Service
51 Bureau of Animal Industry
52 Bureau of Plant Industry
53 State Relations Service (Agric. Expt. Stations before 1915)
54 Coöperative Agricultural Extension Work
55 Office of Markets and Rural Organization
56 Weather Bureau
57 Bureau of Entomology
58 Bureau of Chemistry
59 Bureau of Biological Survey
60 Bureau of Public Roads and Rural Engineering
61 Bureau of Soils
62 Bureau of Crop Estimates
63 Bureau of Farm Management and Farm Economics
64 Bureaus of Horticulture and Insecticide
65 Miscellaneous.

Department of Interior:

66 Geological Survey
67 Bureau of Mines
68 Bureau of Education and Howard University.

Department of Commerce:

69 Coast and Geodetic Survey
70 Bureau of Standards
71 Bureau of Fisheries
72 Bureau of the Census.

Miscellaneous:

73 Public Health Service (Treasury Department)
74 Bureau of Labor Statistics (Dept. of Labor)
75 Children's and Women's Bureau (Dept. of Labor)
76 Library of Congress
77 Smithsonian Institution and National Museum
78 Colleges for Agriculture and Mechanic Arts (Land Grant)
79 Federal Boards for Vocational Education
80 National and District of Columbia Parks; Botanical Gardens.

Group III Public Works

81 Rivers and Harbors
82 Panama Canal Construction
83 Public Buildings, New Construction (Supervising Architect's Office)
84 Rural Post Roads and Forest Roads
85 Alaska Railway
86 Reclamation Service.

Group IV Army and Navy

87 War Department (Except Rivers and Harbors, etc.)
88 Navy Department
89 Armament and Fortifications, Panama Canal
90 Maintenance and Care, State, War and Navy Buildings.

Group V Pensions and Care of Soldiers, Etc.

91 Pension Office and Pensions
92 War Risk Insurance
93 Rehabilitation of Soldiers, Federal Board of Vocational Education
94 Care of Soldiers—Public Health Service.

Group VI Obligations Arising from the Recent War

95 Railroad Administration
96 Shipping Board
97 Food and Fuel Administration
98 Miscellaneous Boards and Commissions
99 Special War Activities.

Group VII Interest

100 Interest on the Public Debt
101 Interest on Loans and Trust Funds.

Group VIII Public Debt, Loans and Trust Funds

102 Public Debt Transactions
103 Loans to European Governments
104 Loans to Farmers, Banks, or Purchase of Stock
105 Seigniorage
106 Trust Funds.

Group IX Revenues

107 Customs
108 Internal Revenue
109 Tax on National Bank Circulation
110 Post Office War Revenue.
(Sales of Government Lands are credited to the Reclamation Service.)

The Fuel Supply of the World

L. P. Breckenridge has submitted the following revised table to be substituted for Table 1 in his article on The Fuel Supply of the World which was published in the January 1921 issue of Mechanical Engineering. This new table gives the figures presented at the Twelfth International Geological Congress held in Canada in 1913.

TABLE 1 TOTAL COAL RESERVE OF THE WORLD IN MILLIONS OF TONS

Eastern Hemisphere:			
Europe:			
Germany	432,356		
Great Britain and Ireland	189,533		
Russia (in Europe)	60,106		
Austria	53,876		
France	17,583		
Belgium	11,000		
All others	28,736		
Total for Europe		784,190	
Asia:			
China	995,587		
Siberia	173,879		
India	79,001		
Indo-China	20,002		
Japan	7,970		
All others	3,147		
Total for Asia		1,279,586	
Africa:			
South Africa	56,200		
All others	1,639		
Total for Africa		57,839	
Oceania:			
Australia	165,572		
New Zealand	3,386		
All other Islands	1,452		
Total for Oceania		170,410	
Total for Eastern Hemisphere			2,292,025
Western Hemisphere:			
North America:			
United States	3,838,657		
Canada	1,234,269		
All others (including Central America)	505		
Total for North America		5,073,431	
South America:			
Colombia	27,000		
Chile	3,048		
Peru	2,039		
All others	10		
Total for South America		32,097	
Total for Western Hemisphere			5,105,528
Total Reserve of the World			7,397,553

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Tidal-Power Development

REPORT on tidal power, outlining scheme for the utilization of tidal power in the estuary of the Severn, which is, next to the Thames, the longest river in England, and where the power available, by reason of the large ebb and flow, is greatly in excess of all the potential sources of inland water power within the United Kingdom put together. For this reason and, prompted by the growing necessity of economizing in the consumption of the national coal resources, the Water Power Resources Committee of the British Board of Trade has undertaken an exhaustive investigation and a scheme for the utilization of such power is suggested in its third interim report published toward the end of last November.

The Committee states that the importance of the project from the national standpoint cannot be easily overrated in view of the magnitude of the power involved, and of the far-reaching character of the economic consequences which would follow the actual development of such a scheme if it could be carried out on sound economic lines.

From data presented, one particular site on the Severn, not necessarily the best, might be rendered capable of developing tidal power representing a saving of from one and a quarter to two and a half million tons of coal per year, and this without even interfering with the navigation in the estuary.

The question is, to what extent can this be actually accomplished? In the Severn estuary the tidal amplitude is large; and the configuration of the estuary is well suited to the purpose in view. The physical characteristics of the land in the vicinity are such as to facilitate the construction of a high-level storage reservoir, while the adjoining industrial district is one in which the power requirements are already large and the power supply is likely to be absorbed completely fo· industrial purposes. At the same time, however, there is no tidal-power development of any considerable magnitude in existence and no experience available to serve as a guide.

In view of this fact a sub-committee composed of Sir Philip Dawson and Prof. A. H. Gibson was appointed for the purpose of a preliminary examination of the subject. While this sub-committee has not been able to secure any definite statement of opinion from the leading manufacturers of water turbines and electric generators that would recommend the Severn scheme as a practical undertaking, its members came to the unanimous agreement that it certainly cannot be dismissed as impractical and that a further and more detailed technical inquiry into the subject of tidal power is amply justified and should be initiated without delay. It is therefore proposed to appoint a larger committee for a more careful study of the problem, and an intensive program of investigation for this committee is projected.

What appears to be one of the greatest difficulties in the way of tidal-power development is due to the intermittent character of the service which such a development can give. The report comes, therefore, to the conclusion that if an electrochemical, electrothermal or other process were devised capable of absorbing an intermittent power supply subject to such variations as are inherent in tidal-power generation, the commercial value of tidal power would be greatly increased. Otherwise, it would be necessary to provide means for providing the intermittent output into a continuous supply more or less constant throughout the working period, and such conversion can be accomplished only at the expense of overall efficiency. (Abstracted through *The Engineer*, vol. 130, no. 3390, Dec. 17, 1920, pp. 614–615, *gA*)

Tidal-Power Development, Prof. A. H. Gibson. A technica paper, the author of which together with Sir Philip Dawson constitute the sub-committee of the committee appointed by the British Board of Trade to investigate the subject of tidal-power development, in particular on the Severn River.

The author discusses the several schemes of tidal-power development proposed from time to time. All of these schemes are based on the employment of one or more tidal basins in which dams or barrages are used, either to separate the tidal basins from the sea or from each other. The power is generated by means of turbines which are arranged so as to operate either on the falling tide only or on both rising and falling tides. In accordance with the various schemes employing two basins, the turbines are placed either in the dividing wall between the basins or in the wall dividing the basins from the sea.

The author comes to the conclusion that for an estuary of the type of the Severn, the use of multiple basins is out of the question on account of the cost. The only schemes worthy of serious consideration appear to be those based on the use of a single tidal basin developing power either in the outflowing tide only or on both rising and falling tides, and with the turbines coupled to

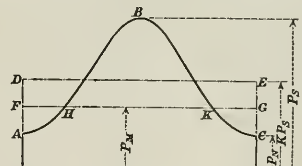


Fig. 1 Curve Representing Tidal Ranges Through one Lunar Cycle

generators which deliver directly into the distributing system when the demand permits of this, and which at other times supply the motors of a pumping station supplying water to an elevated reservoir for which a secondary system of turbines is supplied as required under a constant head.

The following will be found of general interest in connection with the design of tidal-power projects.

Mean Output during a Lunar Cycle. When the tidal range for each day during a lunar cycle is known and the working period and mean head for each day have been settled, the output in horsepower-hours per tide from the primary turbines may be determined and the curve may be plotted on a base representing the number of tides to show the output per tide, as in Fig. 1. The mean height of this curve represents the mean output of the primary turbines over the lunar cycle.

Assuming the curve representing the tidal range to be a sine curve with a mean height of H and a fluctuation $\pm h$ and assuming the working head to be proportional to the tidal range, the output per tide with the given turbine capacity will be sensibly proportional to the square of the tidal range and for any particular tide will be equal to—

$$k(H + h \sin \theta)^2$$

where k is a constant. From this is derived the mean output of he primary turbines over the whole cycle as being equal to—

$$\frac{3(P_S + P_N) + 2\sqrt{P_S P_N}}{8} \text{ hp-hr.} = KP_S \text{ hp-hr.}$$

If, for example, the tidal range at springs is twice as great as at neaps, so that $P_S = 4P_N$, the mean output will be $0.594P_S$, while if $P_S = 8P_N$, the mean output will be $0.51\ P_S$.

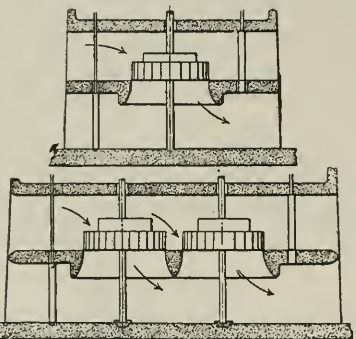
The curve *ABC* of Fig. 1 represents the output per tide in the clase where $P_S = 4P_N$, while *OD* represents the mean output per

tide over the cycle. Actually, however, a portion p of the output of the primary turbines is lost in the process in various ways. If q be the fraction of a complete tide during which the primary turbines operate and if P_M be the mean output into the distribution system from both primary and secondary turbines in horsepower hours per tide, then if p be taken as being equal to 50 per cent and if the turbines operate for 5 hr. per tide,

$$P_M = \left\{ \frac{100 - 50}{100 - 20} \right\} KP_S = 0.625\ KP_S$$

With the system of operation involving a 10-hr. working period per tide P_M would equal a value 66 per cent greater than would be obtained if all the output of primary turbines were utilized for storage.

From this the author proceeds to the consideration of the three basic schemes of tidal-power development, namely:



Figs. 2 and 3 Settings for a Dam in a Tidal-Power Development

I—Turbines operating on a falling tide only with a constant rate of fall in the basin.

II—Turbines operating on both rising and falling tides with constant rates of rise and fall in the basin.

III—Turbines operating on rising and falling tides under the natural difference of head existing at any given instant.

An analysis of the first scheme of operation on a falling tide only with a constant rate of fall in the basin shows that the range of working heads (assuming Severn conditions) is from 25 ft. to 8 ft., and the difficulty of insuring reasonable efficiencies at constant speed over this range would be great. By reducing the working head at spring tides this inequality may be reduced, and by arranging the working period so to extend beyond low tide a greater output may be obtained. By limiting the turbine capacity to that necessary to absorb the energy available at neap tides, the cost of the turbines and of the time in many cases will be reduced to 74 per cent of its original value. This can be done at a sacrifice of only 15 per cent of the continuous 24-hr. output, with economies in several other directions.

The second and third schemes are discussed in detail, the general conclusion arrived at by the author being that the first scheme, which involves operation on a falling tide only, has the disadvantage that the output is only about two-thirds of the output theoretically possible with double-way operation (Table 1). On the other hand, the output per unit of turbine capacity is sensibly the same, while it enables a much more efficient type of turbine setting to be used and the number of sluice gates to be halved. It has the further advantage where applied to a navigable river that the depth of water in the basin never falls below mean tide level or thereabouts, so that navigation above the basin is improved. The scheme is essentially more simple than any one involving double-way operation, and the balance of advantages would appear to be heavily in its favor.

Double-way operation under natural head has the disadvantage that the variation in working head is normally very great, while if the conditions be modified so as to reduce this variation the power developed falls off seriously.

General Arrangement of Turbines. In view of the large number of turbines necessary, and of the great volume of water to be handled, the only feasible arrangement, in a large installation, consists of a long dam, which may require to be curved, or to be carried diagonally across the estuary in order to provide sufficient room for the turbines and sufficient waterway for the necessary sluices. A simple type of setting which has been suggested is shown in Fig. 2, and a second type, intended to reduce the necessary length of dam and the number of sluices by installing the turbines in a double bank, is shown in Fig. 3. Owing to the fact that the modern low-speed turbine has of necessity a high velocity of flow through its runner, often amounting to as much as $0.75\sqrt{(2gh)}$, it is necessary for high efficiency to form the discharge passages with easy curves and gradually increasing sections, so as to reduce the loss of energy at discharge to a minimum, and so as to reduce the velocity of ultimate discharge to something in the neighborhood of 4 ft. per sec. For example, with a mean working head of 13 ft. (4 m.) the velocity of discharge from the runner, taking this to be only $0.5\sqrt{(2gh)}$, would be equivalent to a head of 2.5 ft., and the maximum possible overall efficiency of the turbine, assuming

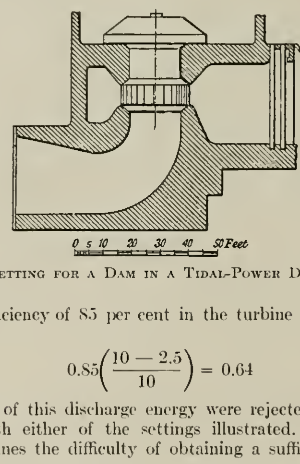


Fig. 4 Setting for a Dam in a Tidal-Power Development

hydraulic efficiency of 85 per cent in the turbine itself, would be only—

$$0.85\left(\frac{10 - 2.5}{10}\right) = 0.64$$

if the whole of this discharge energy were rejected, as would be the case with either of the settings illustrated. With double-banked turbines the difficulty of obtaining a sufficient waterway area in the face of the dam to insure even such velocities as these is almos insuperable, and would appear definitely to preclude this type of setting.

The only really efficient type is indicated in Fig. 4. Adopting

TABLE 1 COMPARATIVE RESULTS OF WORKING UNDER TIDAL-POWER DEVELOPMENT SCHEMES I, II AND III

Scheme	Method of Operation		Output, Continuous 24-Hour, assuming 50 per cent Losses in Pumping and Storage	Working Period per 25 Hours: Springs	Working Period per 25 Hours: Neaps	Working Heads: Springs Max	Working Heads: Springs Min.	Working Heads: Neaps Max.	Working Heads: Neaps Min.	Capacity (under a Head of 13 ft.) of Primary Turbines required for the Scheme
I	Falling tide only—with constant rate of fall in basin	(a)	7,680	7.4	6.6	25.0	21.0	9.8	8.0	36,700
		(b)	8,400	12.0	6.6	22.5	8.0	9.8	8.0	33,600
II	Rising and falling tides—with constant rates of rise and fall in basin:									
	All energy absorbed	(a)	13,150	13.0	12.0	11.9	10.0	7.8	6.5	116,000
	Only part of energy absorbed on a rising spring tide	(b)	11,000	13.0	12.0	11.9	10.0	7.8	6.5	68,000
III	Operation on rising and falling tides under natural head		12,400	20.4	13.6	19.0	4.0	6.0	4 0	54,000

under this head, of approximately 60 b.hp. per foot run of the dam. With smaller turbines the output per foot run of dam would be smaller, amounting to abou 50 b.hp. per foot run for turbines of 2000 b.hp. capacity.

Thus in Scheme I, seventeen turbines, each of 2000 b.hp. capacity would be required, and these wou'd require a dam at least 680 ft. long.

Owing to the relatively large variations in working head in any simple scheme, the question of the most suitable type of genera'ing machinery is one of some difficulty. Under the extreme variations of head occurring in any such scheme, the efficiency of any constant-speed turbine falls off somewhat rapidly, especially at the lower heads, although recent developments of such turbines have shown results which would have appeared impossible only a few years ago. Turbines are now available which are capable of operating under a variation of head equal to 50 per cent on each side of the mean, with efficiencies which do not fall appreciably below 70 per cent over this range, so that this method of operation is quite feasible. It is understood that one well-known firm is prepared to construct variable-speed turbines coupled to constant-speed alternators, and if this can be done without undue mechanical complication and cost, it will probably prove the best solution.

Another possibility consists in coupling the primary turbines to alternators, at a fairly low frequency, and to transmit all the power, through a comparatively short transmission line, to motor-driven centrifugal pumps coupled to synchronous motors. In order to avoid the cost and complication of transformers, the limit of voltage might be that for which the machines can be conveniently wound, i.e., about 10,000 volts. Under these conditions the speed of the primary turbines would be allowed to vary with

with provision for adjusting the number of stages in use according to the speed of the primary turbines. This method, involving the storage of all the output of the primary turbines, however, involves a relatively low overall efficiency.

The difficultites of speed variation and electrical regulation could largely be overcome by the use of direct-current generators, which would enable the turbines to be operated always at the speed corresponding to the available head, and under conditions of high hydraulic efficiency, and in view of the possibilities of the Thury scheme of high-pressure direct-current generation and transmission this method must be considered as offering a possible solution.

Another possibility consists in coupling the primary turbines directly to centrifugal pumps discharging into the storage reservoir through one or more conduits or pipe lines. The practical feasibilities of this depends on the topographical features of the site. Where the storage reservoir is not in very close proximity to the dam, and where the head is large, the cost of the necessary conduits would in general be excessive. Moreover, the difficulty of arranging the design of the dam so as to include these would be great. It is probable, indeed, that this latter factor would preclude the use of this otherwise simple method in any installation having a long dam and a large number of primary turbines, though it might offer the best solution in a small installation.

For any given scheme it is essential to give full consideration to all the possible mechanical and electrical expedients for developing the power, and to compare these from the view of simplicity, overall efficiency, first cost and cost of operation and maintenance. (*Engineering*, vol. 110, nos. 2867 and 2868, Dec. 10 and 17, 1920, pp. 778–780 and 793–795, 17 figs., *tA*)

Ignition and Cooling in Gasoline Engines—Reports of the National Advisory Committee for Aeronautics

THE Fifth and Sixth Annual Reports of the National Advisory Committee for Aeronautics covering the years 1919 and 1920 present a mine of valuable information on subjects connected with the design and construction of aeroplanes and their propelling machinery. As it would be difficult to present even the main conclusions of the work reported in about 1000 pp. of the original documents, attention will be called here only to what might be called the high spots of this important work.

The parts of particular interest to mechanical engineers, in general, are those dealing with the power plant of an aeroplane, particularly as much of the information contained in the report has immediate application to gasoline engines generally and not to aeroplane engines exclusively. The two subjects most extensively dealt with in the report are ignition and cooling in engines. In the field of ignition, again, particular attention is paid to spark plugs. Only one investigation (Report No. 58), by F. B. Silsbee, deals with characteristics of high-tension magnetos.

As regards spark plugs, Report No. 51, by F. B. Silsbee, gives a general discussion of the causes of failure of spark plugs, which are enumerated as follows: 1, Fouling with carbon deposit causing short-circuit; 2, fouling with oil deposit causing open circuit; 3, breaking of the insulator; 4, preignition; 5, conduction through the insulator; 6, electrical puncture of the insulator; 7, minor troubles such as warping and breaking of electrodes, etc.

Experience in the altitude laboratory at the Bureau of Standards and authoritative information received from France indicate that the first type of failure accounts for over 50 per cent of the trouble encountered in practice, particularly at high altitudes, and the third type for nearly 40 per cent; the second type of failure occurs quite frequently when first starting an engine, but very seldom develops after the engine is once running. The other types of failure are of relatively rare occurrence, but must be kept in mind in the design of spark plugs, since departure from the conventional designs is very liable to produce one or another of them.

As regards remedies for these troubles, the author comes to the conclusion that these are so conflicting in character that no general conclusions can be drawn and the design of a spark plug is in every case a matter of balancing opposing conditions to suit requirements in the particular engine considered.

The subject of gas leakage in spark plugs has been investigated by L. B. Loeb, L. B. Sawyer, and E. L. Fonseca.

The method used by the Bureau of Standards for determining gas leakage may be described as follows: The plugs to be tested are screwed into a pressure bomb, which is then filled with compressed air while submerged in a bath of oil heated to any desired temperature. The leakage of air through the plug is measured by the displacement of oil in an inverted bell jar placed over the plug. Standard conditions for testing the relative merits of different types of plugs are 15 kg. per sq. cm. (225 lb. per sq. in.) air pressure and 150 deg. cent. (302 deg. fahr.) temperature.

In the course of this investigation an interesting series of tests was made to ascertain the relation, if any, between leakage and pressure. No definite relation between the variables has been deduced; neither has it been possible to establish any definite relation between temperature and leakage. An effort was also made to determine whether there was on the whole any relation between the design of the plug and its gastightness. From data obtained it would appear that a molded insulator is distinctly superior to the other types in the matter of gastightness, and the good performance of gas plugs is said to be due to their being of molded construction.

The other methods of assembly have been found defective in one or another respect. As regards porcelain and mica insulators, the difference in respect to gastightness has been found to be very slight. It was found, however, that the laminated structure of the mica does not seriously decrease gastightness of the plug, and on the whole it would appear that leakage is more dependent upon workmanship than upon design, as tight and leaky plugs have been found in nearly every design submitted for test.

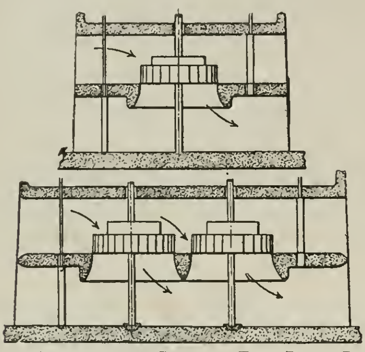
The question of the comparative temperatures in spark plugs

tide over the cycle. Actually, however, a portion p of the output of the primary turbines is lost in the process in various ways. If q be the fraction of a complete tide during which the primary turbines operate and if P_M be the mean output into the distribution system from both primary and secondary turbines in horsepower hours per tide, then if p be taken as being equal to 50 per cent and if the turbines operate for 5 hr. per tide,

$$P_M = \left\{ \frac{100 - 50}{100 - 20} \right\} KP_S = 0.625\ KP_S$$

With the system of operation involving a 10-hr. working period per tide P_M would equal a value 66 per cent greater than would be obtained if all the output of primary turbines were utilized for storage.

From this the author proceeds to the consideration of the three basic schemes of tidal-power development, namely:



Figs. 2 and 3 Settings for a Dam in a Tidal-Power Development

I—Turbines operating on a falling tide only with a constant rate of fall in the basin.

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An analysis of the first scheme of operation on a falling tide only with a constant rate of fall in the basin shows that the range of working heads (assuming Severn conditions) is from 25 ft. to 8 ft., and the difficulty of insuring reasonable efficiencies at constant speed over this range would be great. By reducing the working head at spring tides this inequality may be reduced, and by arranging the working period so to extend beyond low tide a greater output may be obtained. By limiting the turbine capacity to that necessary to absorb the energy available at neap tides, the cost of the turbines and of the time in many cases will be reduced to 74 per cent of its original value. This can be done at a sacrifice of only 15 per cent of the continuous 24-hr. output, with economies in several other directions.

The second and third schemes are discussed in detail, the general conclusion arrived at by the author being that the first scheme, which involves operation on a falling tide only, has the disadvantage that the output is only about two-thirds of the output theoretically possib!e with double-way operation (Table 1). On the other hand, the output per unit of turbine capacity is sensibly the same, while it enables a much more efficient type of turbine setting to be used and the number of sluice gates to be halved. It has the further advantage where applied to a navigable river tha' the depth of water in the basin never falls below mean tide level or thereabouts, so that navigation above the basin is improved. The scheme is essentially more simple than any one involving double-way operation, and the balance of advantages would app ar to be heavily in its favor.

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Genera' Arrangement of Turbines. In view of the large number of turbines necessary, and of the great volume of water to be handled, the only feasible arrangement, in a large installation, consists of a long dam, which may require to be curved, or to be carried diagonally across the estuary in order to provide sufficient room for the turbines and sufficient waterway for the necessary sluices. A simple type of setting which has been suggested is shown in Fig. 2, and a second type, intended to reduce the necessary length of dam and the number of sluices by installing the turbines in a double bank, is shown in Fig. 3. Owing to the fact that the modern low-speed turbine has of necessity a high velocity of flow through its runner, often amounting to as much as $0.75\sqrt{(2gh)}$, it is necessary for high efficiency to form the discharge passages with easy curves and gradually increasing sections, so as to reduce the loss of energy at discharge to a minimum, and so as to reduce the velocity of ultimate discharge to something in the neighborhood of 4 ft. per sec. For example, with a mean working head of 13 ft. (4 m.) the velocity of discharge from the runner, taking this to be only $0.5\sqrt{(2gh)}$, would be equivalent to a head of 2.5 ft., and the maximum possible overall efficiency of the turbine, assuming

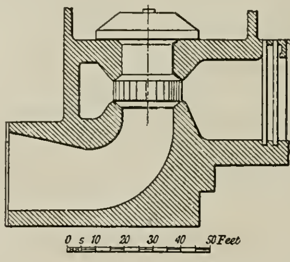

Fig. 4 Setting for a Dam in a Tidal-Power Development

hydraulic efficiency of 85 per cent in the turbine itself, would be only—

$$0.85\left(\frac{10 - 2.5}{10}\right) = 0.64$$

if the whole of this discharge energy were rejected, as would be the case with either of the settings illustrated. With double-banked turbines the difficulty of obtaining a sufficient waterway area in the face of the dam to insure even such velocities as these is almos insuperable, and would appear definitely to preclude this type of setting.

The only really efficient type is indicated in Fig. 4. Adopting

TABLE 1 COMPARATIVE RESULTS OF WORKING UNDER TIDAL-POWER DEVELOPMENT SCHEMES I, II AND III

Scheme	Method of Operation		Output, Continuous 24-Hour, assuming 50 per cent Losses in Pumping and Storage	Working Period per 25 Hours: Springs	Working Period per 25 Hours: Neaps	Working Heads, Springs: Max	Working Heads, Springs: Min.	Working Heads, Neaps: Max.	Working Heads, Neaps: Min.	Capacity (under a Head of 13 ft.) of Primary Turbines required for the Scheme
I	Falling tide only—with constant rate of fall in basin	(a)	7,680	7.4	6.6	25.0	21.0	9.8	8.0	36,700
		(b)	8,400	12.0	6.6	22.5	8.0	9.8	8.0	33,600
II	Rising and falling tides—with constant rates of rise and fall in basin:									
	All energy absorbed	(a)	13,150	13.0	12.0	11.9	10.0	7.8	6.5	116,000
	Only part of energy absorbed on a rising spring tide	(b)	11,000	13.0	12.0	11.9	10.0	7.8	6.5	68,000
III	Operation on rising and falling tides under natural head		12,400	20.4	13.6	19.0	4.0	6.0	4 0	54,000

would be required, and these wou'd require a dam at least 680 ft. long.

Owing to the relatively large variations in working head in any simple scheme, the question of the most suitable type of genera'ing machinery is one of some difficulty. Under the extreme variations of head occurring in any such scheme, the efficiency of any constant-speed turbine falls off somewhat rapidly, especially at the lower heads, although recent developments of such turbines have shown results which would have appeared impossible only a few years ago. Turbines are now available which are capable of operating under a variation of head equal to 50 per cent on each side of the mean, with efficiencies which do not fall appreciably below 70 per cent over this range, so that this method of operation is quite feasible. It is understood that one well-known firm is prepared to construct variable-speed turbines coupled to constant-speed alternators, and if this can be done without undue mechanical complication and cost, it will probably prove the best solution.

Another possibility consists in coupling the primary turbines to alternators, at a fairly low frequency, and to transmit all the power, through a comparatively short transmission line, to motor-driven centrifugal pumps coupled to synchronous motors. In order to avoid the cost and complication of transformers, the limit of voltage might be that for which the machines can be conveniently wound, i.e., about 10,000 volts. Under these conditions the speed of the primary turbines would be allowed to vary with largely be overcome by the use of direct-current generators, which would enable the turbines to be operated always at the speed corresponding to the available head, and under conditions of high hydraulic efficiency, and in view of the possibilities of the Thury scheme of high-pressure direct-current generation and transmission this method must be considered as offering a possible solution.

Another possibility consists in coupling the primary turbines directly to centrifugal pumps discharging into the storage reservoir through one or more conduits or pipe lines. The practical feasibilities of this depends on the topographical features of the site. Where the storage reservoir is not in very c'ose proximity to the dam, and where the head is large, the cost of the necessary conduits would in general be excessive. Moreover, the difficulty of arranging the design of the dam so as to include these would be great. It is probable, indeed, that this latter factor would preclude the use of this otherwise simple method in any installation having a long dam and a large number of primary turbines, though it might offer the best solution in a small installation.

For any given scheme it is essential to give full consideration to all the possible mechanical and electrical expedients for developing the power, and to compare these from the view of simplicity, overall efficiency, first cost and cost of operation and maintenance. (*Engineering*, vol. 110, nos. 2867 and 2868, Dec. 10 and 17, 1920, pp. 778–780 and 793–795, 17 figs., *tA*)

Ignition and Cooling in Gasoline Engines—Reports of the National Advisory Committee for Aeronautics

THE Fifth and Sixth Annual Reports of the National Advisory Committee for Aeronautics covering the years 1919 and 1920 present a mine of valuable information on subjects connected with the design and construction of aeroplanes and their propelling machinery. As it would be difficult to present even the main conclusions of the work reported in about 1000 pp. of the original documents, attention will be called here only to what might be called the high spots of this important work.

The parts of particular interest to mechanical engineers, in general, are those dealing with the power plant of an aeroplane, particularly as much of the information contained in the report has immediate application to gasoline engines generally and not to aeroplane engines exclusively. The two subjects most extensively dealt with in the report are ignition and cooling in engines. In the field of ignition, again, particular attention is paid to spark plugs. Only one investigation (Report No. 58), by F. B. Silsbee, deals with characteristics of high-tension magnetos.

As regards spark plugs, Report No. 51, by F. B. Silsbee, gives a general discussion of the causes of failure of spark plugs, which are enumerated as follows: 1, Fouling with carbon deposit causing short-circuit; 2, fouling with oil deposit causing open circuit; 3, breaking of the insulator; 4, preignition; 5, conduction through the insulator; 6, electrical puncture of the insulator; 7, minor troubles such as warping and breaking of electrodes, etc.

Experience in the altitude laboratory at the Bureau of Standards and authoritative information received from France indicate that the first type of failure accounts for over 50 per cent of the trouble encountered in practice, particularly at high altitudes, and the third type for nearly 40 per cent; the second type of failure occurs quite frequently when first starting an engine, but very seldom develops after the engine is once running. The other types of failure are of relatively rare occurrence, but must be kept in mind in the design of spark plugs, since departure from the conventional designs is very liable to produce one or another of them.

As regards remedies for these troubles, the author comes to the conclusion that these are so conflicting in character that no general conclusions can be drawn and the design of a spark plug is in every case a matter of balancing opposing conditions to suit requirements in the particular engine considered.

The subject of gas leakage in spark plugs has been investigated by L. B. Loeb, L. B. Sawyer, and E. L. Fonseca.

The method used by the Bureau of Standards for determining gas leakage may be described as follows: The plugs to be tested are screwed into a pressure bomb, which is then filled with compressed air while submerged in a bath of oil heated to any desired temperature. The leakage of air through the plug is measured by the displacement of oil in an inverted bell jar placed over the plug. Standard conditions for testing the relative merits of different types of plugs are 15 kg. per sq. cm. (225 lb. per sq. in.) air pressure and 150 deg. cent. (302 deg. fahr.) temperature.

In the course of this investigation an interesting series of tests was made to ascertain the relation, if any, between leakage and pressure. No definite relation between the variables has been deduced; neither has it been possible to establish any definite relation between temperature and leakage. An effort was also made to determine whether there was on the whole any relation between the design of the plug and its gastightness. From data obtained it would appear that a molded insulator is distinctly superior to the other types in the matter of gastightness, and the good performance of gas plugs is said to be due to their being of molded construction.

The other methods of assembly have been found defective in one or another respect. As regards porcelain and mica insulators, the difference in respect to gastightness has been found to be very slight. It was found, however, that the laminated structure of the mica does not seriously decrease gastightness of the plug, and on the whole it would appear that leakage is more dependent upon workmanship than upon design, as tight and leaky plugs have been found in nearly every design submitted for test.

The question of the comparative temperatures in spark plugs

having steel and brass shells was investigated by C. S. Cragoe (Report No. 52) to determine whether brass is superior to steel for that purpose, because of its greater heat conductivity. The tests were made on an aeronautical motor and also on a truck motor. In the latter case, however, a special cylinder head was used which gave a maximum compression of about 115 lb. per sq. in., which brought the truck motor practically into the aeronautical-motor class as far as temperature conditions were concerned.

The results were somewhat unexpected. The temperatures of the brass shells were found to be considerably higher than the steel in each case. The temperatures in the center of the porcelain were also higher in the case of brass shells. This is explained by the following: The heat received from the hot gases in the cylinder at the inner end of the brass plug is more readily conducted longitudinally to the upper part of the shell, which is thus maintained at a relatively higher temperature in spite of the loss of heat from the upper portions of the shell and insulator by radiation and convection. Since the contact between the porcelain and the plug in the engines tested was above the plane of the engine water jacket, the porcelain was less effectively cooled in the case of the brass plug where the upper part of the metal is hotter, and consequently shows a higher temperature throughout its length.

In this instance the tests can hardly be considered as conclusive, as apparently the design of the engine was such that the good features were carried out on an engine where the spark plug sits in a water-cooled boss, as is the practice in a good many tractor engines.

One of the most important parts of the spark plug, and also the one that is particularly apt to give trouble, is the insulator. Commercially, three kinds of insulators are known: mica; the various insulators produced from talc or soapstone, known under various trade names such as lava, steatite, etc.; and ceramic insulators, generally, though not always correctly, referred to as porcelains. Of these the third class is by far the most extensively used, especially for engines other than aeronautical. The properties and preparation of ceramic insulators for spark plugs constitute one of the most interesting reports published by the National Advisory Committee in relation to the subject of ignition.

The first problem was to develop a method of measuring resistances of insulators at high temperatures, a subject of great importance as the insulator of a spark plug has to withstand the high voltages applied to it mainly when it is heated to quite a considerable extent.

A method has been developed by the Bureau of Standards in which alternating current is used (volt-ammeter method) and tests have shown that successful measurements on a single specimen give results repeating to a few per cent. This method, however, gives results for the material in the unpolarized state, leaving largely open the very wide field of investigation concerning the phenomenon of polarization in spark-plug porcelains. The term polarization, it may be stated, has been applied to a phenomenon the fundamental manifestation of which is that if a constant direct-current voltage be applied to a specimen the resulting current will decrease at first rapidly and then more gradually. If the applied direct-current voltage be then suddenly reversed the initial current in the new direction is found to be approximately equal in magnitude to the original current and much greater than the value immediately preceding the reversal. This implies a counter-electromotive force and is analogous to certain phenomena observed when polarization is present.

The measurements made of electrical resistance of various insulating materials at high temperatures (R. K. Honaman and E. L. Fonseca) have shown that quartz is by far the best of the materials tested as far as resistance at high temperature is concerned, although several of the laboratory porcelain bodies approach this fairly closely. The mica plugs show fairly high resistivity, but it should be noted also that this material loses its water of crystallization at temperatures approaching 1000 deg. cent. and becomes very soft and friable. The steatite and Rajah porcelains from Germany are not notably high in resistivity. The French porcelains, on the whole, have been found to be not as good as the more modern American bodies.

The average commercial porcelain was found not capable of fulfilling the conditions required for spark-plug service nor for any other conditions where high-tension currents are employed and the temperature is considerably above atmospheric conditions. Because of this, an extensive investigation was undertaken (report by A. V. Bleininger), as a result of which porcelains possessing usually high qualities were developed at the Pittsburgh laboratory of the Bureau of Standards. One of the features of one of the porcelains developed was the replacement of the usual magnesia flux by beryllium oxide, which, among other things, is of interest as giving a lower thermal expansion of the porcelain than is the case in feldspathic porcelains. Attempts were also made to replace quartz, for which purpose a number of substances were tried. It was found that such materials as highly calcined kaolin, alumina, zircon or sillimanite, either natural or synthetic, are suitable, the question of selection of any one of these materials being determined by its price or available supply.

Among other things the report gives complete formulas for several new porcelains.

The subject of cements for spark-plug electrodes is covered in a report by H. F. Staley. It was found that cements in spark plugs are a prolific source of trouble. In the first place, they are apt to eat away the nickel electrode wire, or if they hold the wire firmly then they are apt to crack the porcelain due to the difference in the coefficients of thermal expansion of the wire and porcelain.

It would appear, however, that while a cement composed of silicate of soda and raw kaolin was developed that would not destroy the nickel wire, the best construction of a spark plug is the one where no cement is used at all, but instead a mechanical seal is provided at the top of the porcelain to make the plug gastight.

All the foregoing reports deal with the subject of spark-plug construction. Next comes a series of reports referring to the performance of spark plugs, starting with the report by L. B. Loeb and F. B. Silsbee on the effect of temperature and pressure on the spark-plug voltage. J. J. Thomson propounded a theory according to which the sparking potential depends solely on the density of the gas between the electrodes, that is, on the total number of molecules between the electrodes. The Bureau of Standards undertook to investigate whether this law held for pressures and temperatures which might occur in the cylinders of a high-compression engine of the aeroplane type just before the ignition of the charge. In aeroplane engines the maximum compression pressures under normal conditions range from 90 to 130 lb. per sq. in., with temperatures up to 300 deg. cent.

These experiments confirm the relation that the breakdown voltage of a spark gap depends only upon the density of the gas and varies with pressure and temperature only as they affect the density. This relation is found to be valid up to 800 deg. cent. and 8 atmospheres pressure. Both the pressure and temperature of the charge in a gasoline engine increase very greatly during the compression stroke, but the sparking voltage can be computed from the linear relations shown in a diagram accompanying the report (plot 5) without a knowledge of these variables separately, since the density is determined solely by the original density and the compression ratio. For small changes in density, as between engines of different compression ratios, the assumption that the voltage is proportional to the density may be made.

With the sudden discharge from an ignition coil or magneto a disruptive spark is produced even at temperatures where a 60-cycle voltage would produce a brush discharge.

The voltage required for a spark plug set at 0.5 mm. (0.020 in.) in an aviation engine of moderate compression is of the order of magnitude of 6000 volts.

It is by no means certain as yet what governs the ability of a spark to fire a mixture in the cylinder of an internal-combustion engine (incendivity of the spark), but it is without any doubt of considerable interest to know the heat energy of various ignition sparks. The Bureau of Standards has developed a method for measuring this energy and carried out a number of such measurements.

The ordinary spark plug is subject to a good many ills, among them fouling with carbon and oil which are deposited on the surface of the insulation and form a conducting path sufficient to prevent sparks from jumping across the air gap. One of the methods suggested as a relief in such a case was the use of a subsidiary gap, usually in series with the main air gap.

Several such devices have been tested by the Bureau of Stand-

in the case of fouling.

Another subject to which a good deal of attention has been paid is that of radiators for aeroplane engines, which is, in a way, of a somewhat passing interest in view of the fact that the general tendency in the development of aircraft engines is toward the entire elimination of indirect cooling.

An extensive report by H. C. Dickinson, W. S. James and W. B. Brown presents a general discussion of test methods for radiators which is of interest also in that it presents a careful analysis of the main factors affecting radiator performance.

The report on head resistance due to radiators is of particular interest to aeronautical engineers. So, in a way, is the report on the effect of altitude on radiator performance. On the other hand, the reports covering results of tests on radiators for aircraft engines give a good deal of information which may be of considerable value also to makers of motorcar radiators.

In these tests it was found that:

1 Heat transfer is a function of mass flow of air, independent of density.

amount of indirect cooling surface the heat transfer increases less rapidly than mass flow at high air speeds.

3 Heat transfer is proportional to the temperature difference mentioned above.

4 Heat transfer is not greatly affected by the rate of water flow provided the rate is above 2 gal. per min. per in. of core depth per ft. width of core. It should be noted, however, that this is true only when the mean water temperature is regarded as constant.

5 Heat transfer from direct cooling surface is not appreciably affected by the composition of the metal. When fins and other indirect cooling surface are used the thermal conductivity of the metal is important.

6 Heat transfer is somewhat increased, but at the expense of a large increase in head resistance by spirals or other forms of passages which increase the turbulence of the air stream. Heat transfer is greater for smooth than for rough tube walls, for, if the surface is rough, it will be covered with a layer of more or less stagnant fluid.

Electric Melting Furnaces

A HISTORY of the commercial development of the electric melting furnace, and descriptions of the principal types of electric furnaces which are now obtainable on the market for various industrial purposes.

In 1877 Siemens succeeded in melting steel by the use of the electric arc. He devised two types of furnaces: An arc-radiation furnace in which the steel was melted by radiation from an arc between two electrodes located horizontally above the metal; and an arc-resistance furnace in which the steel itself was made one of the electrodes of the arc.

The arc-radiation furnace was subsequently developed by Captain Stassano of the Italian Army, who employed three electrodes coming together in triangular formation above the bath and used a three-phase arc. From forty to fifty furnaces of the Stassano type are at present in operation throughout the world.

There are other furnaces of a somewhat similar character, heated by radiation from the arc. Sometimes the arc is changed a little in shape. Such a one is the Rennerfelt furnace, which is essentially of the same general type, though differing in details. It consists of one vertical and two horizontal electrodes, which project the arc like a blowpipe on the surface of the metal.

There are still other types of the arc furnace. There is the rocking arc furnace, in which the electrodes pass through the sides of the furnace, but the metal is rocked so that it is uniformly heated, thus combating unevenness of temperature caused by intense heating near to the arc. This particular modification of the arc-radiation furnace has been found very useful in the melting of alloys containing volatile metals, such as, particularly, brass.

The arc-resistance furnace was commercialized by Girod, a Swiss electrical engineer. He constructed a saucer-shaped, steel-melting hearth and put through a hole in the bottom of it a soft low-carbon steel rod. The electrode passing through the hearth was 18 in. long; in running it melted 6 in. and left 12 in. solid. This automatically sealed it, and the current was taken away from the projecting end outside, which was water-cooled. The Bethlehem Steel Co. runs a 10-ton Girod furnace at Bethlehem.

Further progress was made by embedding the electrode in the bottom of the hearth. A typical development on this principle is the Heroult arc furnace, in which two electrodes are used. The current passes from one electrode through the slag to the metal, through the metal, and thence back to the other electrode. There are therefore two arcs in series. Nearly two hundred and fifty Heroult furnaces are operated in the United States.

The resistance furnace is a type of furnace which does not use the arc. In it the metal is heated by the resistance of a solid or liquid material. The resistance-radiation furnace is one where the metal is heated by radiation from the resistor, the latter being heated by the direct passage of the current. Another form of resistance furnace operates on what is termed the "pinch effect," that is, the force which, when a current of high density passes through a properly proportioned liquid resistor, causes the liquid metal to be ejected from the center and the cooler metal to flow in from the periphery. Liquid metal in small channels communicating with a larger bath of metal, is heated through its own resistance. This type of furnace has received many modifications, among which is the use of current generated in the tubes by induction, so doing away with electrodes.

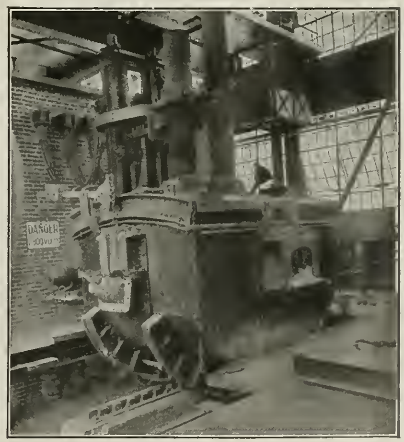

Fig. 1 Greaves-Etchells Three-Ton Electric Furnace

The Greaves-Etchells furnace is of the arc-resistance type. The transformers are connected delta on the primary side and Y on the secondary. One of the legs of the transformer is applied directly to the bottom of the furnace by means of copper busbars and a copper plate, which conducts the current through a bottom composed principally of magnesite and dolomite, in such a way that there is a graded resistance, beginning with a low resistance and ending high. The other two legs of the transformer are connected to movable electrodes, which extend down through the roof. Regulation is then maintained by the usual types of furnace regulators. Two voltages are used, the higher voltage for melting down and the lower for refining. Fig. 1 shows a rocking Greaves-Etchells three-ton electric furnace.

By a careful analysis of the conditions described above, it will be noted that the combination of a resistive bottom and the delta-Y connection of transformers is one which prevents serious overload-

ing of one phase, at the same time doing away with a specially high reactance, which is necessary on other makes of furnaces.

Metallurgically, a furnace which uses the bottom as a resistor, and therefore as a heat producer, is superior to one which generates all the heat above the bath. This is especially true of the production of alloy steel, where materials are used which have a higher specific gravity and also higher melting point than the steel itself. Rabbling becomes unnecessary in the Greaves-Etchells furnace, and the roofs last longer, since they are not punished so severely.

The shape of the lining of the electric furnace of the arc type affects its performance very materially, and if not correct may produce cold spots or hot spots in the metal.

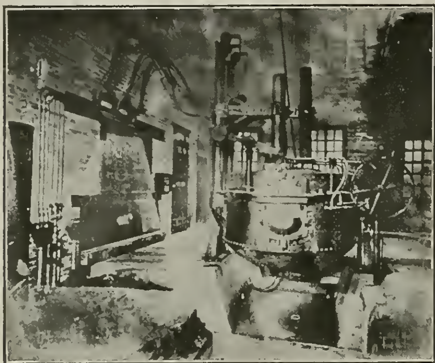

Fig. 2 One and One-Half-Ton Moore Electric Steel Furnace

For a detailed discussion of this subject, reference is made to the original article by F. W. Brooke.

In the Moore rapid "Lectromelt" arc-resistance furnace the tilting mechanism is placed above the floor and the tilting motor is mounted on a bracket to the side of the furnace where it is accessible and out of harm's way from molten steel slag and dirt. There is no mechanism in the furnace pit. The conducting arms of this furnace are also the electrode-supporting arms, a fact which permits placing the insulation between the furnace shell and the arms back at the supporting columns where it is not subject to the rapid deterioration from the heat above the furnace. The inverted dome-shaped bottom of the furnace prevents any possibility of floating the furnace bottom through the expansion of the shell, as the bottom refractories are arched in place. This furnace is designed for the rapid casting of steel, the usual time of melt-down being from one-half to three-quarters of an hour. A $1\frac{1}{2}$ ton Moore electric steel furnace is represented in Fig. 2.

An illustration of a Weeks rotating brass furnace is given in Fig. 3. In this type of furnace the metal is melted by the open single-phase arc produced by horizontal electrodes passing through the center axis of the drum. It is necessary in using an electric arc for melting brass to keep the metal thoroughly mixed in order to prevent the zinc content from boiling out, since zinc volatilizes at a lower temperature than the melting point of copper. This has been accomplished by rotating the drum about the electrodes which constantly mixes the superheated surface with the colder metal at the bottom of the bath, thus keeping the bath at a uniform temperature and the zinc so well mixed with the copper that volatilization is a minimum. The Weeks furnace operates single-phase and has for the $\frac{1}{2}$-ton size a kilowatt rating of 200 and for the one-ton size 300 kw. The power factor averages around 80 per cent.

An interesting induction furnace of the vertical ring type is the Ajax-Wyatt electric furnace. The construction of this furnace will be readily understood by noticing the sectional views of Fig. 4. In the resistor rapid circulation is obtained as a result of the combined forces exerted therein, namely "motor effect," "pinch effect," and "thermal effect." Each of these forces tends to force the metal upward. The strongest force exerted is that due to "motor" effect which is applied in greatest degree of force at the angle, which is so placed that it is at the extreme bottom of the furnace. The heating and the stirring is all applied from the bottom. No mechanical contrivance is necessary to produce circulation, or mixing. The heat losses are merely those due to radiation, and the small transformer losses. The Ajax-Wyatt furnace has thus far been developed only for melting the copper-zinc alloys. It is possible to handle the full commercial range of such alloys as is used in rolling-mill practice. Development work is progressing in adapting the furnace to other uses, and it is expected that it will shortly be possible to handle all the non-ferrous alloys in this furnace, and possibly some of the ferrous metals. (Symposium in *Journal of the American Institute of Electrical Engineers*, vol. 39, no. 12, Dec. 1920, pp. 1034–1043, 16 figs.)

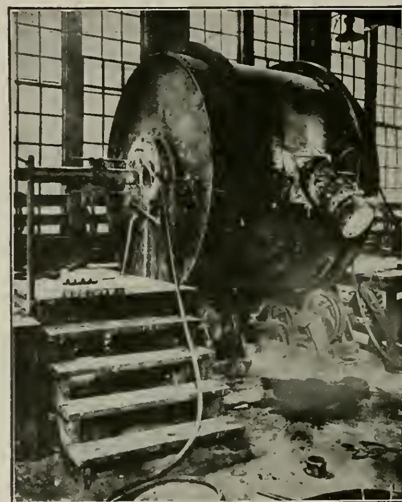

Fig. 3 Weeks Electric Rotating Furnace

A simple type of arc-radiation furnace which can be operated directly on a 220-volt motor circuit, without transformers, has been designed by Frederick von Schlegell, of the Industrial Electric Furnace Co., Chicago. The arcs are drawn, sustained and regulated by a balance system automatically giving stability. The heat element is suspended through the roof, and consists of an

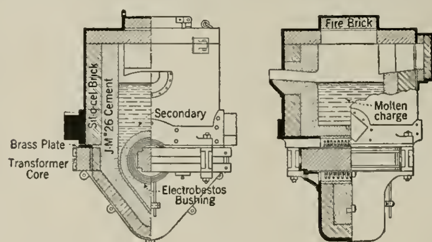

Fig. 4 Sectional Views of Ajax-Wyatt Electric Furnace

electric arc torch, which diffuses a large, intensely hot flame. The shell is cylindrical and of extra heavy steel plate, and is supported on heavy rocker trunnions which allow it to lock after pouring. Tilting is by hand and all mechanical tilting equipment has been eliminated. The furnace is built for single-phase, three-phase or direct current. With single-phase or direct current, two electrodes are used and with three-phase three electrodes. They are held in place by a refractory sleeve so mounted that the sleeve and electrodes can be raised or lowered or swung aside to permit charging through the top opening of the furnace. This does away with side doors and prevents loss of heat. The furnace is lined with an insulating coat next to the shell and a ganister lining mixed with a small percentage of fireclay, and a pine-tar product is ram-

no. 359, Nov. 15, 1920, pp. 929–930, 2 figs. *d*)

Short Abstracts of the Month

BUREAU OF STANDARDS

Steel Rails from Sink-Head and Ordinary Rail Ingots. The object of this investigation was to determine the relation of ingot practice to the properties of rails from such ingots, and in particular to determine the amount of total discard necessary to obtain rails free from piping and segregation above 12 per cent, which have been rolled from steel made in accordance with varying melting, casting and ingot practices.

To that end 35 ingots, made by the converter process at Hadfield's, Sheffield, England, and cast by the sink-head process with large end uppermost, were shipped to Sparrows Point, Md., and rolled into rails; these were compared with 15 rail ingots made in the ordinary manner with the small end uppermost. Each sink-head ingot, of about 5300 lb. weight, and, deoxidized with aluminum in the mold, represented a separate heat of converter steel, and all the heats and ingots were made in the same manner. The composition and properties of these ingots were of remarkable uniformity. The comparison ingots, of 7300 lb. each, were from three separate open-hearth heats, an additional variation being made in the casting and open-hearth practice for each. Five ingots were selected from each of these three heats. Thus, in reality, comparison was made of four different kinds of steel of very nearly the same composition and physical properties, and of two types of ingot form.

The comparison was made by rolling most of the ingots into rails and taking test specimens at each rail cut, as well as from a considerable portion of the upper part, in 5-ft. steps, of the rail bar from each ingot. In this way there was obtained a detailed physical, chemical and metallographic survey of each ingot, and it was possible to delimit exactly the regions of sound and homogeneous from those of unsound and segregated steel. Two complete sink-head ingots were cut longitudinally and examined, as also were representative blooms from both sink-head and ordinary ingots.

The results obtained indicate a decided superiority of the sink-head ingots over the comparison ingots as made of three grades of steel (Tables 17 and 18), although the sink-head ingots suffered from the disadvantage of having gone cold before rolling. The Hadfield type of ingot required discard of only 18.4 per cent on the average (13 per cent top discard to eliminate piping and segregation above 12 per cent), while the average ingot of the ordinary type for rails required a total discard of 43.9 per cent (26 per cent top discard), with great variations dependent upon the furnace and ingot practices.

The comparison ingots from heat M1–M5, made of non-deoxidized rising steel chilled on top of ingot by cast-iron caps, required excessive discard to eliminate positive segregation at the top and negative segregation at the bottom of the ingot, the latter often accompanied by dangerous enclosed pipes.

The second heat (M6–M10), made of rising steel deoxidized with aluminum in the molds, the ingot tops of which were cooled with water, required the least total discard of the three heats. It was more subject to piping and less to segregation than the first heat of ingots made in the usual manner.

The third heat (M11–M15), made of quiet or "killed" steel, was not chilled on top with water or caps and was deoxidized with aluminum in the molds. The ingots of this heat required an intermediate amount of total discard when compared to the first and second heats; this heat was the only one for which a greater top discard was required to eliminate piping than to eliminate segregation above 12 per cent. One of the ingots of this third heat contained a small pipe at the bottom, and all the rails from the middle and bottom of the ingots showed high negative segregation.

The distribution of physical properties throughout the length cast, and of the ingot practice.

It has been established in the foregoing that after removal of the top discard of 13 per cent the Hadfield type of sink-head ingot is free from piping and undue segregation. The ordinary type of ingot, cast small end up without sink head, as is usual for rail ingots, requires an average top discard of 26 per cent, and the remainder of the ingot is liable to contain enclosed piping and excessive segregation. Defective rails, from the middle and bottom portion of the ingot, are not certainly detected by means of existing rail specifications, and as a result of this uncertainty rails containing pipes or excessive segregation may get into service with disastrous results.

The surface condition of the rails from the sink-head ingots was not so good as for the ordinary ingots, but this is not considered an essential characteristic of rails from such ingots.

The markedly differing characteristics of the three heats of comparison ingots leads one to raise the question whether or no it might be advisable to specify, at least in some degree, the methods of steel manufacture or of ingot practice for rails and similar products on which the safety of the traveling public depends.

While it is not claimed that the use of the sink-head process for the manufacture of ingots will solve all rail problems, it is maintained that its adoption would be a step in the right direction in view of the present heavy casualties and property losses on American railroads. The necessary changes in mill operations, it is believed, could be made without too great difficulties. (Abstract of *Technologic Paper of the Bureau of Standards* No. 178, by George K. Burgess, *c*)

The Electric Arc-Welding of Steel: The Properties of Arc-Fused Metal. A fusion weld is fundamentally different from all other types in that the metal of the weld is essentially a casting. The arc-fusion weld has characteristics which are peculiar to it alone. A knowledge of the mechanical properties of the arc-fused metal which is added during the process of welding is fundamental in the study of arc welding. The mechanical properties as revealed by stressing in tension were determined upon specimens (0.505 in. diameter, 2 in. gage length) cut from blocks of arc-fused metal prepared under conditions similar to those met in welding. Additional specimens were also prepared by expert welders outside of the Bureau and submitted for comparison with those prepared by the Bureau.

Two types of electrodes, a "pure" iron and a low-carbon steel, were used. During fusion the composition changes considerably as the carbon and other elements are eliminated and the two types become very much alike in that respect. In each case a considerable percentage of nitrogen is taken up.

The mechanical properties of the arc-fused metal as measured by the tension test are essentially those of an inferior casting. The most striking feature is the low ductility of the metal. All of the specimens examined (about 70) showed evidence of unsoundness in their structure—tiny enclosed cavities, oxide inclusions, and lack of intimate union. These appear to be a necessary consequence of the method of fusion as now practiced. They determine almost entirely the mechanical properties of metal. The observed elongation of specimens under tension is due to the combined effect of the numerous unsound spots rather than to the ductility of the metal.

The material is, however, inherently rather ductile, as may be shown by the changes produced in its microstructure by cold-bending.

A characteristic feature of the microstructure of the arc-fused metal is the pressure of numerous microscopic plates within the ferrite grains. These persist in the metal upon prolonged heating, for example, 6 hr. at 1000 deg. cent. in vacuo were not sufficient to remove them. The various lines of evidence available indicate that they are related to the nitrogen content of the metal.

The microscopic examination indicates that there is but little, if any, relation between these so-called "nitride plates" and the path of rupture produced by tensional stresses. The effect of the grosser imperfections of the metal is so much greater than

any possible effect of those plates in determining the mechanical properties that the conclusion appears to be warranted that this feature of the structure is a matter of relatively minor importance in ordinary arc welds.

Judged from the properties of the metal after fusion, neither type of electrode used appears to have a marked advantage over the other. The use of slight protective coatings on the electrodes does not appear to affect the mechanical properties of the arc-fused metal materially in any way. The specimens were prepared in a manner quite different from that used ordinarily in electric arc welding and so do not justify specific recommendations concerning methods of practice in welding. (Abstract of *Technologic Paper of the Bureau of Standards* No. 179, by Henry S. Rawdon, Edward C. Groesbeck, and Louis Jordan, *e*)

INTERNAL-COMBUSTION ENGINES

Possible Fuel Savings in Automotive Engines, H. C. Dickinson and S. W. Sparrow. Report of tests carried out at the Bureau of Standards. The apparatus employed made it possible to see the acceleration of the engine by means of an acceleration disk mounted on the dynamometer shaft. This was of steel, 33 in. in diameter and $^1/_2$ in. thick. Its inertia added to that of the dynamometer was about equal to that of a 3500-lb. car on direct drive with a gear ratio of 5 to 1 and 32-in. wheels.

Among other things, the tests covered the influence of jacket-water temperature on fuel economy. Two series of tests were made; in the one the temperature of the water entering the jacket was maintained at 162 deg. fahr., and in the second at 72 deg. fahr. Runs were made at full load and at 0.8, 0.6, 0.4, and 0.2

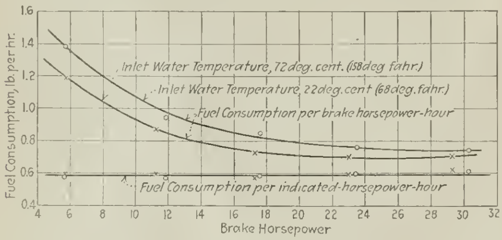

Fig. 1 Curves Showing the Relation Between Fuel Consumption and Jacket-Water Temperature

of full load, with five carburetor adjustments at each throttle setting. From these results the minimum fuel consumption for each setting has been selected and plotted in Fig. 1. From this it appears that the fuel consumption per unit power based on brake horsepower is considerably higher with the cold jacket water.

It may be mentioned, in this connection, that tests made several years ago by J. B. Replogle showed that a very considerable economy in fuel consumption is obtained when the temperature of water is carried to a still higher point than was used by the Bureau of Standards in its test, namely, at the boiling point.

Other tests cover the influence of intake-manifold heating on acceleration and on the maximum horsepower of the engine, it having been found that heat supplied to the charge increases the maximum power of the engine. (Paper presented at the meeting of the American Petroleum Institute, Nov. 17, 1920; abstracted through *Journal of the Society of Automotive Engineers*, vol. 8, no. 1, January 1921, pp. 3–9, 14 figs., *cg*)

MACHINE TOOLS

Improving Efficiency of Twist Drills by Enlarging the Helix Angle

Helix Angle of Twist Drills, Bruce W. Benedict, Mem.Am. Soc.M.E. The operation of the twist drill resembles the action of tearing. The more the action of the tool resembles cutting as opposed to tearing, the more effective the tool is. This condition is secured by increasing the keenness of the cutting edge to a degree that does not result in a sacrifice of its endurance.

As regards twist drills, the author doubts if their manufacturers have attempted to utilize fully the principle of keenness in the cutting edge to the extent permitted by the use of high-speed steel, and with one exception they are producing high-speed twist drills of exactly or of approximately the same cutting angle as was established by them in the days of the carbon-steel drill. In fact, with one exception, milled drills of both carbon and high-speed steel of prominent makers have identical helix angles. (The helix angle as here used is the angle between the cutting face at the periphery of the drill and the axis of the drill and is a measure by which keenness of the cutting edge or the degree of the cutting angle is determined.)

With the exception of one company which markets a special drill having an angle of 32 deg. at the point, the helix angles of milled drills vary between 20 and 26 deg., the majority having angles of either 22 or 26 deg. In many of these drills the helix angle is decreased gradually toward the shank, a total of two or three degrees, so that cutting angles become increasingly blunt as the drills wear.

To determine the most efficient helix angle for use on high-speed

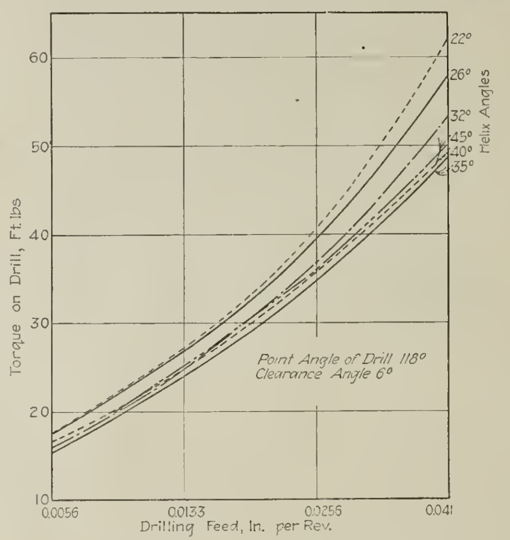

Fig. 2 Power Required to Drive 1-In. Drills of Various Helix Angles at Various Feeds in Cast Iron

milled twist drills, an investigation was carried out with milled drills having helix angles ranging from 10 to 45 deg., 1-in. drills being used throughout.

Data are given in the original article showing the effect of changes in the helix angle on the power required to rotate the drill against the work and remove the chip (Fig. 2), which show a very peculiar variation.

In connection with these curves, the curves of Fig. 3 showing the total end thrust on drills of various helix angles is of considerable interest. Here the thrust decreases progressively as the helix angle increases, reaching the minimum for drills of 45 deg. angle. For certain mechanical reasons, however, it is inadvisable to consider the use of helix angles above 45 deg.

Further tests have shown that the drill with a 35-deg. helix angle retains its cutting edge at least as well as drills with helix angles of 22 and 26 deg. under usual drilling conditions, while it is more efficient in ejecting chips in drilling deep holes than drills with smaller helix angles.

As regards clearance, it has been found that a drill with a helix angle of 35 deg. and a clearance angle of 6 deg. has approximately the same quantity of metal in the cutting end as the 26-deg. angle drill with a clearance angle of 12 deg. (Fig. 4).

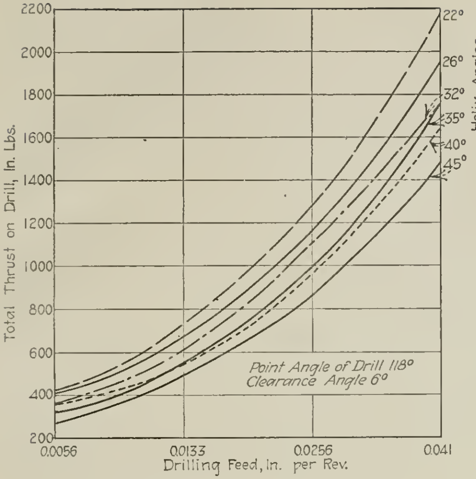

Fig. 3 Total End Thrust on 1-In. Drills of Various Helix Angles at Various Feeds in Cast Iron

twist drill has a helix angle of 35 deg. and that it is possible that development in the shape of the flute will lead to the employment

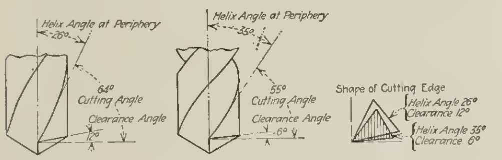

Fig. 4 Comparison of Cutting Angles of Usual and Proposed Designs of Drills

of helix angles above 35 deg. and the attainment of still greater efficiencies. (*American Machinist*, vol. 53, no. 26, Dec. 23, 1920, pp. 1175–1178, 5 figs., *epA*)

Sellers 16-Ft. Planer. Description of a machine tool remarkable for its size and some of the features of design, built by Wm. Sellers and Company, of Philadephia, for a large shipbuilding concern. The machine weighs nearly half a million pounds and is driven by a motor of 75 hp. capacity.

So large is the machine that in order to make its transportation possible it had to be made in several parts and assembled on the spot. This means that it had to be designed and built with particular care so as to make the maintenance of alignment possible.

In particular, the table is 13 ft. wide and was shipped in three lengthwise sections. The bearings on the table, one of which is flat and the other a V, are lubricated by oil delivered by a pump installed for this purpose only, which is, however, the standard practice of Wm. Sellers and Company.

The cross-rail has a span of 16 ft. between supports, which ordinarily might entail a vertical deflection due to the weight of the rail and saddles. In the machine under consideration, however, this is eliminated by giving the rail an extended-back type of construction which makes it very rigid and by the application of an arched girder bolted to the top surface of the cross-rail and provided with a solid abutment at one end and a wedged abutment at the other.

Another difficulty caused by the length of the cross-rail is the tendency of the screws and rods for moving the saddles to sag in the middle. To maintain their alignment, sliding bearings are used. These bearings, three in number, have an automatic position.

Instead of the ordinary bolts and nuts for clamping the cross-rails to the uprights, the work of clamping is done by pneumatic cylinders, each operating two bolts. The four cylinders are connected to a valve having a selective movement, permitting the cylinders to either open or close. After the cross-rail has been clamped the air passage may be released by the valve, as the clamps are so designed that they will not loosen until air is applied in the reverse direction. This is important, as should the air pressure fail at any time the clamp would otherwise relax and the work might be spoiled.

Other details are described in the original article. (*American Machinist*, vol. 53, no. 22, Nov. 25, 1920, pp. 973–976, 3 figs., *dA*)

MANAGEMENT

An Experiment with Rest Pauses, J. Loveday. Part of a report of the Industrial Fatigue Research Board. While the experiment covered a period of little more than six months, it is of considerable interest. The experiment was carried out at the plant of a firm having two factories, in one of which shoes were manufactured and in the other heels and stiffeners only.

In the stiffener and heel works all the employees with the exception of the foremen were women, the working hours in 1918 being 46 per week. In 1918 the firm found itself confronted with the problem of increasing output without adding new machinery, owing to the extreme difficulty of obtaining machinery at that time. The difficulty arose particularly in the press room where the leather is cut into pieces of the shape required by a mechanical press working upon a heavy knife of the requisite form. The presses are of two types, single and double, a double press being a bench with a press at either end. The operation demands skill and care: flaws in the leather must be avoided and the skin cut with as little waste as possible. The problem has been successfully solved by the adoption of the following plan:

It was determined to make the experiment of working the double presses with a team of three girls, each operative working 40 min. in each hour and resting 20 min., instead of with two girls working continuously throughout the day. It was hoped thus to increase the output of the machine—a hope which has been justified by results. The experiment was begun in January 1919 on a machine with results so favorable that in July six double presses were being operated on this system. A comfortable and attractively furnished rest room, quiet and restful in color, has been provided, and but for the difficulty of arranging for further rest rooms, a difficulty which can only be overcome by building, the plan would already have been greatly extended. There the girls, when they come down from work, are free to rest or to occupy themselves with crocheting, knitting, etc., as they may desire.

Six girls, one for each machine, go to the rest room on arrival at the factory in the morning, and do not start work until 8 o'clock; from then onward the period of rest is 20 min. in the hour throughout the day. Those whose turn it is to rest at 11.40 a.m., and at the corresponding period in the evening, are allowed to go home. The experiment was constituted with the consent of the operatives after thorough explanation, and, though somewhat skeptical at first as to success, they were willing to give it a trial.

The operatives are paid by day rate plus a bonus on output. This bonus is computed by calculating the weekly output of the press and dividing it into three equal parts, so that the three members of each team receive an equal bonus, proportional to the amount of work done during the week.

With the new arrangement a total increase of output on the six presses was obtained amounting to over 44 per cent, and this very high figure is attained with the reduction of the working hours of the individual operative by one-third, and without the addition of new machines. Sufficient data are not available to draw any accurate conclusions as to the actual increase or decrease in output of individual workers, but it would appear that there was such an increase. In particular, it appears that a change benefited especially the comparatively unskilled and the less robust workers, who otherwise would be more liable to fatigue.

As regards the effect on workers, it is stated that at first the girls did not believe the scheme would prove successful, and did not believe they could put out enough in such short hours. Experience, however, reconciled them to the system and none of them at the time of the investigation desired to return to the former hours. This was particularly so in the case of the weaker and less highly skilled girls. (*Report No. 10 of the Industrial Fatigue Research Board, Great Britain*, abstracted through *Engineering and Industrial Management*, vol. 4 (New Series), no. 23, Dec. 2, 1920, pp. 716–718, *gp*)

MEASURING APPARATUS (See Railroad Engineering)

Instrument for Indicating and Recording the Speed of a Railway Train

Recording Speed Indicators, A. G. Newell. While the recording speed indicator might be of great service in railroad operation, as the author points out, there are many elements some of which are of psychological rather than mechanical character which have so far interfered with its useful adoption. Some operating officials are rather reluctant to set a speed restriction and require its observance at all times. Engineers who are not familiar with the working of the speed recorder are also apt to look upon it with disfavor, even though they often change their opinion after becoming familiar with it, as they realize that an instrument of this kind eliminates taking of chances by the other fellow and puts each crew on the same basis.

A speed-recording device on the locomotive is of particular interest as it permits more certain and, curiously enough, more rapid operation over bridges in bad condition, slow track or curves. At present it is the practice of a good many foremen to place very slow limits of speed over bridges and parts of track undergoing repairs, in the expectation that enginemen will not hold their trains to the letter of the order and will in most cases make two or three times the speed that the order calls for, with the result that enginemen obedient to the order go at speeds very much lower than is actually necessary. The correct speed can be set and maintained, however, without difficulty where recording speed indicators are used.

The experience of the El Paso and Southwestern System is described in practice. Their experiments were started in 1907 with a Flaman tachograph brought from France. This instrument gave satisfaction and in 1911 three more of the same make were applied. These four instruments met with such success that it was decided to adopt them as a standard appliance for all road engines on the system. A mechanic was sent to the factory in France and made a thorough study of the instrument. A modern shop for testing and repairing was then fitted up at the general shops at El Paso, Tex. Since then 114 locomotives in road service have been equipped with the Flaman tachograph and there are sixteen reserve instruments on hand.

The apparatus has a speed-indicating dial graduated from zero to 90, each division representing one mile in speed. A small black pointer plays over the face of the dial, indicating the speed being made at all times when the engine is moving in either direction. The lower part of the case contains the speed- and time-recording mechanism and the recording tape, the record on the tape being made by two styles. A sample of a record is given in Fig. 5. The time-recording style rises from the bottom line to the top line in a given interval, which in various types of indicators may be either 10 or 30 min., making a sudden and vertical drop from top to bottom. The degree of inclination of the oblique lines made by the style depends on the speed being made, the greater the speed the less the inclination. During the time the engine is standing the time-recording style will move up in a vertical line or a series of vertical lines, each full line from bottom to top representing 10 or 30 min., depending on the tape used, and each fraction of a line its portion of time.

The mechanism of the instrument is of clockwork type and receives its motion from a series of springs which must be wound by the engineer by means of a small crank before the engine leaves the roundhouse track or at any time after the engine has stood for a period of 30 min. or more during the trip. When the engine is moving in either direction the clockwork is wound automatically by means of transmission rods and gears, receiving its motion from a driving stud and arm attached to the right back side-rod pin and will continue to run for a period of from 30 to 40 min. after the engine has stopped.

The instrument is so arranged that tampering with it is quite difficult. The cost of the apparatus at present is said to be $270 for each instrument and $193 for applying it. The average length of time an instrument will stay in service without repairs is about four months. (*Railway Review*, vol. 68, no. 1, Jan. 1, 1921, pp. 7–10, 4 figs., *d*)

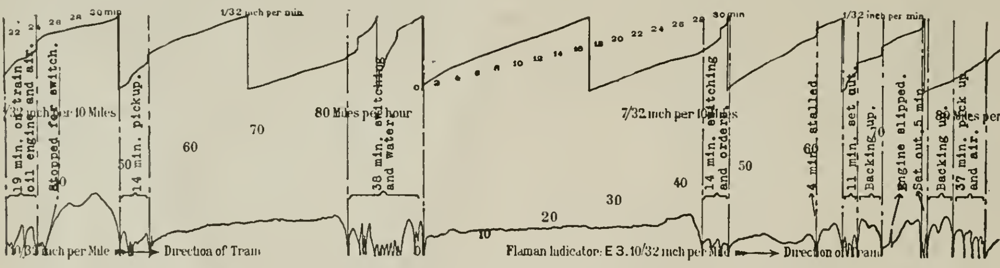

Fig. 5 Sample of Tape Made by a Flaman Tachograph in Use on a Locomotive of the El Paso & Southwestern System

MECHANICS (See Munitions)

MISCELLANEA

Power and Fuel Facts. The following figures are of great interest in that they emphasize in an unusual way the need for fuel conservation:

Prime movers of all kinds in U.S. (stationary and locomotive)	100,000,000 hp.
Used at average load factor of	14 per cent
Used for average period per week	23.5 hr.
Develop per year	125 billion hp-hr.
Water power available	50,000,000 hp.
Coal (without lignite) in ground	2500 billion tons
Petroleum in ground	7 billion bbl.
Used for power only (locomotive and stationary) on basis of present power delivered, resources will last:	
Water power, if all developed	indefinitely
Coal used by best practice	57,000 yr.
Coal used by average practice	7,500 yr.
Petroleum (allowing 40 per cent gasoline)	9.25 yr.
Of prime movers installed:	
Steam plants, coal-fired, make up	52 per cent
Hydraulic plants make up	8.2 per cent
Combustion engines and other types make up	39.8 per cent
Of power developed:	
Public utilities use	42 per cent
Manufacturing plants use	28 per cent
Railroads use	30 per cent
Of 1 ton of coal in the ground, or	2000 lb.
Best recovery brings to the surface	1900 lb.

By best large central stations	608 lb.
By best small central stations	304 lb.
By locomotives, best practice	175 lb.
By small individual plants, average practice	76 lb.

(*Power Plant Engineering*, vol. 25, no. 1, Jan. 1, 1921, p. 1, *g*)

MOTOR-CAR ENGINEERING (See Internal-Combustion Engines)

MUNITIONS

The Aerodynamics of a Spinning Shell, R. H. Fowler, E. G. Hallop, C. N. H. Lock and W. H. Richmond. An extensive paper containing the results, theoretical and experimental, of work carried out by the Munitions Inventions Department for the British Ordnance Committee, on the motion of a spinning shell through air at velocities both greater and less than the velocity of sound.

A description is given of the motion of the spinning shell considered as a rigid body under the effects of gravity or the reaction of the air; this latter is supposed to be known in terms of the position and velocity coördinates of the shell and the state of the air through which it moves. The motion of the shell thus described is then compared with results of experiments and the more important components by the force system imposed by the air are determined numerically as functions of certain variables, such as the velocity of the center of gravity of the shell.

The aerodynamic problem of the motion of the shell alone forms the subject of the investigation and not the general hydrodynamic problem of the motion of the complete system formed by the shell and air together.

The actual experiments consisted of observations of the initial motion of the shell (more particularly the angular motion of its axis of symmetry) over a limited range near the muzzle of the gun. The velocities experimented with ranged from 40 ft. per sec. to 2300 ft. per sec. Using the values of the components so determined, the actual motion of the shell can be calculated with equal certainty in the more general cases which are inaccessible to direct and detailed observation.

One of the interesting parts discovered in the tests is that the spinning shell moves in a manner different from that of the motion of a top. (*Philosophical Transactions of the Royal Society of London*, Series A, vol. 221, no. A 591, pp. 295-387, 15 figs., *tdA*)

PNEUMATIC TRANSMISSION

Laws Governing Closed-Circuit Pneumatic Transmission

Fundamental Properties of Closed-Cycle Pneumatic Transmissions, Jacques de Lassus. The author attempts to establish the laws governing pneumatic transmission operating with a constant mass of gas in a closed circuit, and, in particular, the polytropic transformations occurring in such a transmission. The following notation is used: γ the coefficient of adiabatic or practically polytropic transformation; K the volumetric ratio of the two chambers, capacity and reservoir, or the ratio of the masses of gases initially present in these chambers; M_r and P_r the mass of the gas and the pressure in the reservoir at every instant; M_c and P_c the mass and the pressure at every instant in the capacity; P_i the initial pressure of compression; M_{ci} the mass initially present in the capacity, and M_{ri} the mass initially present in the reservoir.

With this notation the author presents the following laws which he designates as theorems.

Theorem I. In a pneumatic transmission operating with a constant mass of gas in a closed circuit comprising two chambers of given fixed dimensions, the pressure obtaining at each instant in one or the other of these chambers divided by the power γ of the mass of gas contained at the moment in the compartment is a *constant.*

This law may be expressed by the relations $P_c = A\,M_c^\gamma$, $P_r = CM_r^\gamma$, where $A = \dfrac{P_i}{M_{ci}^\gamma}$ and $C = \dfrac{P_i}{M_{ri}^\gamma}$. It is well to call attention in this communicating chambers where there is neither assistance from nor protection of external work and where the flow is governed only by the difference of pressures obtaining between the two chambers.

Theorem II. The power $\frac{1}{\gamma}$ of the pressure obtaining at each instant in the reservoir added to the power $\frac{1}{\gamma}$ of the pressure obtaining in the capacity multiplied by the coefficient K is a constant sum equal to the product of (coefficient K + unity) by the power $\frac{1}{\gamma}$ of the pressure at rest or initial pressure of compression. This law is expressed by the formula—

$$P_r^{\frac{1}{\gamma}} + KP_c^{\frac{1}{\gamma}} = (K+1)P_i^{\frac{1}{\gamma}}$$

Theorem III. The volumetric degree of compression ρ at the compressor which is variable at successive stages and which corresponds to any given stage K_n of the ratio of the masses of gas in the two chambers is equal to the inverse of the ratio $K_n \times$ the constant factor K. Moreover ρ is independent of the initial pressure of the charge.

$$\rho = \frac{K}{K_n}$$

Theorem IV. The value of K_m, which is the ratio of the masses of gas respectively contained in the capacity and the reservoir in a state which corresponds to a maximum output of work per revolution of compressor, is a function exclusively of K and of the coefficient γ of transformation.

$$K = \frac{\gamma^{\frac{1}{\gamma-1}}K_m}{[1-(\gamma-1)K_m]^{\frac{1}{\gamma-1}}}$$

From this law one can see that the ratio ρ_m which corresponds to the maximum couple at the compressor is a function of only K and γ.

Compensation of Leakages. If we raise to the power γ the two members of the formula which express the second law and if we express the first member in the form $P_r\left(1+\dfrac{K}{\sigma}\right)^\gamma$, we obtain a binomial expression $(X+1)^m$, where X, which is a variable, has its values comprised between 0 and 1 if K is, for example, less than 4. Since m has a value not in the immediate neighborhood of unity, we arrive by developing the expression in a Taylor series at an expression $P_r + MP_c$ = constant, where the coefficient M has a value close to K raised to the power of γ.

This expression means that if we act on a piston in two stages of which the sections are in the ratio M with the pressure P_r constantly applied on the smaller section and the pressure P_c constantly on the large section, the piston will remain in equilibrium under the action of constantly applied opposed forces. This device makes it possible to insure the invariability of the gaseous mass in the circuit. As soon as a noticeable leak occurs or as soon as the average internal energy of the gaseous mass tends to deviate at any prevailing state from the scale of values established by the theory presented above, the two-stage piston becomes immediately possessed of a tendency toward displacement in one or the other direction, and its displacement may then be used to provide a communication respectively between the capacity or reservoir and a charging or exhausting compartment, according to the direction of the displacement of the piston. Such a piston insuring the invariability of the gaseous mass in the circuit and having the ability to return to its position of rest whenever the cause of disturbance disappears, is called a "pneumatic balance." At all states of operation it plays the double rôle of a device for automatically compensating for losses and of governor in the operation of the circuit.

Operation under Different Initial Potentials. If the regulation of the distribution of the receiver is constant, then in accordance with the third law the same ranges of velocities and couples will be obtained with the same apparatus, no matter what may be the

initial potential of the charges; that is, no matter what may be the power which the group must deliver for a given velocity of the compressor. In other words, the apparatus is absolutely comparable with itself, no matter what may be the value of P_i; in particular (Theorem IV), the maximum of the motor couple at the compressor preserves the same location between the extreme points in the operation of the transmission. Therefore, within practical limits determined by the strength of materials employed, the same transmission may be used for a wide range of power, simply by varying the spring or the counter pressure of the pneumatic balance in such a manner as to modify the constant of its equation of equilibrium without, however, changing the average position of equilibrium of its balance; that is, without changing anything in the arrangement of the different organs of the apparatus. (*Comptes Rendus des Seances de l'Academie des Sciences*, vol. 171, no. 21, Nov. 22, 1920, pp. 992–995, *tA*)

STEAM ENGINEERING

Tests of the Unaflow Pumping Engine, D. A. Decrow. Description and data of tests carried out on an experimental engine with a view to determining certain factors. The engine is a single-cylinder, horizontal crank-and-flywheel pumping unit of the extended type having a nominal capacity of $2^1/_2$ to 3 million gallons in 24 hours. The engine itself has a steam cylinder $13^1/_2$ in. in diameter by 21 in. stroke.

The main data are presented in the original article in the form of tables and the results would appear to indicate that the permissible speeds of this type of engine are much higher than is considered advisable for other types of crank-and-flywheel pumping engines. The results of the steam economy would also indicate higher economy for the higher speeds and temperatures. (*Journal of the New England Water Works Association*, vol. 34, no. 3, Sept. 1920, pp. 195–199, *e*)

TESTING APPARATUS

Junkers Water-Eddy Brake. Description of a water brake of the eddy type employed in the testing laboratory of Doctor Junkers for testing oil engines with a power output of the order of 1000 hp. Essentially, the brake consists of the rotor A (Fig. 6)

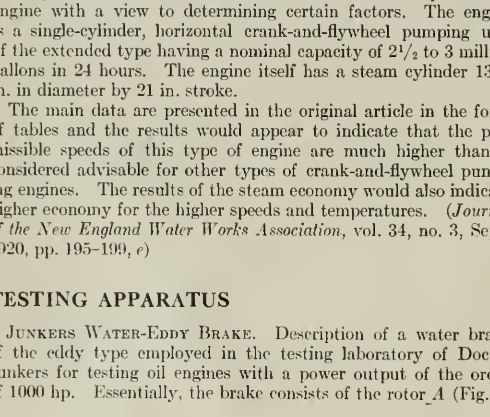

Fig. 6 Junkers Eddy-Type Water Brake
(*Wage* = Scale)

keyed on a shaft and a stator B located centrally with respect to the shaft. The stator and rotor are provided along their peripheries with finger-like attachments arranged in a certain manner, water being circulated between these attachments. If now the rotor A be set in rotation the water between the finger-like attachments offers a resistance which converts the energy supplied by the motor into heat, and this heat is in its turn carried away by the water. The brake has therefore no solid parts rubbing against each other. The thickness of the water rings determines the output which the brake is capable of handling and the regulation is carried out in a very simple manner by varying the level of the water rings, this being done by regulating the water inlet and outlet valves. Preferably the water admission is so regulated that no steam is produced, as this would make conditions in the test room unpleasant.

If water is admitted at 10 deg. cent. (50 deg. fahr.) and discharged with an outlet temperature of 65 deg. cent. (149 deg. fahr.) then the brake will require 636/55 = 11.6 kg. [2545/(149–50) = 25.7 lb.] of water per b. hp-hr. The brake is equally suitable for all kinds of motors, outputs and speeds. Thus the original article illustrates a brake of this type applied to the testing of an exhaust-steam turbine of 6400 hp. at 210 r.p.m. Another illustration shows a 600-hp. Diesel motor, etc. One of the advantages claimed for this brake is that it prevents the engine from running away under any conditions whatsoever. (*Wirtschafts-Motor*, no. 9, Sept. 1920, pp. 19–20, 5 figs., *d*)

VENTILATION

Determination of Dust Content of the Air in a Room

Theory of Dust Action, O. W. Armspach. Report of investigations on air dust and its determination carried out jointly by the research bureau of the American Society of Heating and Ventilating Engineers and the United States Bureau of Mines.

Dust for the purpose of the investigation is defined as particles of matter so finely divided that they easily remain suspended in air, and the velocity of fall is comparatively low. They are considered as spheres. The length of the time that a particle remains in suspension depends upon its diameter, its density, and the density and viscosity of the air.

The following important conclusions have been established:

1 The dust content in a room depends upon the density of the material, velocity of fall of the particles, and the size of the room; the dust will accumulate until a definite content is reached, depending upon the rate of fall and the number of air changes,

2 The total dust given off by various machines when handling different materials can be determined from the average count resulting in the room;

3 Dust conditions can be greatly improved by providing the proper number of air changes; there is, however, a limit to this number and usually five changes per hour are sufficient;

4 For equal conditions of air dustiness, as the density of the material increases, the weight per cubic foot decreases;

5 All dust determinations should be on a basis of the number of particles per cubic foot.

A formula is derived for the velocity of fall of dust particles in terms of their radii and density and the density and viscosity of air. A chart constructed from the formula for various kinds of dust is represented in Fig. 7. It will be observed, for example, that a particle with a diameter of 2 microns and a density of 8, will fall at the same rate as a particle having a diameter of 5.75 microns and a density of 1. With a constant density the velocity increases as the size of the particle increases, and the increase in velocity becomes greater as the diameter becomes greater; that is, for the larger particles the friction of the air is less effective and the velocity of fall more nearly equals that due to gravity. Fig. 7 further shows that the density of the dust particle is an important factor when the conditions of air dustiness in a room are considered. Particles of iron dust 2 microns in diameter will fall at a rate of 12 ft. per hour, whereas particles of wood dust of the same size would fall only $1^1/_4$ ft. per hour. Therefore, when equal quantities of wood and iron dust are produced in different rooms, the conditions of air dustiness in these rooms will differ considerably. The average size of the particles in a steel-grinding establishment will be very much smaller than the size of the particles in a furniture factory, and the means of controlling the dust as necessary to maintaining desirable conditions in the various establishments must be compatible with the fineness and the density of the material handled.

It follows that the average dust count in a room will depend upon the kind of material, the conditions at the source, velocity of fall, and the length of time that the dust-producing machines have been in operation. Formulas are derived and graphs constructed indicating the number of particles of various kinds of dust in a cubic foot of air in a room of given capacity with equally unfavorable conditions at the source. It is thus determined that the heavier dusts reach the maximum-content conditions early in the day, while for wood and other lighter materials the dust content continually increases even after the tenth hour is reached. A dust count alone is therefore not sufficient when designing a

So far the effects of the conditions at the source of dust and the velocity of fall of the particles have only been considered. In addition, there is a decrease in the dust content due to the change of air in the room. This change may result from natural infiltration of air from outdoors or by exhausting the air from the room by mechanical means. When air leaves the room, each cubic foot carries with it a certain number of particles, depending upon the dust content in the room. Also an equivalent amount of air must enter the room. There is therefore a continuous process of dilution taking place, and the dust content in the room

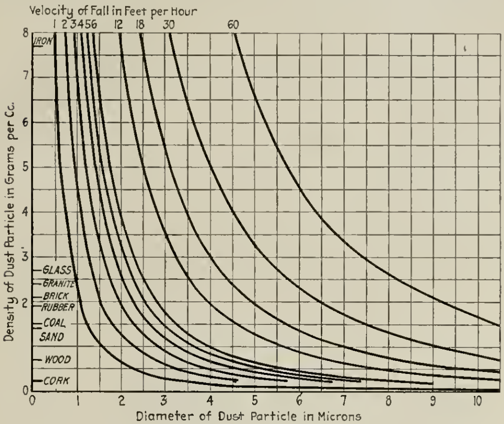

Fig. 7 Chart Showing Velocities of Fall for Various Kinds of Dust

is decreased. When the dust leaving the room due to the air change, plus the dust falling from the room, is equal to the total dust liberated, the conditions are balanced and the dust content in the room remains constant. Fig. 8, also constructed from a formula, shows the effect of changing the air on the dust content. The curves have been plotted for dust 2 microns in diameter falling with a velocity of 1 ft. per min., and 100,000 particles per

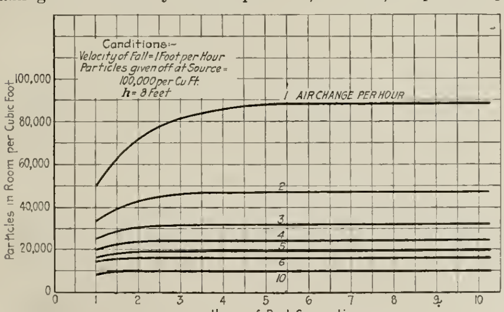

Fig. 8 Curves Showing Effect of Air Change on Dust Content

cu. ft. per hour are given off at the source. Note that with one air change the result in the room at the end of the fifth hour is 88,000 particles per cu. ft. With two air changes the result is only 47,000 particles. If no air is allowed to enter the room the result will be 389,600 particles per cu. ft., or an increase of 342 per cent over the result obtained with one air change.

It will be readily seen that counting methods are superior to weight measurements in air-dust determinations. It is possible to have very different weights for the same conditions of dustiness with different dusts. For example, the weight of 100,000 particles of iron dust of a size which could cause them to fall at the rate of terial, the greater must be the weight per cubic foot to result in equal conditions of dustiness. Thus a dust determination based upon weight is extremely misleading. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 26, no. 9, Dec. 1920, pp. 819–829, 6 figs., *t*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Attaining Normal Grinding Speeds With Extremely Small Wheels

A grinding-wheel spindle designed to operate at 104,000 revolutions per minute was exhibited at the recent London machine-tool exposition. *Machinery* for January 1921 describes this spindle, which is equipped with a wheel $^1/_4$ in. in diameter, attaining, therefore, a cutting speed of about 6800 ft. per min. It is the product of the A. A. Jones & Shipman Co., Leicester, England. The drive is from an electric motor running at 2500 r.p.m. through an intermediate shaft which runs at 9150 r.p.m. Each bearing contains 12 balls of $^1/_8$ in. diameter. The balls are not caged. A special kind of rubber is used for the driving belts. The spindle apparently reaches its critical speed at 33,000 r.p.m., as when it attains approximately this speed the belt starts to oscillate badly; as the speed increases, however, this effect dies down and the belt again runs smoothly. This spindle is yet in the experimental stage, but it has been run hour after hour without undue heating, the period being apparently limited by belt endurance. The wheel was not cutting during these runs.

A more definite stage of practicality has been reached with the next size of spindle, which is provided with the same type of cup and cone bearings designed to run at 40,000 r.p.m. and fitted with a $^1/_2$-in. wheel to give a surface speed of approximately 5000 ft. per min. This spindle is regularly in work at the maker's plant and is said to have been operated at 37,312 r.p.m. grinding out hardened steel gears, with a band of rubber that had stood for three working days without stretching or warping. This spindle has been tested by the National Physical Laboratory up to a speed of 45,460 r.p.m.

The University of Wisconsin has established a Bureau of Commercial and Industrial Relations which will provide information or service in this field. A series of bulletins treating with the following subjects are in process of issue at monthly intervals.

- A Labor Policy and The Labor Audit
- Job Analysis
- The Cycle of Employment
- Industrial Housing
- Government in Industry
- Underemployment and Absenteeism
- Wages and Earnings
- Insurance and Pensions
- Industrial Training and Vocational Guidance
- Industrial Housekeeping
- Plant Newspaper
- Industrial Safety and Hygiene.

In addition to the above circulars a Bibliography Service will be developed. Arrangements are being made to carry forward special Research Service and to make the results available to those interested. A plan is being worked out whereby advanced students may be detailed to special projects in industrial units, working under the close supervision of the Industrial Relations Bureau.

An Analysis of Machined Fits

A.E.S.C. Sectional Committee Acting Through One of Its Sub-Committees Presents a Comprehensive Questionnaire to American Industry

THE July 1920 issue of MECHANICAL ENGINEERING announced the organization and the personnel of the Sectional Committee on Plain Limit Gages for General Engineering Work, a Sectional Committee which is working under the Rules of Procedure of the American Engineering Standards Committee and is sponsored by The American Society of Mechanical Engineers. After a preliminary canvass of the gaging situation carried on during the summer months, the Committee subdivided itself into three working sub-committees. To these sub-committees have been assigned the three subdivisions of the subject, viz., (*a*) standards and tolerances for manufactured material; (*b*) methods of gaging manufactured material; and (*c*) gages and their limits, manufacture, and use.

The Sub-Committee on Standards and Tolerances for Manufactured Material, to which has been assigned the task of preparing a set of standard allowances and tolerances for mating parts in interchangeable manufacture, has after considerable discussion and consultation with manufacturers prepared a questionnaire, full and complete, answers to which it earnestly requests. Since by the method of its organization the report of the full Committee when approved by the A.E.S.C. will establish American standard practice, it is very desirable that everyone interested in any way in this set of standards should know of this activity and should have a part in it, if he so desires. MECHANICAL ENGINEERING therefore takes pleasure in reprinting this questionnaire in full and invites its readers to send their replies addressed to the Committee, care of The American Society of Mechanical Engineers, 29 West 39th Street, New York City.

QUESTIONNAIRE

For the purpose of clearness and after very careful consideration, the Committee has subdivided all machined fits into four classes. These are listed below with the kinds of work which seem to fall in each class.

CLASS NO. 1 LOOSE FITS

Machined fits of agricultural, domestic, and other machinery of similar grade (wagons excepted)
Mining machinery
Controlling apparatus for marine work, etc.
Textile and rubber machinery, candy and bread machinery and others of similar grade
Some parts of ordnance
General machinery for manufacturing.

Question 1. What allowances do you make in this class?

CLASS NO. 2 MEDIUM FITS (Moving Parts)

2 *a* High Speeds (over 600 r.p.m) and Heavy Pressures

Electrical machinery
High-speed parts of woodworking machines
Sewing machines
Machine tools
Locomotives
Printing machinery
Automotive
Ordnance
General machinery for manufacturing.
A well-known firm uses allowances of 0.0005–0.004 in. up to 6 in. for work of this class.

Question 2. How does this compare with your practice?

CLASS NO. 2 MEDIUM FITS

2 *b* Ordinary Speeds (under 600 r.p.m.) and Light Pressures

Machine tools
Printing presses and machinery
Typewriters, calculating machines, etc.
Locomotives
Automotive—general parts
Textiles, rubber machinery
Ordnance
General machinery for manufacturing.
A well-known firm uses allowance of 0.0005–0.0025 in. up to 6 in. for work of this class.

Question 3. How does this compare with your practice?

CLASS NO. 3 SNUG FITS

(Designated as the closest fit that can be assembled by hand.)

3 *a* *Slight Allowance* (0.00025 to 0.00075 in.)

Gear trains and change gears for general work
Mating parts, fixed or not, moving on each other, such as studs for gears and levers, keys
General machinery for manufacturing.

Question 4. Do these allowances agree with your practice?

3 *b* *Close Fit* (commonly known as wringing fit, no allowance, not considered interchangeable manufacturing but selective assembling)

Crankshafts
Precision-ground machine spindles
Gears in index train of precision gear-cutting machines
Slots and tongues such as are used for grinding machines, milling machines, etc.
Surveying and scientific dental instruments, etc.
General machines for manufacturing.

Question 5. Should no allowance be made in machining the fits in this class?

CLASS NO. 4 TIGHT FITS

4 *a* *Drive Fits* for Light Sections

Automotive
Ordnance
General machines for manufacturing.
A well-known firm uses negative allowance from 0.00025 to 0.001 in. up to 6 in.

Question 6. How does this compare with your practice?

4 *b* *Force Fits* for Heavy Sections

Locomotive and car wheels
Crank disks, armatures, flywheels
Automotive
Ordnance
General machines for manufacturing.
A well-known firm uses negative allowance from 0.00075 to 0.005 in. up to 6 in.

Question 7. How does this compare with your practice?

4 *c* *Shrink Fits*

Locomotive tires and similar work
Ordnance.
A well-known concern's practice is as follows: Where thickness exceeds $^3/_8$ in., 0.0005 to 0.005 in. up to 6 in. in diameter. Where thickness is less than $^3/_8$ in., up to 6 in. in diameter, 0.00025 in. to 0.0015 in.

Question 8. How does this practice compare with yours?

The Committee would greatly appreciate having your full answers also to the three following general questions with as much explanatory information as possible:

Question 9. How many of the four kinds of fits previously mentioned apply to your work?

Question 10. Will you send the Committee blueprints or other data showing your practice in as many of these cases as possible?

Question 11. How do you specify both allowance and tolerance for mating parts—such as a solid 2-in. bearing and the shaft which runs into it?

The following sketches show some of the problems. Will you kindly give the Committee as much information as possible regarding your practice in such cases.

Question 12. What allowance and what tolerance would you give on such a piece as shown in Fig. 1: (*a*) for a milling-cutter arbor, (*b*) for a work-holding mandrel?

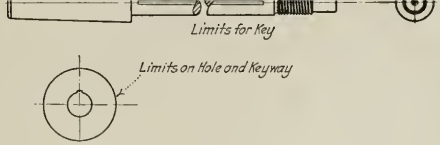

Fig. 1

Question 13. What allowance and what tolerance would you give on the keys and keyways shown in Fig. 2, where
(*a*) Keys are tight in both shaft and hub;
(*b*) Keys are tight in shaft—sliding in hub;
(*c*) Keys are tight in hub—sliding in shaft?

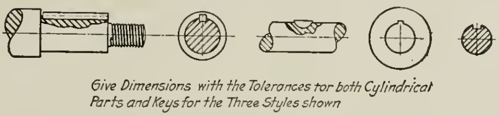

Fig. 2

Question 14. What difference in allowances and tolerances would you give on the bearing and gear fit shown in Fig. 3?

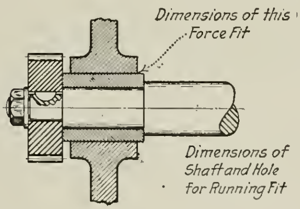

Fig. 3

The fit of a wrench is shown in Fig. 4.

Question 15. What is your practice as to allowance and tolerance for maximum looseness and maximum tightness?

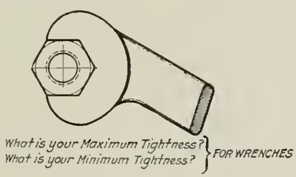

Fig. 4

The rocker arm shown in Fig. 5 contains several kinds of fits.

Question 16. What allowance and tolerance would you give at *A*, *B*, and *C*?

Two shrink fits are shown in Figs. 6 and 7, one a thin shell, the other a locomotive tire. The latter also has a press fit.

Question 17. What is your practice on work of this or a similar character?

In multiplying movements the lost motion often plays an important part.

Question 18. What is your practice in such cases as shown in Fig. 8—for both allowance and tolerance?

Fig. 9 shows a light sliding fit for accurate grinding or similar work. Fig. 10 illustrates a working slide fit for turret slide or for similar purposes.

Question 19. What are your allowances and tolerances in such cases?

Question 20. Do they vary with the length of the slide?

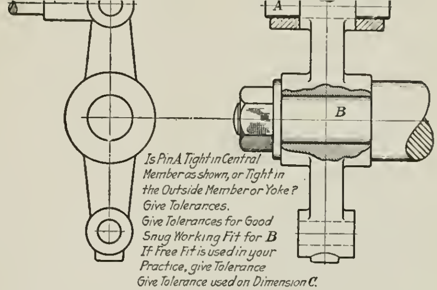

Fig. 5

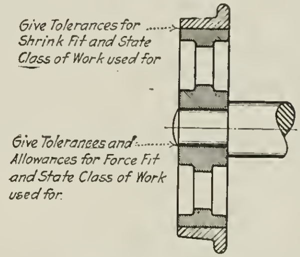

Fig. 6

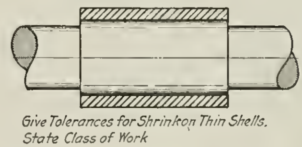

Fig. 7

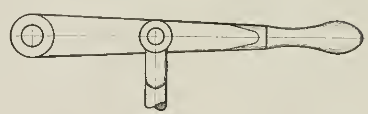

Fig. 8

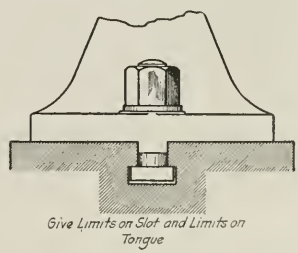

Fig. 9

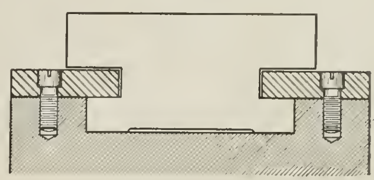

Fig. 10

(*Continued on page 144*)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Committee Notes

THE Special Committee on the Strains due to the Vibration of Shafting will probably organize during the present month under the chairmanship of Mr. N. W. Akimoff. The work of this committee is most important owing to the fact that within recent years a number of failures of the main shafts of vessels have failed from this cause. The committee plans to collect the present knowledge on this subject and then to complete the work as far as possible for the use of the engineering profession.

The Committee on the Present State of the Knowledge Regarding Riveted Joints, under the chairmanship of Dr. A. D. Risteen, will also begin work soon. It is not expected that these two committees will report within two years on account of the amount of work to be done.

The Research Committee plans to use the library of the United Engineering Society and any other collection of data for the work of these committees, and would welcome suggestions from members of the Society regarding problems which demand investigation.

The Scovill Bulletin

The Scovill Manufacturing Company, Waterbury, Conn., has issued as a supplement to the Scovill Manufacturing Company Bulletin, a pamphlet of fifteen pages giving a short description with a photograph of its chemistry and test building, and a paper on the application of metallurgy to the brass industry. The paper includes halftones showing the peculiar nature of alloyed metals and the effects of improper handling during the course of manufacture. The effect of annealing, of continued heating at high temperatures, of improper casting practice, of improper annealing, of improper manufacturing methods and the results of experimental annealing are illustrated in the halftones. The pamphlet also contains halftones showing part of the equipment of the laboratory and explains how the microscope can be an aid in the manufacturing department. Mention is made of the diseases of metals, also of casting, shop problems and the selection of the proper metal for particular pieces of work.

Report of British Inquiry Committee on Lubricants and Lubrication

The Report of the Inquiry Committee on Lubricants and Lubrication has now been published for the Department of Scientific and Industrial Research by H. M. Stationery Office.

The Committee was set up as the outcome of an application made to the Advisory Council for a grant in aid of proposed researches to determine the relation between the viscosity of lubricants and the load on a bearing, and the action of lubricants at high temperatures as applied to commercial methods of oil testing. The Advisory Council deprecated an attempt to obtain partial results in any section of the field for research in lubrication and recommended that an Inquiry Committee be set up under the Department to prepare a memorandum on the field for research, containing an analysis of the problems involved together with a suggested scheme of research which would be likely to lead to valuable results.

The Report of the Committee under these terms of reference is now published and is divided into the following sections:

1 Introductory
2 Bibliography
3 Research work instituted by the Committee
4 Bulletins
5 Existing knowledge of lubrication
6 Review of existing knowledge
7 Recommendation for future research on Lubricants and Lubrication
8 Liaison with the American Bureau of Standards
9 Conclusion.

Subjoined to the Report are 20 appendices by various authors which contain particulars of a number of researches instituted by the Committee on certain fundamental problems on which knowledge was lacking.

Copies of the report (price 2s.6d., by post 2s.8½d.) may be obtained through any bookseller or directly from H. M. Stationery Office at the following addresses: Imperial House, Kingsway, London, W. C. 2, and 28 Abingdon St., London, S. W. 1; 37 Peter St., Manchester; 1 St. Andrew's Crescent, Cardiff; 23 Forth St., Edinburgh; or from E. Ponsonby, Ltd., 116 Grafton St., Dublin.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A2–21. Artificial Seasoning of Gage Steels. An investigation has been made by the Bureau of Standards on various seasoning treatments on the permanence of gage steels. Various hardened gages were heated in oil at different temperatures under varying time conditions and subject to seasoning by dipping in hot oil and iced brine. Short gages of 1/8 in. showed no appreciable change in length with or without various artificial seasoning treatments over a period of seven months beginning one or two weeks after hardening. Length gages of 2 in. showed no appreciable change in planeness. For studying length change it has been shown that lengths from 6 in. to 8 in. are desirable.

Duplicate gages show wide variations in length change. One block showed no dimensional change in 217 days between first and last measurement, while a duplicate decreased 0.00018 in. in the same period. On account of softness, stainless steel is unsatisfactory. Higher-carbon alloys of this type would be more desirable, with a possible decrease in chromium which would not impair the stainless qualities and at the same time reduce the production cost. Plain carbon steel of 1.18 per cent carbon appears least desirable from the standpoint of permanence. The most desirable steels are HC and K, subject to different seasoning treatments. Measurements at intervals of one week, 1, 2, 4, and 7 months after initial measurements of length and planeness do not give very much information regarding the progress of the changes taking place. Where great changes occur they appear to progressively increase with time. Many changes occur immediately following the first measurements. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials B2–21. Reinforced-Concrete Slabs. The Cement Gun Company, Inc., of Allentown, Pa., has issued a pamphlet of thirty-two pages on the Strength of Gunite Slabs. The formula used for these slabs has been checked under the supervision of Prof. M. O. Fuller, of Lehigh University, by a number of tests of slabs of 4-ft. span, 6-ft. span and 8-ft. span. The pamphlet contains data for balance percentage of reinforcement, safe loads for gunite slabs with a factor of safety of 4 with 1:3 mix and 1:2½ mix, and safe live loads for factor of safety of 5 with a 1:3 mix. The tables give the thickness of the slabs and the area of reinforcement per foot of width of slab. The pamphlet contains an analysis of the data by George F. Strehan and the report of Professor Fuller with tables containing the data obtained on the tests from the slabs, the cement and the sand used, as well as curves giving the results of the tests and photographs showing the method of testing. Address Cement Gun Company, Allentown, Pa.

Cement and Other Building Materials B3–21. Floor Treatment. The Bureau of Standards has issued a report on the service tests of various floor treatments carried out by the Bureau. The first materials were applied to the floors of the Northwest Building of the Bureau of Standards five months after its completion in March 1918. The sections were panels 8 ft. square and extending the width of the corridor and

Fluosilicate, Indurite, Liquid Concrex, Esco, Bilchaco, Concreto, Minwax, Thermowax and Saum's Preservative, produced by different manufacturers, and simple materials made at the Bureau of Standards such as sodium silicate, aluminum sulphate, linseed oil, fuel oil and soap and soap treatment.

The results of the home-made solutions are given below from A to J and U and V, while the other results are from the manufactured materials mentioned above under their trade names.

A. A treatment of 15 per cent solution of magnesium fluosilicate applied in three coats gave a surface which was quite hard after two years and three months of service with no wear showing except for a few small areas. The first coat was one part solution and two parts water; the second coat was one part solution and one part water; the third coat was two parts solution and one part water.

B. An 8.7 per cent solution of magnesium fluosilicate applied in three similar coats has been in use for one year and nine months. This shows considerable wear.

C. A $14^1/_2$ per cent solution of magnesium fluosilicate applied once in a heavy coat has been used for two years and two months and appears to be in a good condition. No wear is apparent.

D. A treatment of $11^1/_2$ per cent solution of magnesium fluosilicate in three coats shows no definite signs of wear after one year and eight months.

E. An 18 per cent solution of magnesium fluosilicate with a small amount of zinc fluosilicate applied in three coats gives no appreciable wear after two years of service.

F. A solution of 7.3 per cent magnesium fluosilicate with 2.6 per cent magnesium sulphate and $4^1/_2$ per cent of free hydro fluosilicate is unsatisfactory.

G. A 16 per cent solution of zinc sulphate with about $4^1/_2$ per cent of free sulphuric acid applied without dilution in two coats has given excellent satisfaction after two years and three months of service. After the first application had dried for four hours the surface was scrubbed with hot water and mopped dry before the application of the second coat. This gave a darker appearance to the original concrete.

H. A 20 per cent solution of sodium silicate containing small addition of organic acid applied without dilution in two coats 24 hr. apart gave excellent results after two years and two months of service. This treatment gave a brighter and more uniform appearance than the original concrete.

I. A treatment of 8 per cent solution of commercial sodium silicate in three coats if preceded by a thorough scrubbing with water gives excellent service after two years and two months. The treatment gives a hard surface of uniform appearance which is lighter in color than the original.

J. A 15 per cent solution of aluminum sulphate applied in three diluted coats gave satisfactory results after one year and six months of service. The surface is not so hard as that obtained by other treatments, but it is effective in holding dust. It is applied without interfering with traffic. The first coat was one part solution to two parts water, the second coat was one part water to one part solution and the third coat was two parts solution to one part water.

K. Gray paint of proprietary make containing lead sulphate, siliceous matter and carbon in varnish vehicle is showing the effects of wear after two years and two months service.

L. A china wood-oil varnish applied in two coats 24 hr. apart has been in service two years and one month with few scratches due to moving machinery. It is wearing thin in places.

M. China wood-oil varnish in two coats applied two years and two months show no appreciable wear.

N. Boiled mineral spirits varnish applied in two coats at intervals of 24 hr. in service two years and one month is worn in places.

O. Gray paint with pigment of basic lead sulphate, zinc oxide, barium sulphate, siliceous matter and carbon in linseed oil, rosin vehicle thinned with mineral spirits, applied in two coats, shows no signs of wear except scratches from machinery after one year and five months. Waxlike finish but not especially resistant to scratching, although under foot traffic.

P. Thick paint of zinc oxide, lithopone and bone black in varnish vehicle containing rosin. Only one coat was used but the directions require two coats. After one year and six months large scratches from machinery were noted. Thick film gives a surface pleasing to walk upon. Small spots have blistered and worn away.

Q. A solution of heavy carbon wax in light carbon oil applied in two coats. After two years and three months it was considerably worn. Object of this treatment is to hold dust and not to harden surface.

R. Treatment of mixture of waxes applied in molten condition worn through under office chairs. Considerable wear after two years and four months.

S. Linseed oil with small addition of citronella applied in first coat and kept dry. Test does not show true value of treatment.

T. Four applications of raw linseed oil thinned with turpentine. Service two years and two months. Results at first not satisfactory but surface hardens gradually and at present is quite hard. It appears to resist the wear very well.

U. Examination of slab subject to frequent scrubbings with thick soap solution. No polished condition results from this under wear.

V. Treatment of emulsion of fuel oil and soap of three quarts of harder than original. Application leaves floors slippery for a few hours.

Conclusions:

1 Materials of the magnesium fluosilicate class gave very good results although more knowledge is needed concerning proper strength of solution.

2 Zinc sulphate treatment gives excellent results.

3 Surface-coating materials are most effective in entirely eliminating dust.

4 Home treatments I and J prove very successful and quite inexpensive. The following directions are given:

A—Sodium Silicate Treatment

Commercial sodium silicate usually varies in strength from 30 to 40 per cent solution. It is quite viscous and has to be thinned with water before it will penetrate the floor. In ordinary cases it will be found satisfactory to dilute each gallon of the silicate with four gallons of water. The resulting five gallons may be expected to cover 1000 sq. ft. of floor surface one coat. However, the porosity of floors varies greatly and the above statement is given as an approximate value for estimating purposes.

The floor surface should be prepared for the treatment by cleaning free from grease, spots, plaster, etc., and then thoroughly scrubbed with clear water. To get the best penetration the floor should be thoroughly dry, especially before the first application, and if practical it is well to let it dry for several days after the first scrubbing. The solution should be made up immediately before using.

It may be applied with a mop or hair broom and should be continuously brushed over the surface for several minutes to obtain an even penetration. An interval of 24 hr. should be allowed for the treatment to harden, after which the surface is scrubbed with clear water and allowed to dry for the second application. Three applications made in this manner will usually suffice, but if the floor does not appear to be saturated by the third application a fourth should be applied.

This treatment when properly applied gives a very hard surface that is bright and uniform in appearance. The commercial sodium silicate can be obtained from wholesale druggists usually at a cost of 40 cents or less per gallon.

B—Aluminum Sulphate Treatment

The solution of aluminum sulphate for this treatment should be made in a wooden barrel or stoneware vessel. The amount required may be estimated on the basis of one gallon of solution for each 100 sq. ft. of area. For each gallon of water $2^1/_2$ lb. of the powdered sulphate will be required. The water should be acidulated with commercial sulphuric acid by adding 2 cc. of the acid for each gallon. The sulphate does not dissolve readily and has to be stirred occasionally for a period of a few days, until the solution is complete.

The floor should be cleaned of grease spots, plaster, etc., then thoroughly scrubbed. When the surface is entirely dry, a portion of the sulphate solution may be diluted with twice its volume of water and applied with a mop or hair broom. After 24 hr. dilute a portion of the original solution with equal volume of water and apply in the same manner as the first. Allow another interval of 24 hr. and make an application using two parts of the sulphate solution to one part of water. Each application should be continually brushed over the surface for several minutes to secure a uniform penetration. After the third application has dried, the surface should be scrubbed with hot water. This treatment will give good results at a cost about equal to that of the sodium silicate treatment. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Chemical, General and Physical A1–21. Inflammability of Jets of Hydrogen and Inert Gas. An article by P. G. Ledig, *Journal of Industrial and Engineering Chemistry*, vol. 12, page 1098, gives the following:

Under favorable conditions a jet of helium containing more than 14 per cent of hydrogen can be ignited in the air.

Eighteen to twenty per cent of hydrogen may be mixed with helium without producing a mixture which will burn with a persistent flame when issuing from an orifice under the conditions prevailing in balloon practice.

More than twenty per cent of hydrogen can not be used in balloon practice without sacrificing safety from fire. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Light A1–21. Personal Error in Using Parallel Cross-Hairs in Micrometer Microscope. The Bureau of Standards has recently made observations on the diameter of wire employed in certain sieves, using a micrometer microscope setting two parallel cross-hairs so that the edge of the wire was midway between them. Five observers were used. The results showed an evident personal error, confirming the metrological principle that it is difficult to match an equal width of bright and dark space. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A3–21. Decarburization of Steel by Heating in Vacuo. Steel specimens heated for 24 hr. at approximately 760 deg. cent. had carbon content reduced from 0.54 per cent to 0.36 per cent. Material was an iron-carbon alloy prepared at the Bureau of Standards to which no addition other than carbon had been made. An explanation for this action assumes the presence of

oxygen in some form, as commercially prepared steel which has been deoxidized in manufacture behaves very differently from the small melts made at the Bureau. This investigation is being continued. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A4–21. Magnesia for Crucibles Used with Electrolytic Iron and Iron-Carbon Alloys. The Bureau of Standards has prepared 100 lb. of electrolytically fused magnesia which contains less than 0.02 per cent SiO_2. This is not large enough to prevent the use of magnesia in melting electrolytic iron and iron-carbon alloys. Crucibles of fused MgO undergo so little shrinkage that it is possible to melt in the tamped and dried crucible without the preliminary calcination to 1500 or 1600 deg. cent. which was necessary with the old type of crucible. Samples of zircon have been obtained to compare with zirkite. These two zirconium refractories are at present obtainable commercially. The preliminary tests showed that refined zircon has a melting point considerable below zirkite cement. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A5–21. Grain Size and Brinell Hardness of Carbon Steel. A paper on relation of grain size to Brinell hardness of annealed carbon steel by Rawdon and Jimeno has appeared in printed form and is ready for distribution. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A6–21. Arc-Fused Steel. *Chemical and Metallurgical Engineering* for Oct. 20, 1920, contains the second installment of results of an investigation on the metallography of arc-fused steel conducted at the Bureau of Standards. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Metallurgy and Metallography B2–21. Heat Treatment of Carbon Steel. The Committee on Heat Treatment of Carbon Steel of the Division of Engineering, National Research Council, is continuing its work on this subject. Many tensile test pieces and impact test pieces have been used. Materials used have been investigated for magnetic properties and all materials have had the preliminary heat treatment. The heat treatment of the specimens has been accomplished in a special furnace and care has been exercised to determine the temperature of treatment very accurately. Address Dr. Henry M. Howe, Chairman of Committee, 29 West 39th St., New York.

Metallurgy and Metallography B3–21. Fatigue of Materials. The joint investigation on the fatigue of materials under the direction of Prof. H. F. Moore is progressing at the University of Illinois. Already many tests have been run, and although no conclusions can be definitely drawn from the results at present, certain indications have been obtained. Address Prof. H. F. Moore, University of Illinois, Urbana, Ill.

Metallurgy and Metallography B4–21. Substitute Deoxidizers. The manufacture and testing of new deoxidizing alloys described in a paper by J. R. Cain for the Division of Engineering of the National Research Council is in progress. Five of the alloys have been made at the Bureau of Standards and five other by the Metal & Thermit Corporation, while the Fitzgerald Laboratories are to make others. The lead-magnesium alloy had had a preliminary test at the Bureau of Standards for deoxidizing American ingot iron. All of the alloys are to be tested at the Bureau of Standards for deoxidizing efficiency. Address J. R. Cain, Bureau of Standards, Washington, D. C.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Metallurgy and Metallography C1–21. Absorption in Furnaces. An inquiry has been received by the Research Committee regarding the absorption of heat by steel. The statement was made that steel absorbs heat as the 6th power of the radiancy and that this absorption does not mean the radiation of heat by the Stefan-Boltzmann Law. The Research Committee is not able to explain this statement and would appreciate any communication with the inquirer regarding the meaning of the above statement and the reference to an authority regarding it. Address A. E. Walden, 100 West Fayette St., Baltimore, Md.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Victor J. Azbe, D1–21. Power-Plant Laboratory. Laboratory equipped with apparatus for chemical analysis and physical tests concerning power-plant economy. Fuels of all kinds, solid, liquid and gaseous, are handled. Apparatus for making determinations of the fusing point of ash, for water testing and analysis of boiler scale are included. General industrial work is to be cared for by the laboratory. Address Victor J. Azbe, 2194 Railway Exchange, St. Louis, Mo.

Scovill Manufacturing Company, D1–21. The Scovill Manufacturing Company, of Waterbury, Conn., has a separate building 213 ft. long, 50 ft. wide and 20 ft. high devoted to research work and control work for its product. The building is subdivided into offices, library and rooms for metallography, electric-furnace work, photography, polishing, weighing, physical testing and a main laboratory for routine work in analysis of brass, bronze, nickel, silver, cupronickel, steel, copper, spelter, special alloys and oils and greases. During the war there were 94 people employed in the laboratory. Address Scovill Manufacturing Company, Waterbury, Conn.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Victor J. Azbe, E1–21. Mr. Azbe, who has been devoting many years to the investigation of losses in steam-power development, has realized the importance of supplementing his field work with the equipment of a research laboratory for prompt and accurate reports on materials used in power plants. For this purpose he has established a laboratory for carrying out chemical analysis and physical tests. This laboratory will be devoted to reports on materials for general industrial work. Address Victor J. Azbe, 2194 Railway Exchange St., St. Louis, Mo.

Materials of Engineering E1–21. Standard Samples. The Bureau of Standards is distributing standard samples of materials for comparison and other uses such as control analysis. During the month of November 434 samples were issued costing $849.25. Sample 23-A of Bessemer 0.8 per cent carbon steel and No. 51 electric-furnace 1.2 per cent carbon steel were issued for the first time. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Petroleum, Asphalt and Wood Products, F1–21. Recent Articles on Petroleum. The recent articles on petroleum and allied substances are compiled each month for the Bureau of Mines by E. H. Burroughs. This bibliography includes articles on geology and the origin of petroleum, on development and production, patents, transportation, storage and distribution, properties and their determinations, refining and refineries, utilization, legislation and legal regulation, statistics, economics, organization and institutions. It also gives a list of bibliographies on this subject. Address Bureau of Mines, Washington, D. C., H. Bain Foster, Director.

Bibliographies Compiled by U.E.S. Library

The Engineering Societies Library announces the completion of bibliographies covering the subjects of Pulverized Coal and Fuel Oil for Raising Steam. The former contains 41 typewritten pages and has 283 references, each accompanied by a short explanatory note. It covers the years from 1910 to 1920. The latter, extending over the years 1911 to 1920, covers 22 typewritten pages and contains 201 references. The search is divided into five parts: (1) General; (2) coal vs. oil; (3) marine use of oil; (4) oil for locomotives and (5) apparatus and combustion.

Those desiring to purchase copies of these bibliographies should address Mr. Harrison W. Craver, Director of the Engineering Societies Library, 29 West 39th Street, New York, N. Y.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Objects to the Use of Greek Symbols

To the Editor:

I wish to make a criticism of the use of Greek letters in the columns of Mechanical Engineering.

My attention has been called to a paper in your November issue, entitled Calibration of Nozzles for Measurement of Air, etc., where repeated use is made of the symbol "psi" for an important coefficient. The objection to a Greek letter in this connection is that the language has been dropped from the educational system. Engineers do not study Greek, and probably few of them know more than three letters of the Greek alphabet.

Greek symbols are therefore unfamiliar to a majority of your readers. Their further use in your columns is hardly defensible except on grounds of tradition and precedent. No reader likes contact with a symbol which he does not know how to pronounce, and which he hesitates to write. The printer must find Greek a nuisance to set up. Those of us who use typewriters find it troublesome, because Greek is not on the keyboard.

I am aware of the fact that engineering literature is full of Greek letters and that certain symbols such as "pi," ratio of circumference to diameter, and "delta," symbol of differentiation, will survive. My plea is that in original papers, offered to engineers through your columns, the use of Greek letters be discouraged, if not definitely forbidden.

E. H. Lockwood.

New Haven, Conn.

Books for Supplementary Reading by Students

To the Editor:

Supplementing my communication in the January number asking for suggestions of books for supplementary reading by students in industrial management, I append a list which we have used for the course at the University of Illinois.

The objects of this supplementary reading are several, namely: To broaden knowledge of the principles underlying the conduct of industrial affairs; to promote a better understanding of the human element and its relation to industry; to enlarge acquaintance with the ideals and methods of distinguished thinkers, investigators, and producers; and to develop clearer conceptions of the tasks which engineers entering the industrial world are called upon to perform.

Four books are to be read and reported from the following list:

- Principles of Management, by Taylor
- Twelve Principles of Efficiency, by Emerson
- Work, Wages, and Profits, by Gantt
- Investigating an Industry, by Kent
- Human Factor in Works Management, by Hartness
- New Industrial Day, by Redfield
- Organizing for Work, by Gantt
- Industrial Goodwill, by Commons
- Motion Study, by Gilbreth.

Books are assigned arbitrarily unless the student already has read certain volumes or when personal preference for particular authors is supported by satisfactory reasons. In the case of students who desire to do additional reading, assignments are made from a subsidiary list of books as follows:

Man to Man, by Leitch; Work and Wealth, by Hobson; Psychology and Industrial Efficiency, by Münsterberg; Time Studies and Rate Setting, by Merrick; Fatigue and Efficiency, by Goldmark; Scientific Management and Labor, by Hoxie; Turnover of Factory Labor, by Slichter; Common Sense and Labor, by Crowther; Personnel Administration, by Tead and Metcalf; Principles of Industrial Organization, by Kimball; Profit-Making Management, by Carpenter.

The reading of books relating to practical application of methods or descriptive of existing systems of management is discouraged at this time, but a complete bibliography of management is supplied and suggestions offered as to the many admirable books which should be helpful in actual practice. It is believed that during this period attention should be focused almost exclusively upon principles rather than upon the details of practice and the selection of books is made with this consideration in view.

This matter is presented here in this form to stimulate interest in the general topic of reading, not only for the younger generation of engineers, but also for all engaged in the profession. What books should be read by young men in training for careers in the industrial or engineering world? What substitutions, withdrawals, or additions in titles can be made with profit in the lists of books referred to previously? Is there a "Three-Foot Shelf of Books" for engineers? These are questions of rather large significance and in my opinion a discussion of them in the columns of Mechanical Engineering will confer direct benefits on a large section of the membership of the Society. May we not have such a discussion?

Bruce W. Benedict.

Urbana, Ill.

Extending Ocean Navigation to the Great Lakes

To the Editor:

Replying to the communication of Charles Whiting Baker on page 592 of Mechanical Engineering for October, concerning the development of the St. Lawrence River as a waterway, I wish to call your attention to some important considerations that have been neglected.

The City of Chicago, one of the most southerly of Great Lakes ports, is closed to navigation by ice for at least five months of the year. Furthermore, the other end of the proposed waterway, the mouth of the St. Lawrence River, is 625 miles north of Chicago. The region of the ocean north of Sable Island and the Banks of Newfoundland, between Cape Sable and Sable Island, in close proximity to the Strait of Belle Isle, is known to all deep-water sailors as the "Graveyard of the Atlantic." The navigation of this region is regarded by all ship owners and underwriters as the most hazardous of the entire globe, owing to the quantities of ice from the coast of Labrador, much of which is forced through the Strait of Belle Isle, involving the Gulf of St. Lawrence in an almost constant menace of snow, ice and fog to all shipping entering or departing from the Gulf and its neighboring waters. The Allan Line of English ships operates from Montreal under a heavy subsidy or contract with the British Government and every winter it is obliged to abandon its regular St. Lawrence route and port of call for some port on the coast further south.

In view of the conditions of navigation above submitted, and of the complete failure of the former attempts to overcome the difficulties, it is respectfully submitted that the theories of Charles Whiting Baker and Mr. Merrick, President of the Association of the Chamber of Commerce of the City of Chicago, together with the visions of great commercial development throughout the fourteen states in proximity to the Great Lakes, as the result of these theories, are based upon misleading and fallacious arguments, resulting from a complete lack of knowledge of conditions as already experienced, and involve the expenditure of millions of dollars in a venture which is foredoomed as a successful financial enterprise.

Garden City, N. Y. E. Platt Stratton.

Sees Danger in St. Lawrence River Project

To the Editor:

The St. Lawrence project is being discussed. This project contemplates the construction of canals, locks and dams whereby to provide a navigable water passage from the Great Lakes to the Atlantic Ocean. That this project will be of value to the United States need not be gainsaid.

It is true that the products and manufactures of the Middle West can be shipped through the lakes and St. Lawrence River and its proposed canals to the ocean for domestic and foreign ports at far less expense than they can now be shipped when they must be transferred from lake boats to rail and then, for foreign commerce, again to boats. It is true that practically all of the commerce of the Middle West would pass through this canal; and the Middle West is our great industrial center. It is said that the railroads would be injured by the diversion of freight traffic; but the railroads would make provision for this loss and their spare rolling stock, if any, would be diverted to other regions in sufficient numbers to permit the operation of the remaining equipment at full capacity.

In the St. Lawrence project, however, resides a grave danger to the economic and political welfare of the country; and this project should not be carried to completion.

The mouth of the St. Lawrence River lies entirely within the boundaries of a foreign country and is comparatively remote from the boundaries of the United States. If the project be carried out, the business of the entire Western and New England States and the political welfare of the whole country at large will be dependent upon the maintenance and continuance of friendly relations with our neighbor. While we have the greatest friendship and respect for that country and hope that serious differences will never arise between us, yet it is not without the bounds of reason, and also of experience, to anticipate serious differences; and, if ever a state of war does spring up, the mere blockade of the mouth of the St. Lawrence River will utterly cripple the entire industrial section of our country. Our railroads will immediately become so congested by the attempted diversion of the water freight to rail as to be useless by reason of the previous reduction of their rolling equipment. No one can predict, in these troublesome times, a continuance of peace. It must be remembered that the country controlling the outlet of the St. Lawrence is but one of the children of that mother country across the sea. That mother country, by virtue of possession of Gibralter at one end and the Suez Canal at the other end, governs traffic in the Mediterranean Sea; and by possession of the Dardanelles controls the economic condition of lower Russia. By diverting the traffic of the industrial section of the United States through the St. Lawrence River, that mother country would control the political and economical welfare, in time of stress, of the United States.

This project must be dropped.

T. T. Greenwood.

Boston, Mass.

Theoretical Consideration of Bending in Shafts

To the Editor:

I have never seen any literature on the subject of bending in shafts in which any attempt is made to consider the pressure distribution of the loads and reactions and the effect various distributions might have. The following was written as the result of a problem presented to me by the engineers of an industrial firm, substantially as stated. The solution with the assumptions made is very simple, and while there may be some published work covering the subject, it has not come to my attention.

So far as the writer has been able to ascertain, the methods used in practice in the calculation of the shaft bending moments have been based on the results of experience rather than any theoretical considerations. One concern had the following method for its standard practice: The reactions were first calculated assuming that they could be considered as concentrated at the centers of the bearings. The reaction forces were then considered as uniformly distributed over areas of width equal to the diameter of the shaft such that the pressure per square inch was equal to the maximum allowable crushing strength of the bushing material. These areas were at the ends of the bearings nearest the force causing the bending and the moment arms were measured from the centers of these areas. As some of the subsequent statements show, there are cases where the general theory on which the above method of calculation is based holds true. Shafts calculated by this method did give shaft sizes which agreed more or less with the results of experience, but since there was no general justification for the theory on which it was based, it was subject to erroneous use. Another concern uses one-quarter of the length of the bearing in determining the moment arm.

The concern first mentioned has recently adopted one-third the length of the bearing as determining how much of the bearing length is to be considered in the moment arm. This adoption was based on the considerations described in following paragraphs. It was found that practically all the shafts used in their work had moment arms which included about one-third the length of the bearing so that that value was satisfactory, the variations from it being within the limits of accuracy of the computations.

The maximum bending in shafts is not only a function of the various total loads and reactions, but is also a function of the distribution of the loads and reactions along the shaft. The distribution along the shaft is practically impossible of accurate determination and is affected by several factors. The flexibility of the shaft, the lack of absolute rigidity of the bearing supports, the quality of the lubrication, oil pressure, friction, and wear of the shaft and bushing, all affect the pressure distribution.

There is a tendency of the shaft to bend in the direction in which the force acts which would cause the shaft to bear only at one end of the bushing. The bearing supports also possess some flexibility and they tend to conform in position with the deflected shaft. All bearings in which the shaft revolves are lubricated and the oil film, unless completely broken, tends to equalize the pressure distribution. The friction in the bearing does not tend to vary the pressure along the shaft as it does in a circumferential direction. Wear and flow of the bushing material are undoubtedly the most important factors in determining the pressure distribution along the bearing.

With a new bearing, the pressure at one end of the bearing will unquestionably be higher than at the other due to the deflection of the shaft. The higher pressure, will however, cause greater flow of the bushing material or greater wear at the points of lesser pressure so that the tendency is to produce or at least approach a uniform distribution of pressure along the shaft. This is particularly true in case the loading is not varying greatly. In the case of intermittent shock or impact loading it is doubtful if the bearing would wear to conform with the extra deflection of the shaft due to the extra intermittent loading, but it would probably do so if the shocks occurred with sufficient frequency.

The length of the bearing would also be a factor to consider, since, if it were sufficiently long, the time required to wear the bearing down might be more than or at least a good part of the life of the machine, so that the number of repetitions of stress at somewhere near the maximum value calculated would be relatively small, making the shaft safer than was necessary. Then, too, the deflection of the shaft would probably be sufficient to cause an opposite reaction at the other end of the long bearing which would also tend to decrease the bending in the shaft. Bearings with lengths less than twice the diameter of the shaft would not be considered as long bearings, and since practically all bearings are within this limit except for other reasons than pressure, velocity, and heat dissipation, they may be neglected in any further considerations. The other considerations seem to point to a practically uniform distribution of bearing pressure along the shaft and it is assumed to be uniform in the following considerations. This assumption makes the problem a very simple one.

First, consider a shaft in which the load causing bending is beyond the bearings as shown in the force diagram, Fig. 1. If the force causing bending is F and the bearing pressure is uniformly distributed along the shaft in the bearings, the reactions may be calculated as concentrated at the centers of the bearings. If a is the distance from the force to the center of the nearest

$$R_1 = \frac{(a+c)F}{c} \text{ and } R_2 = \frac{aF}{c}$$

With uniform distribution of bearing pressure along the shaft the shear diagram is as shown in Fig. 1, in which R is the point of zero shear. R is at a distance d from the end of the bearing nearest the force F and

$$d = \frac{bF}{R_1} = \frac{bcF}{(a+c)F} = \frac{bc}{a+c}$$

The bending at any point in the shaft is equal to the area of the shear diagram either to the right or the left of the point. Since the maximum bending occurs at the point of zero shear, the maximum bending moment is

$$M = \left(a - \frac{b}{2}\right)F + \frac{bcF}{2(a+c)}$$
$$= \left(a - \frac{b}{2} + \frac{bc}{2(a+c)}\right)F$$
$$= \left[a - \frac{b}{2}\left(1 - \frac{c}{a+c}\right)F\right]$$

The actual bending-moment diagram for the shaft under consideration is shown in Fig. 1. The distance y is equal to $d/2$ and the area of the rectangle having F for one side and $a + y - b/2$ for the other is equal to the area of the shear diagram to the right or left of the point R. It will be noted that at the point of maximum bending the shear is zero, so that while designers ordinarily omit it from their computations because it is generally a relatively small factor in the shaft stress, it really is a zero factor at the point of maximum bending.

In case the force F is between the bearings, its pressure distribution along the shaft becomes the primary factor in the determination of the bending in the shaft. In case the loading of the force F along the shaft is practically uniform, the same equation just developed is applicable, only in this case a becomes the distance between R_1 and F and c the distance between R_2 and F, while b becomes the length of the load distribution along the shaft.

It is evident that except in short shafts there is not much difference in the bending moments determined by the above method and by the use of the distance to the center of the reaction as the moment arm. These considerations, however, are very important in the economy of material in short shafts.

In short shafts there are generally two forces as well as two reactions causing bending in the shaft. These forces may be external to the two bearings either on opposite ends of the shaft sure distribution on the bearings along the shaft is considered uniform, the bending-moment diagrams may be determined individually and then be combined to give the resultant bending

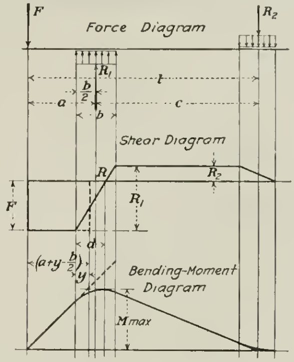

Fig. 1 Bending in Shafts

moments. The resultant points of maximum bending will probably be at some other points than the points of maximum bending for the individual forces taken alone, but will be very near them, and in the case of the two forces on opposite ends of the shaft overhanging the bearing and the case where only one force is between the bearings and the one external to the bearings is large enough to bring the maximum resultant bending in the shaft in the bearings, will not vary materially from the maximum individual moment. In the other cases, depending on the conditions of the loading, the maximum resultant bending moment may or may not differ greatly from the maximum bending moment due to one of the forces, but a trial calculation should at least be made before ignoring the other.

The foregoing method of calculation seems to offer a fairly theoretical solution which will agree quite well with practice and in some cases of design should permit of an economy of material over present methods of design. In other cases it will serve as a very good check on the safety of shafts, since any error due to the assumptions in the method is on the side of safety.

Charles W. Good.

Ann Arbor, Mich.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

Rules for the Staying of Plain Circular Furnaces

The attention of the chief boiler inspectors in the states and municipalities where the A.S.M.E. Boiler Code is effective has been called to the fact that the question of the rules for the staying of plain circular furnaces has been under consideration by the Boiler Code Committee for several months as a result of certain features that have been noted in Cases Nos. 256 and 293, in their relation to the special allowance made in Par. 212c of the Boiler Code.

A special sub-committee to the Boiler Code Committee was appointed at the October meeting of the Committee to thoroughly investigate this matter, and as a result of the discussion of the matter at the December meeting, it was decided that it would be advisable to inform them of this situation and suggest that in view of a possible revision of Par. 212c, this Rule of the Boiler Code should not be used until the Committee's investigation can be completed and reported upon.

Conference Committee on Welding

The Boiler Code Committee takes pleasure in announcing that the American Society of Refrigerating Engineers has appointed a Committee to confer with the Sub-Committee of the Boiler Code Committee on Welding. The above is the result of an invitation extended by the Council of the A.S.M.E. at the request of the Boiler Code Committee. It is the desire of the Boiler Code Committee that the Committee of the American Society of Refrigerating Engineers shall coöperate with the Sub-Committee of the Boiler Code Committee in discussing the rules now in the Code and in proposing to the Boiler Code Committee any revisions or new rules that may be embodied in the Code at the next revision period. The personnel of the Committee appointed by the American Society of Refrigerating Engineers is as follows:

Louis Doelling, *Chairman*, New York, N. Y.
E. F. Miller, Cambridge, Mass.
Fred Ophuls, New York, N. Y.
Norman M. Small, Waynesboro, Pa.
Harry Sloan, Milwaukee, Wis.

MECHANICAL ENGINEERING

The Monthly Journal Published by The American Society of Mechanical Engineers

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Yearly subscription, $4.00, single copies 40 cents. Postage to Canada, 50 cents additional; to foreign countries $1.00 additional.

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

Motorships

Charles E. Lucke

European shipbuilding nations, the Scandinavians at first, but now practically all, including England, France, Holland and Italy, in addition to Germany, have for some years been building large Diesel engines and auxiliary equipment for the driving of seagoing vessels. In more recent years this movement has been accelerated by the proved economy of the equipment that has been found most reliable and the reduction in cargo-carrying costs by the motorship over the steamship. The raising of all prices and costs by the war has directed attention to every possible source of saving, and this among other things has further increased the volume of motorship building at the expense of steamship construction.

During this whole period of experimental development of the propelling machinery, and with its perfection the large-scale demonstration of lower cargo-carrying costs over competing steam equipment, America has done nothing with the motorship. On the contrary, there has been a great increase in steam cargo carriers, first as a result of war demands and later as a national movement for the reëstablishment of the American merchant marine in a position of some commanding importance at sea.

While America has been building more and more steamships, the Europeans have been building fewer in proportion, replacing them by motorships, partly on the basis of demonstrated reliability but mainly on the basis of proved reduction of operating costs. Only now have our shipping interests passed the period of consideration and entered upon that of action.

It has taken some years to convince American shipping interests that the motorship is reliable; it has taken some years to convince these same interests that America can build satisfactory engines and that they need not be reproductions of European models; but it can be said definitely that shipping interests have now reached the point of accepting this situation. It is admitted that American Diesel engines can be built equal in quality to those built in Europe and also at competing costs, but in spite of this there has not as yet been any great adoption of the motorship in this country. Only a few have been contracted for today, although a great many projects are under consideration.

Apparently American shipping interests have not yet been convinced of the superior operating economy and lower cargo-carrying costs of the motorship as compared with the steamship, especially when the latter is provided with the geared-turbine Scotch-boiler type of equipment. At the present time the future of the motorship in American shipping activities seems to be hanging in the balance of these comparative costs of operation.

The motorship equipment costs materially more to buy than does the steamship equipment. Its fuel consumption is materially less, the ratio at sea being 1 to $2^1/_2$ and still more favorable while in port. While there are corresponding differences in all of the other items of expense, such as wages and subsistence of crew, maintenance, repairs, stores, to mention a few of the leading items, it appears that the main elements of controversy and uncertainty lie in the balancing of the money saving by the motorship, due to fuel economy, against the excess of fixed charges which it must carry.

Whether or not the cheaper steamship, burning $2^1/_2$ times as much fuel as the motorship at sea, will give a lower or higher total cost of handling cargo per ton-mile, depends not only on the difference in the first costs, but also upon the prices of fuel per gallon, on the number of sea-miles per year of operation or horsepower-hours per year, or the ratio of time spent at sea to that in port; and in the case of the fuel on whether or not the motorship burns the same grade of fuel at the same price as does the steamship. For any given first-cost differential, constituting a fixed-charge handicap against the motorship, the money saving by the superior fuel economy of the motorship will be more than enough to offset it and show a net profit, provided the ship is kept at sea in actual cargo carrying a sufficiently large proportion of the total time. It will also depend on the fuel-price differential, as well as on the fuel price itself.

Analyses of these cost factors and totals indicate that the motorship is best adapted to long-distance voyages, the longer the better, and in this connection it should be noted that in the double-bottom bunkers of the motorship sufficient fuel can be carried for a total of 20,000 miles, which is much more than in the case of a steamship. The minimum length of voyage that can be profitably assigned to the motorship in competition with the steamship would seem to depend on the fuel-price differential, assuming the two ships do not burn the same grade of fuel.

As to fuel price, it seems pretty clear from what statistics are available that the general trend of price is upward, and that in view of the growth of the automotive undustry this will continue so. This being the case, so far as forecasts are at all justified, it would seem fair to predict that, if anything, conditions in the future will favor the motorship more than in the past, because with a given saving in fuel per ton-mile by the motorship over the steamship, the money saved will be greater the higher the price of fuel.

The matter of price differential, however, is a disturbing factor. The Diesel engine has in the past consistently used a higher grade of fuel oil than has been burned under the boilers of the steamship and at prices ranging from 25 cents to 50 cents a barrel more than the steamer bunker oil. Due to the increase in the demand for light petroleum products for motor cars and similar uses, there is almost sure to be a greater differential in price between the lighter fuel that the motorship has been using and the low-grade steamer bunker oil than has been the case in the past. This would be serious, and the saving in the motorship would be wiped out if the differential were great enough, provided it were true, as some think, that the Diesel engine could not burn the lower grade of oil.

As a matter of fact there is no reason to believe that the Diesel engine cannot burn this low grade of oil except that so far it has not done so. It has not done so mainly because it is necessarily more troublesome, and so far it has not been necessary to take that trouble. It is quite clear, however, that when the price differential becomes great enough, it will be worth while to go to some trouble

which will restore to the motorship all of the advantages to which it is entitled.

To adapt the motorship to the burning of the lower-grade oil, which seems to be really the only step necessary to eliminate even the residual doubts remaining in the minds of American shipping interests, there are only two factors of any importance to be studied, namely, spraying of the oil and ignition temperatures.

It appears from all of the research work that has been done on spraying, particularly in connection with the spraying of oil in boiler furnaces with the so-called mechanical atomizers, that all oils can be sprayed equally well regardless of their other physical properties if they are brought by heating to the same viscosity. It would seem as if this should also be true when the oil is sprayed into a cylinder against a pressure of from 400 to 500 lb. per sq. in., and some experimental work already done confirms this as a reasonable conclusion, though it is not yet a commercially established fact.

If the heavier residual fuel oils have, as may be the case, a higher ignition temperature than the lighter ones, there may be some difficulties about ignition at the compression which has been used for the lighter fuels. In this case two remedies are available: one to raise the compression, which has the objection of overloading the bearings, framing or the running gear and consequently increasing weights to avoid this; and the other to use an igniting fuel in small amounts, not exceeding 10 per cent of the total injected before the main supply of fuel, as has been done in Europe in burning tar oil. As soon as it appears to be necessary American engineers will undertake the building of the auxiliary apparatus and make the modifications necessary to adapt any grade of oil to the oil engine that can be fed through pumps from storage tanks, and thus wipe out any price differential that may exist, or may develop in the future, with every prospect of success. In general, whatever appliances are successful with one type of engine will be successful with all, because engine differences are not such as will prevent the general adoption of a broad scheme of fuel-oil conditioning developed for this purpose.

It may be said, therefore, that America is about to enter on its program of motorship development and use, and in fact has actually entered it within the last year. The rate of adoption depends upon the speed with which established facts become recognized and known, and are followed by building orders. It is of considerable interest to note that the motor-car industry, in which America now leads the world, developed in Europe in quite the same way as the motorship industry, and it is not too much to expect that once American interests become convinced that the motorship is what the Europeans think it is, American motorship construction and operation will also lead the world.

Charles Edward Lucke.

What Happened in Italy

The recent attempt at industrial communism in Italy is of particular interest to engineers because of its development in the metal-working industries. Light has been thrown on the sequence of events and the underlying causes by the publication in *Current History* for December (The New York Times Company) of translations of official documents bearing on the situation, which form the basis of the following summary.

The quasi-revolution which occurred was a forcible attempt on the part of the workers to overcome the dominance of capital and to secure a position where labor would be raised from the position of a commodity, with wages subject to the laws of supply and demand, to that of a participant in the management of industry.

The background for the unrest is to be found in the fact that in Italy, more than any other country, special industries had been founded, or existing industries measurably increased, to meet the demands for war material, while the amount produced had depended almost entirely on the supply of raw materials secured from abroad. Under this situation the return to normal conditions, with curtailed production, must necessarily have produced more or less of a crisis. Coupled with this were two disturbing factors: one,

Italian workman previous to the war.

Wage advances did not keep pace with the advances in the cost of living, due in part to the prohibition of emigration, and the point was reached early last fall where the Federation of Italian Metal Workers made a demand for a 50 per cent increase in wages, which was promptly denied by the employers. Immediately a "stay-in" strike resulted, the men remaining in the factories and drawing their pay, but doing as little work as possible and reducing output by as much as 50 per cent. The employers then decided to close their plants and issued a lockout order. The workers retaliated by taking forcible possession of the factories and within a few days practically all the engineering and metallurgical plants in Italy were under control of the workers, a declaration being issued by the Federation to this effect on September 3.

The Government tried to effect a settlement, but the employers refused its proposals and the Government then made it plain that it would not use force to eject the workers from the factories, as this could not be done without bloodshed. Two days later the Employers' Federation passed a resolution demanding the evacuation of the factories as a condition for resuming negotiations and resolutions were framed upbraiding the Government for its "pretense of neutrality" and "its hesitation, not only to defend law and order, but to maintain the position of the state as a superior body or force, representative of the national interest, armed both with the will and capacity to guarantee the security of civil and of social life."

On September 12 an important conference of the workers of Milan decided to hand over to the General Federation of Labor the direction of the movement and the matter was put before the Government by the workers, calling for a modification in the relations which previously obtained between employers and employees. The gist of their statement is embodied in the following quotation:

> Such modification should tend to permit the latter (the workers), through the agency of their trade unions, to be in a position to know the real state of their industry, to be acquainted with its technical and financial workings, and to be able, through the work of their factory delegations (being offshoots of the trade unions) to coöperate in applying factory regulations, to control the appointment and dismissal of the employees, and thus to inspire the normal life of the factory with the necessary discipline.

The prime minister, Signor Giolitti, now intervened and what amounted to an ultimatum was presented to the employers calling upon them to accept the principle of the workers' demand for "controllo," this word being generally interpreted to mean participation or coöperation in factory management rather than absolute control, as has sometimes been assumed.

On September 16, the General Federation of Italian Employers submitted to this demand in a statement containing the following:

> It consents, provided that the other side be truly inspired by a like intention, to accept the principle of a control of industry to be carried out on the basis of legislative regulations, granted that such regulations do not establish any monopoly or superiority of the trade-union organizations, lay down the principle of the coöperation and joint responsibility of the various factors of production, be carried out to the advantage of the community, and abstain from interfering in the freedom of movement necessary to industrial undertakings.

The Government finally issued a degree calling for a commission of an equal number of members from each side to formulate suggestions for solving any questions that might arise in the application of factory rules and the appointment and dismissal of workers; calling upon workers of all classes to resume their employment.

It cannot now be predicted whether, as one writer has said, this "revolution" was only a "dress rehearsal" for a worse one to follow, or whether stability has probably been attained. An excellent summation of the situation as it now appears, however, has been given in the *Engineering Review* (London) for December, by Andrew Stewart, of the Consolidated Pneumatic Tool Company, Ltd., from which the following extracts are taken:

> What terminated the revolutionary experiment was the discovery that there was no money to pay wages at the end of the week, nor was there any money to purchase raw materials. Sellers of materials were not prepared to do business with people who apparently could not pay. A few managed to carry on for a week or two by selling what they could and applying the proceeds to pay wages, but it was soon found that the value of

the product was insufficient for the purpose; in other words, the business quickly became insolvent.

They also found that they had to face problems of policy and administration, which they were incapable of solving; in short, they had taken over a great commercial machine which they could not run. In their anxiety to secure all the supposed products of their labor, they discovered that they could not even produce sufficient to pay the worker his normal wage, while the capitalist could do so, and even get something for himself. The capitalist could work the machine; they could not; and the "profits" accruing from the workers' control were a will-o'-the-wisp.

One of the outstanding features of the "revolution" is that, while it has fizzled out, it has achieved some notable results. It has demonstrated that an intelligent and well-informed democracy is poor material for the revolutionary. A less intelligent democracy would have plunged Italy into an abyss of misery far beyond the worst that has ever occurred in Russia, for it is obvious that, while in an agrarian district a revolutionary change has an imperceptible immediate effect, since stocks of food and necessities generally are sufficient for a long period, in an industrial district the necessities of the workers can be met only by an immediate exchange of the products of industry for the necessaries of life, and anything which interferes with the flow of industrial products from the producer, or the return flow of food and other manufactured articles to the producer, must have an immediate and disastrous effect on the worker.

Fuel Efficiencies From a National Standpoint

There are several methods for determining the relative efficiency of fuels. This may be on the basis of the number of B.t.u's usefully obtained per pound of fuel; or the number of B.t.u's usefully obtained from one dollar's worth of fuel at the plant; or, again, the number of B.t.u's usefully obtained for each dollar of expenditure in connection with the fuel. The latter includes not only the cost of the fuel itself delivered at the plant, but all the direct and indirect items involved in handling the fuel up to the moment where it generates power, and possibly even afterward.

These methods of fuel appraisal are all on the B.t.u. basis and are concerned only with the individual conditions of the particular plant considered. There is a growing realization, however, that heat-unit efficiency is only one of the many items to be considered, and that a broader view, on a national basis, with due regard to fuel conservation and the interests of the public, must be taken.

If a concern burns, say, 500 tons of coal daily, this means, roughly, ten gondola cars a day. These cars have to be hauled from the mine, possibly over a badly congested section of railroad. Delay and increased expenditure are thus created in the transportation of other freight vitally needed both by the purchasers of the coal and by other concerns in the same industrial district.

From a national point of view it would be well to consider whether it would not result in better overall efficiency if the concern in question were to use its fuel in some form which could be transported in such a way as not to interfere with the shipment of other freight.

From a national point of view, again, the consideration now being given to the utilization of coal at the mouth of the mine and the transportation of the fuel in the form of electric current to points where it is to be used, is of pressing importance. Electric current, however, cannot as yet be efficiently used for heating, of which modern industry requires a large amount; and in the generation at the mouth of the mine in the immense plants which would be required there would be difficulty, in many cases, in securing an adequate supply of water for condenser operation.

In a paper presented by Sir Arthur Duckham before a meeting of the Institution of Petroleum Technologists, held in London last October, the author advocates another solution of the problem—the development of a process for converting coal at the mine into gas and oil fuel. He feels assured that this dual end can be attained by the adoption of the vertical-retort system of gas making, combined with an appropriate water-gas plant. The basic idea is to utilize the heat in the coke through formation of water gas by passing steam through the hot coke. "During the war," he states, "it was possible to put these ideas into practice and in continuous-working vertical retorts it became possible with steaming to obtain over 20,000 cu. ft. of very serviceable gas per ton of coal instead of the 12,000 that used to be obtained previous to the war. It was further found that with the water gas ascending the retort, the hydrocarbons generated were protected from the coal and so gave a further amuont of gas and lighter tar oils."

The scheme advocated by Sir Arthur Duckham, although somewhat different in method and intent, is in accord with the suggestion of Prof. R. H. Fernald in the December number of Mechanical Engineering, that an intensive study be made of low-temperature distillation processes to determine whether a combination of low-temperature distillation and the manufacture of by-product producer gas can be made a commercial success and constitute a solution of the natural-gas problem which this country now faces.

This whole subject is yet in a very undeveloped state. It is one that is bound to receive increasing attention and study and that may ultimately have an important bearing on fuel conservation as well as on the efficiency of plant operation, considered in their broader aspects from a national standpoint.

Utilization of Tidal Power

A great deal of attention has recently been given in England to the possibility of utilizing tidal power on a large scale. The British Ministry of Transport has conceived a grandiose scheme for the utilization of half a million horsepower from the tidal movements in the estuary of the river Severn, which empties into the Bristol channel at the junction of the Lower Avon, west of Bristol. The proposal, as stated in an interim report of the Water Power Resources of the Board of Trade, abstracted elsewhere in this issue, and as described in *The Engineer*, for December 3, 1920, is to construct a dam across the river where it is some 2½ miles wide, with a barrage, in portions of which are to be installed turbines and generators of a capacity in excess of one million continuous horsepower. About half that amount of power is to be available for distribution, the surplus energy being employed to pump water into a high-level reservoir placed at a short distance up the river. When by reason of the rise of tide in the Severn estuary below the dam it is no longer possible to work the turbines in the dam, water is to be allowed to flow from the reservoir through other turbines, thus producing a constant supply of half a million horsepower.

It follows, therefore, that for the full operation of the scheme there will have to be two gigantic hydroelectric stations, one of them, that in the dam, capable of generating upward of one million horsepower and the other, that in connection with the high-level reservoir, capable of producing over half a million horsepower. For portions of each day one or other of the two stations will be entirely inoperative, though for part of the time they would be working in parallel. The periods of working of the two stations would, of course, vary considerably because of the seasonal variations in the tides.

A striking feature of the proposal is that the water is to be forced into the high-level reservoir through a tunnel driven through more than a mile of solid rock. The tunnel is to be 40 ft. in diameter; that is, it will have nearly four times the cross-sectional area of an ordinary double-line railway tunnel.

Published statements about the cost of the development are very much at variance, ranging between $40,000,000 and $150,000,000; but it is claimed in the official report that even at the higher figure the project would be on a sound economic basis and would be a "paying proposition," not only effecting a saving in coal consumption of from three to four million tons per year, but allowing electricity current to be sold at a small fraction of present rates.

Professional Sections of the A.S.M.E.

Ten years ago the Committee on Meetings of the A.S.M.E. arranged for the formation of a number of sub-committees of specialists in different branches to secure papers and arrange for sessions in the special subjects in which they were interested. These sub-committees were instituted largely through the foresight of Dr. Charles E. Lucke, then a member of the Committee, with the underlying thought that the solution of problems worked out in one branch of engineering is often applicable and always

engineering practice.

How well these ideas have worked out can be shown by reference to the sessions of a single sub-committee—that on Textiles, which has been conducted under the able chairmanship of Charles T. Plunkett, president of the Berkshire Cotton Manufacturing Company, Adams, Mass., and the secretaryship of the late E. W. Thomas, who was agent of the Boott Mills, Lowell, Mass. While the sessions of this sub-committee have been conducted in the interests of the textile industry, but few of the papers have dealt specifically with the production of textiles. Rather have they treated of the broader problems met with in the industry, of interest as well to those in other fields. Subjects have been treated such as the principles of valuing property, specifications for factory timbers, higher steam pressures, heating by forced circulation of hot water, heat transmission through various types of sash, sawtooth roof construction, industrial power problems, etc.

The success of the sessions sponsored by the various sub-committees, and the evident interest in the special subjects treated, finally led to the formation of Professional Sections which, beginning with the last Annual Meeting of the Society, took the place of the former sub-committees. Already eight such Sections have been formed, in most of which large numbers of members have designated their desire to become associated. In the Management Section, for example, there are 1230, in the Machine Shop 727, Fuel 614, Materials Handling 676, Power 1151, and Railroads 467.

A pleasing development in this Sections movement has been the formation of the Forest Products Section, which held a most interesting session at the Annual Meeting, an account of which appears in this number. This is the initial movement for special attention on the part of the engineers to the problems of the woodworking industry, and the diversity and character of the papers presented indicate the breadth and scope of this branch of industry, starting with the felling of the timber in the forest, and continuing with its transportation to the mill and its transformation into lumber or into the more finished products with which we are all familiar, ranging from furniture to matches. It is not unlikely that many of the problems in other branches of engineering will be found to have a direct bearing on those in the woodworking industry, and that, on the other hand, the ingenuity and skill which have so long been displayed by the inventive minds among the woodworking fraternity will prove enlightening to those in the more strictly engineering fields.

Bill Introduced in Senate to Make Metric System Only Legal Standard

A stringent bill "to fix the metric system of weights and measures as a single standard for weights and measures," and which goes to the extent even of curtailing personal liberties, was introduced in the Senate on December 16, 1920. Certain of its provisions are that from and after 10 years no one shall sell goods, charge for transportation of goods, or pay for work or labor, where weights and measures are involved, except by the metric system; and that after that time no one "shall use or attempt to use....any other system." Also, that from and after four years no one shall "manufacture or make for himself for use or purchase for use any weight or measure or weighing device....in any other system than the metric."

University of Illinois to Appoint Research Graduate Assistants

The University of Illinois now maintains 16 research graduate assistantships in the Engineering Experiment Station of that University, two of which have recently been established by the Illinois Gas Association, for investigation in the field of gas engineering. There will be 15 appointments to these assistantships this in engineering, physics or applied chemistry. These appointments must be accepted for two consecutive collegiate years, and for the successful accomplishment of the required work the degree of Master of Science is conferred. Nominations to these positions are made from applications received by the Director of the Station, Dean C. R. Richards, not later than March 10. Full information as to the form of application, funds available, etc., will be supplied upon application to the Director.

Frank Harvey Ball

In the death of Frank H. Ball in Detroit on November 12, 1920, the mechanical and engineering world lost one of its most active members, as practically all of his life was devoted to the invention and manufacture of useful mechanical devices.

Mr. Ball was born on May 21, 1847, in Oberlin, Ohio, and was educated in the grammar and high schools of Buffalo, N. Y. After some early experiences in a country sawmill on his father's farm he entered into the production of steam engines for drilling and operating oil wells. He brought out the well-known Ball automatic high-speed engine and founded the Ball Engine Co., of Erie, Pa., of which he was general manager from 1880 to 1890. He then formed the Ball & Wood Co., Elizabeth, N. J., acting as general manager of this firm until 1895, when he became general manager of the American Engine Co., Bound Brook, N. J., producing the American Ball engine.

Retiring from the steam-engine business several years ago, he and his youngest son invented and put on the market the Ball

Frank Harvey Ball

& Ball carburetor for gasoline engines. In 1913 he became manager of the carburetor department of the Penberthy Injector Co., Detroit, Mich., a position which he still held at the time of his death.

Mr. Ball was not only a successful engineer but also an enthusiastic yachtsman. From his boyhood days on the Niagara River he always owned some kind of a sailing craft and was the winner of many sailing races in Buffalo, Erie and Cleveland. For several years his sailing houseboat, the *Sommerheim*, aroused great enthusiasm and interest in Great South Bay, L. I. In Erie, his devotion to yachting resulted in the formation of the Erie Yacht Club, of which organization he was made the first and only honorary member.

Mr. Ball became a member of the Society in 1883. He was one of its managers from 1888 to 1891 and from 1894 to 1896 a vice-president. He also belonged to the Society of Automotive Engineers, in which organization he took an active interest.

NEW HONORARY MEMBERS OF THE A.S.M.E.

At the Annual Meeting of The American Society of Mechanical Engineers held in New York last December, honorary memberships in the Society were conferred upon six distinguished engineers, three of whom are residents of European countries, the Honorable Sir Charles Algernon Parsons, of London, England, Lord William Weir, of Glasgow, Scotland, and Grande Ufficiale Ingegnere Pio Perrone, of Genoa, Italy. Brief sketches of the achievements of these honorary members follow.

Captain Robert Woolston Hunt

A full biographical sketch of Captain Hunt was published in the January 1919 issue of Mechanical Engineering, on the occasion of his eightieth birthday anniversary celebration. Captain Hunt, now head of the Robert W. Hunt and Company, consulting engineers, of Chicago, was for many years connected with the Cambria Iron Company and the Troy Steel and Iron Company, during which time he assisted in many notable developments in the iron and steel industry.

Captain Hunt has been a member of this Society since 1880. He was president in 1891. He is also a member of the American Institute of Mining and Metallurgical Engineers, the American Society of Civil Engineers, the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute of England, the American Society for Testing Materials, and other societies. He was awarded the John Fritz Medal in 1912 "for his contributions to the early development of the Bessemer process."

Dr. Samuel M. Vauclain

Doctor Vauclain is senior vice-president of the Baldwin Locomotive Works of Philadelphia. He has been with this company since 1883, first in charge of all buildings and equipment of the entire works, methods of manufacture and devising of special tools and machinery, and later in full charge of the plant, including manufacturing.

During the war he was special officer of the United States Government, supervising the manufacture and production of heavy ordnance. In 1917 he was appointed chairman of the Cars Committee and the coöperative Committee on Locomotives of the Council of National Defense.

The University of Pennsylvania conferred upon him the honorary degree of Doctor of Science in 1906, and he received awards from the Paris Exposition in 1900, from the Buffalo Exposition in 1901, from the St. Louis Exposition in 1904, and from the Seattle Exposition in 1908. He has been a member of the A.S.M.E. since 1894 and was vice-president from 1904 to 1906. He is also a member of the Institution of Civil Engineers of Great Britain, the American Society of Civil Engineers, the American Institute of Mining and Metallurigcal Engineers, the American Railway Engineering Association, the American Philosophical Society, and other organizations.

Rear-Admiral Robert Stanislaus Griffin

Rear-Admiral Griffin, Washington, D. C., was Engineer-in-Chief of the Bureau of Steam Engineering, which during the war covered all steam and internal-combustion engines for the Navy, took care of the upkeep of 2000 vessels, and furnished protection for vessels by the construction of emergency submarine destroyers.

The notable achievements of the Bureau during the war were largely due to the efficiency and influence of Admiral Griffin. By using electric welding in the repair of about fifty German merchant vessels seized by our Government, he made it possible, in five months, to transport to France nearly 600,000 troops. The Bnrean improved the wiring for gun-fire control systems on all installed communication systems for the service of the guns on transports and ships carrying armed guards and provided recognition signals on all vessels operated by the Navy.

Other achievements of far-reaching importance were securing control of the wire output of this country, the perfection of the submarine detector, and the installation of numerons radio equipments on vessels and at coastal stations.

Honorable Sir Charles Algernon Parsons

The commercial development of the steam turbine and its application to useful purposes on a comparatively large scale, one of the distinct achievements in steam engineering during the latter part of the nineteenth century, has become inseparably associated with the name of Charles Algernon Parsons, of London.

In 1884 Sir Charles became a partner in the firms of Messrs. Clarke, Chapman, Parsons and Company. The electrical industry at that time being the latest development of engineering, he conceived the idea that a high-speed, direct-coupled engine was required to drive the dynamo and that the steam turbine was the engine to do it.

His inventions include non-skid chains for automobile tires; an auxetophone in 1898; and the compound turbine known by his name, introduced about 1884, improved by a condenser in 1891, and adapted for maritime use on the *Turbinia* in 1897. About 1910 he invented a geared turbine.

He is the author of many publications and monographs on the steam turbine. He is a member of the Institution of Civil Engineers of Great Britain, the Institution of Mechanical Engineers, and of nnmerous other scientific and engineering societies.

Lord William Weir

Among the many engineers who did splendid service during the war, none served better than Sir William Weir, of Glasgow, Scotland, late British Director-General of Aircraft Production. As a member of the firm of Messrs. G. and J. Weir, Ltd., Glasgow, he took an active part in the manufacture of munitions immediately after the opening of hostilities, not only by helping to extend greatly the operations of his own company, but also by taking a leading share in the organization of the West of Scotland area for war purposes. His energy and his genius for work of this kind were recognized early, and in 1915 he was asked by Mr. Lloyd George to join the Ministry of Munitions, and later to undertake the duties of Director of Munitions in Scotland. Later still he was transferred from Glasgow to London and appointed Controller of Aeronautical Supplies to the Army and Navy. Afterward he was made a member of the Air Board; in December 1917, he was appointed Director-General of Aircraft Production in the Ministry of Munitions, and in January 1918 he was made a member of the newly established Air Council. He was knighted early in 1917 as a recognition of the value of his services to the nation. He is a native-born and home-trained Glasgow man, has had a wide experience of engineering practice and problems, and is an enthusiast in original research and in designing, and an organizer of outstanding ability.

Lord Weir is a vice-president of the Institution of Mechanical Engineers and a member of the Institution of Civil Engineers. He was president of the Institution of Marine Engineers for the year 1920.

Grande Ufficiale Ingegnere Pio Perrone

Signor Perrone is president of Ansaldo and Company of Genoa, Italy, which firm prior to the war was engaged in shipbuilding, making of turbines, construction of locomotives and building of electric machinery.

At the beginning of the war the firm offered to turn over its establishment to the Italian government for making large guns. The offer was not accepted but it went ahead and made guns after the best French designs, and, without a single order from the Italian government, completed two thousand pieces. After the Caporetto disaster Italy turned to the Ansaldo organization for guns, and its pieces were placed in the field at once and performed a feat which stopped the advance of the Austrians.

The firm grew to employ one hundred thousand men and women, and in the last two years of the war it bought in America and shipped to Italy in its own steamers war material which cost about fifty million dollars. It supplied ten thousand cannon, three thousand aeroplanes, many millions of projectiles and several scores of warships, torpedo boats and submarines for the use of the Italian army and navy.

AN ANALYSIS OF MACHINED FITS

(*Continued from page 133*)

The two remaining sketches, Figs. 11 and 12, show combinations which occur frequently in machine design.

Question 21. Will you kindly give your practice in such cases?

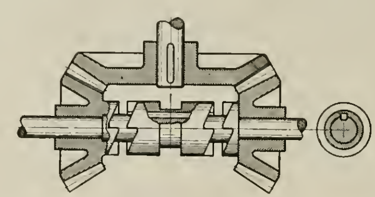

Fig. 11

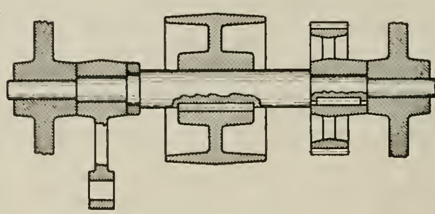

Fig. 12

Please bear in mind that the Committee has no desire that its report shall impose arbitrary standards in any case. Its first work consists in securing data as to the best present practice in this country, with the sole aim of aiding interchangeable manufacture in every way possible. Your coöperation will aid greatly in reducing manufactu ing costs in many places and in improving our already high standards of manufacture.

Last Meeting of Engineering Council—Work of Various Committees and Departments Taken Over by American Engineering Council—Classification and Compensation of Engineers—National Public Works Department Association

ON January 1, 1921, Engineering Council, which was established in 1917 by the United Engineering Society to provide coöperation between engineering societies for the consideration of questions of general interest to engineers and their relations to the public, and to provide a means for united action upon questions of common concern to engineers, merged into American Engineering Council, the executive body of The Federated American Engineering Societies. The transition brings to American Engineering Council the experience and knowledge gained by the Engineering Council and its various departments, as well as many of the individuals who have carried on the work of the Engineering Council.

The final meeting of Engineering Council was held in Washington on December 16, 1920. The morning session was devoted almost entirely to the closing of the affairs of the Council. Unfinished business and incompleted projects were referred to the United Engineering Society with the suggestion that they be laid before the new American Engineering Council with favorable recommendations.

The principal action of a continuing nature taken by the Council was the adoption of the resolution to the effect that the present financial stringency and the prospect that Federal revenues during the next year will not equal the Government expenses, make it a matter of good citizenship for every considerate person to avoid advocating expansion of Government activities; that in consequence of this belief, Engineering Council would endeavor to set the example by withdrawing its previously enlisted support of efforts to secure increased appropriations for certain Government engineering projects.

A committee consisting of Philip N. Moore, J. Parke Channing and Alfred D. Flinn was appointed to prepare a final report of the Council which would be also a history of its activities.

During the afternoon calls were paid to the chiefs of technical bureaus of the Government, the Chief of Engineers, U. S. Army, Chief of Yards and Docks of the Navy Department, Director of U. S. Reclamation Service, Director of U. S. Geological Survey, and Director of the Bureau of Mines.

In the evening the hosts of the afternoon and a number of the members of the new American Engineering Council were guests at a farewell dinner of the Council. Tokens of esteem were presented to J. Parke Channing, chairman of the Council for three years, who was largely responsible for the Washington office of the Council and the movement for a National Public Works Department, to the Secretary, Alfred D. Flinn, and also to M. O. Leighton, the Washington representative of the Council as well as chairman of the National Public Works Department Association.

Important Committees of American Engineering Council

A number of the important committees and departments of Engineering Council have been requested to continue their work, acting as committees of American Engineering Council. Brief notes are here given on some of these and on other new committees appointed, and fuller notes on the Committee on Classification and Compensation of Engineers and the National Public Works Department Association.

The Patents Committee, of which E. J. Prindle is chairman, will continue to work for an increase in both the pay and personnel of the United States Patent Office, as provided for in the Nolan Bill. The Washington office of Engineering Council has taken over by the new Council and will serve the member-societies of the F.A.E.S. as this office has in the past served the member-societies of the United Engineering Society. A. C. Oliphant as acting assistant secretary is in charge.

The Engineering Societies Employment Bureau, with Walter V. Brown retained as manager, will be continued by American Engineering Council. Until such time as a more comprehensive plan can be formulated, the secretaries of the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers will act as managers of this department. Applicants for employment will be divided into two classes, preferred and ordinary, the preferred applicants being those who are members of constituent societies of American Engineering Council, and the ordinary applicants all others.

J. Parke Channing, formerly chairman of Engineering Council, becomes chairman of the Committee on Public Affairs of American Engineering Council. This committee will handle the governmental activities of the F.A.E.S.

The elimination of waste in industry will be one of the chief tasks of American Engineering Council. A committee has been appointed to investigate this important phase of industrial development.

Colonel William Barclay Parsons is chairman of a Committee on Military Affairs, and also a Committee on New York State Government Reorganization. D. L. Hough heads a Russian-American Committee, the aim of which will be to bring the engineers of the United States and Russia closer together.

Classification and Compensation of Engineers

One of the most important of the committees whose work will be carried on by the American Engineering Council is the Committee on the Classification and Compensation of Engineers. A final report recently submitted by the chairman of the committee, Arthur S. Tuttle, and the secretary, Charles Whiting Baker, reviews briefly the activities of the committee since the time of its organization in April 1919.

The first stage of its work was completed in December 1919, at which time a report of the work accomplished was presented to Engineering Council, together with recommendations as to he adoption of a classification of engineers in governmental and railroad services and a tentative plan for compensation and promotion. An abstract of this report was published in the February 1920 issue of Mechanical Engineering.

During the year 1920 a campaign was inaugurated on behalf of the classification which had been adopted by Engineering Council with a view toward securing its general adoption and recognition as a standard for all branches of engineering service. A canvass was made of over 600 societies, associations and individuals and an analysis of the replies received shows that the endorsement of the classification is practically unanimous. The classification has actually been put into effect in a number of instances and the salary schedule has generally been endorsed.

Although the Committee has no method of measuring the results of the publicity work it has done nor the extent to which its recommendations have been followed by industrial concerns and engineering corporations, it is of the belief that more and better results have been produced than the returns at hand indicate. The Committee pointed out the need of a further publicity program to educate legislators and the general public as to the importance of the services of the engineer and also to establish personal contact with representative engineers in various parts of the country, impressing on each individual and also upon the various engineering societies the necessity of coöperation in the movement.

The final recommendations of the Committee deal with the following matters:

1 Provision for the immediate increase in compensation of the engineering staffs of the Federal Government

2 Conference with a committee of American Railway Engineering Association for the purpose of bringing about the acceptance of a common standard for the classification of engineers
3 Investigation to determine the relation between engineering charges and the cost of work supervised.

These matters have been the subject for special studies and reports during the year.

The American Engineering Council has already appointed a Committee on the Classification and Compensation of Engineers with Mr. Tuttle as chairman.

National Public Works Department Association

American Engineering Council, which voted on December 17, 1920, to take over the activities of Engineering Council, will continue the campaign to reorganize the Department of the Interior by the establishment of a National Department of Public Works. This campaign has been conducted by the National Public Works Department Association which was organized in April 1919 under the auspices of Engineering Council.

The work of this organization, while not completed, has reached a point where the establishment of a Department of Public Works seems practically assured, as is shown in an abstract of the report of M. O. Leighton, chairman of the Association, published in the January issue of Mechanical Engineering, p. 60, and in a similar report submitted by C. T. Chenery, secretary of the Association. "This was the first successful effort of the engineering profession," stated Mr. Chenery, "to directly influence the national thought and national policy." He reviewed the progress of the movement and spoke in appreciation of those to whom the engineering profession is particularly indebted for their active and effective work in the campaign, many of whom will continue their services by supporting the American Engineering Council in its efforts to bring about the creation of the new department.

Engineering and Industrial Standardization

A.I.E.E. Sponsor for Rating of Electrical Machinery

The American Institute of Electrical Engineers was designated as sponsor for the rating of electrical machinery by the American Engineering Standards Committee at its meeting on December 4, 1920, and the responsibility for the work has already been officially accepted by the Institute. A sectional committee, which will include official representatives of the Electric Power Club, the National Electric Light Association, and various other interested bodies, is being formed to carry out the work.

These arrangements have been made at the request of the electrical industry, in order to prepare as quickly as possible for the next meeting of the Rating Committee of the International Electrotechnical Commission, at which questions of great importance to the industry, including the fundamental basis of rating, will be taken up. At the last meeting of the Rating Committee in Brussels in March 1920 the American delegates presented a proposal for a system of rating based upon the hot-spot principle, which was tentatively adopted by the Rating Committee and published as a recommendation to the various national bodies composing the Commission, for official adoption by the Commission at its next meeting.

Standardization of Zinc

The American Society for Testing Materials and the American Zinc Institute have accepted joint sponsorship for the standardization of zinc under the auspices and rules of procedure of the American Engineering Standards Committee.

The Association Belge de Standardisation has suggested international standardization of the following matters pertaining to zinc: grades of commercial zinc; gage thicknesses and tolerances for sheet zinc; methods of sampling and determining moisture content of ores; and methods of analysis of ore and spelter. The American committee will work along the lines of the Belgian suggestion, but the work will not be confined to these points.

The Belgian Association has suggested similar work on the other non-ferrous metals.

Terminal Markings for Electrical Apparatus

The Electric Power Club has been designated as sponsor for the standardization of terminal markings for electrical apparatus. A sectional committee responsible for the work, and upon which all organizations interested in the subject will be officially represented, is being organized.

At the Brussels meeting of the International Electrotechnical Commission in March 1920 some of the European delegates proposed a method for marking terminals of transformers. The American delegates suggested that it would be preferable to treat the more general subject of terminal markings for electrical apparatus consistently. As a result the Americans were requested to propose a systematic plan for the whole subject.

The Electric Power Club has already done a large amount of work on the subject and has developed a general plan which is in wide use among American manufacturers. Parts of the plan, particularly the part relating to transformers, have been adopted by other organizations, including the American institute of Electrical Engineers and the National Electric Light Association.

It is hoped to secure agreement of all interested bodies on a general plan for representation at the next meeting of the International Electrotechnical Commission.

Correlation of Standardization Work in the Mining Industry

At an informal conference, held in Chicago on August 30, 1920, of representatives of leading organizations interested in the standardization of mining equipment and practice, it was unanimously voted to recommend to the American Engineering Standards Committee that there should be organized a General Correlating Committee for Mining Standardization; that this committee should be made up of representatives of organizations which are now engaged in standardization work, or which might be expected to engage in it; and that the committee might well be started with a nucleus of two representatives of each of the leading national organizations interested in the subject. In compliance with this recommendation the American Engineering Standards Committee invited the five organizations mentioned below to designate two members each to represent them upon such a General Correlating Committee, with the understanding that the nucleus so formed might enlarge itself. These representatives are as follows:

1 American Institute of Mining and Metallurgical Engineers: Graham Bright, Howard N. Evanson
2 American Mining Congress: Chas. A. Mitke, Warren R. Roberts
3 Mining and Metallurgical Society of America: E. S. Berry, B. Britton Gottsberger
4 National Safety Council: F. P. Sinn, S. J. Williams
5 U. S. Bureau of Mines: E. A. Holbrook, O. P. Hood.

The Committee has held one meeting. Summaries are being prepared of the standardization work now in progress in the various organizations. The work of the committee will include such matters as (1) delimiting specific projects which might be most advantageously handled as units; (2) recommending the order in which the various projects should be taken up in order that the needs of the industry should be served best; and (3) making recommendations as to what bodies should act as sponsors for specific projects, and as to what bodies should be represented upon the sectional committees for such projects.

Aircraft and Automobile Materials of Construction. Vol. 1. Ferrous Materials. By Arthur W. Judge. Sir Isaac Pitman & Sons, Ltd., London and New York, 1920. Cloth, 6 × 9 in., 755 pp., illus., charts, tables, diagrams, $9.

This book has been written for the user of the ferrous materials employed in the construction of automobiles and aircraft and in general mechanical construction. It is therefore not concerned with the metallurgical processes to which these materials may have been previously subjected, but with their composition, strength and properties as received from the steel manufacturer, and with modes of heat and other treatment. The work covers a wide range, and is intended as a reference work for designers and builders of machines.

Application of Dyestuffs to Textiles, Paper, Leather and Other Materials. By J. Merritt Matthews. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 784 pp., illus., tables, $10.

The present volume is an outgrowth of the author's earlier work, Laboratory Manual of Dyeing and Textile Chemistry, but has been broadened in scope to appeal to the interest, not only of students, but of all those concerned in the application of dyestuffs. The author has endeavored to incorporate the latest knowledge of the subject. Contains an eighteen-page bibliography.

Applied Naval Architecture. By W. J. Lovett. Longmans, Green & Co., New York, 1920. Cloth, 6 × 9 in., 664 pp., charts, tables, diagrams, $12.

The present work is a specialized treatise on the design and construction of moderate-speed merchant vessels, 350 ft. and upward in length. As naval architecture is not an exact science, absolutely accurate solutions are not necessary in many cases, and for these the author has given special attention to approximate methods, whereby results may be obtained rapidly.

Calcul des Organes des Machines. By J. Boulvin. Gauthier-Villars et Cie, Paris, 1921. Paper, 7 × 10 in., 524 pp., diagrams, charts.

The present work deals with the calculation of boilers, cylinders, pipe systems, rotating and reciprocating machinery, eccentrics, gearing and transmission systems. Throughout, it is concerned with the determination of their dimensions from the resistance of materials, so that the tension or deformation will not exceed the limits desired. Empirical formulas are avoided. Numerous difficult problems have been given special attention and are treated in a novel manner.

Compressed Air Plant; The Production, Transmission and Use of Compressed Air, with Special Reference to Mine Service. By Robert Peele, Fourth edition, revised and enlarged. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 529 pp., illus., diagrams, tables, $4.50.

This volume deals with the varied uses of compressed air in engineering, particularly in mining, tunnelling, quarrying and other work involving rock excavation. A chapter on the measurement of air consumption has been added to this edition, and also information on air-lift work. Typographical errors have also been corrected.

Detail Design of Marine Screw Propellers. By Douglas H. Jackson. Sir Isaac Pitman & Sons, Ltd., London and New York, 1920. Cloth, 6 × 9 in., 104 pp., tables, charts, diagrams, $2.50.

The author feels that many works on screw-propeller design carry theoretical considerations too far for the average designer. He therefore here presents, in small compass, an outline of the accepted theories, a full treatment of the practical application of them, and a short description of the various manufacturing methods. A chapter on repair work is also included.

A Dictionary of Chemical Terms. By James F. Couch. D. Van Nostrand Co., New York, 1920. Cloth, 5 × 7 in., 208 pp., $2.50.

This volume is designed to serve the convenience of readers of chemical literature by providing accurate definitions for the complex terminology of this science, in convenient form. The treatment of the terms lies between that of a standard dictionary of the English language and that of an encyclopedia.

Ein Neues Prinzip für Dampf- und Gasturbinen. By Konrad Baetz. Otto Spamer, Leipzig, 1920. Paper, 6 × 10 in., 80 pp., illus., diagrams.

The author states that the investigations described in this monograph have occupied his attention for twenty years, but that his inability to construct a model machine has caused him to publish this record of his work, in the hope that further investigations may be stimulated thereby. The problem under consideration is that of combining, in a single machine, the modes of action of the reciprocating steam engine and the steam turbine. This the writer accomplishes by a "cellular" turbine, whose rotating member is composed of cells, in which the steam alternately is compressed and expanded. The book gives the theoretical calculations supporting the author's theory and the results obtained by experiment.

Electric Traction and Transmission Engineering. By Samuel Sheldon and Erich Hausmann. Second edition, revised. D. Van Nostrand Co., New York, 1920. Cloth, 5 × 8 in., 319 pp., illus., diagrams, charts, $3.

This textbook attempts to present a perspective view of the design of a complete railway installation, from the cars to the power-station, to indicate the nature and sequence of the various problems entailed, and to suggest or illustrate methods for their solution. It is intended to assist students and young engineers to discriminate as to the pertinency or necessity of specific details.

Electro-Deposition of Metals. By George Langbein. Translated, with additions, by W. T. Brannt. Eighth edition, revised and enlarged. H. C. Baird & Co., Ind., New York, 1920. Cloth, 6 × 9 in., 875 pp., illus., diagrams, $7.50.

This book is intended as a reference book and practical guide on electroplating, based upon the scientific principles underlying the art, but devoid of mathematical technicalities. The present edition has been thoroughly revised and modernized, and new methods have been added wherever necessary.

Encyclopedia of Marine Appliances. Compiled by Alexander McNab, 1920. The McNab Company, Bridgeport, Conn. Cloth, 9 × 12 in., 206 pp., illus., $5.

An interesting catalog of marine appliances, made or sold by the publishers.

The Engineering Draughtsman. By E. Rowarth. E. P. Dutton and Company, New York. Cloth, 6 × 9 in., 269 pp., diagrams, tables. $5.

This book, intended for those familiar with the elementary principles of engineering drawing, is a collection of ninety-six exercises, arranged to illustrate the application of the principles in the production of working drawings. These examples show how working drawings of details are made from information obtained from general assembly drawings; how assembly drawings are made from detailed working drawings; how detailed working drawings are modified in shape and size to suit new machines. The plates cover a wide range of work and are taken from drawings of commercial machines.

Handbook of Building Construction. Editors-in-chief, George A. Hool and Nathan C. Johnson. First edition, first impression. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 2 vols., frontispiece, illus., diagrams, tables. $10.

This has been prepared to provide the architect, engineer and builder with a reference work covering thoroughly the design and construction of the principal kinds and types of modern buildings, and their mechanical and electrical equipment. Each section is the work of a specialist, and although condensed, gives the

information usually needed for reference by the engineer in practice. The volumes are fully illustrated by diagrams and figures.

Handbook of Engineering Mathematics. By Walter E. Wynne and William Spraragen. Second edition, revised and enlarged. D. Van Nostrand Co., New York, 1920. Cloth, 4 × 7 in., 290 pp., diagrams charts and tables, cloth.

This is an endeavor to present in handy form and convenient pocket size, references to the theoretical and applied mathematics used in engineering. It contains the underlying engineering data and applications, as well as the mathematical formulas. The present edition has been enlarged by additions to the mathematical sections and tables of functions, and the physical and chemical constants have been revised.

The Handbook of Industrial Oil Engineering. By John Rome Battle. Vol. 1. Lubrication and Industrial Oil Section. J. B. Lippincott Co., Philadelphia, cop. 1920. Cloth, 5 × 8 in., 1139 pp., illus., diagrams, tables, charts. $10.

This handbook is intended to assist in the intelligent selection and use of lubricants for all purposes, and has been prepared for manufacturers, sellers and users of industrial oils. The range covered is a wide one and includes the use of oils in heat-treating steel, in foundry practice, in soap making and as insecticides, as well as for lubrication. Specific information on the use of oils in the major industries is given. The book also has a section on marketing and a selection of mathematical and engineering data.

Higher Mechanics. By Horace Lamb. University Press, Cambridge, 1920. Cloth, 6 × 9 in., 282 pp., frontispiece, diagrams. $8.

This treatise includes three-dimensional kinematics, statics and dynamics, and may be regarded as a sequel to the author's two former treatises on statics and dynamics. The author attempts to confine his attention to matters of genuine kinematical or dynamical importance, and to avoid those of purely mathematical or historical interest. The book is designed as an introduction to the subject.

The Human Motor, or the Scientific Foundation of Labour and Industry. By Jules Amar. E. P. Dutton & Co., New York, 1920. Cloth, 6 × 9 in., 485 pp., illus., charts, diagrams, $10.

This book is a study of the human body as a motor and of the conditions that govern its effectiveness. The author has collected the physiological data which govern the efficiency of human work and has also included a brief summary of the principles of mechanics. The work of Chauveau and Taylor is discussed and criticized, and the latter's system carefully examined.

Industrial Stability. Edited by Carl Kelsey. (Vol. 90 of the Annals of the American Academy of Political and Social Science) Philadelphia, 1920. Paper, 7 × 10 in., 168 pp., $1.

The thirty-four papers here brought together as contributions to current discussion of the general subject, present the views of business men, manufacturers, philosophers, social workers, attorneys and economists on one of the most pressing questions of the day. The major topics are the trend toward industrial democracy, labor representation in industrial management, collective bargaining, securing production, and industrial stability; and the individual papers are grouped accordingly.

Laboratory Manual of Testing Materials. By William Kendrick Hatt and H. H. Scofield. Second edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 5 × 8 in., 188 pp., tables, chart and diagrams, $1.25.

This concise manual of instructions for procedure in the usual physical tests of structural materials is the outcome of the operation of the Laboratory for Testing Materials of Purdue University. It is intended as a guide in class work and investigations and to explain the details of the methods. The present edition has been thoroughly revised in accordance with current practice.

The Manufacture of Sugar from the Cane and from the Beet. By T. H. P. Heriot. Longmans, Green and Co., New York, 1920. (Monographs on industrial chemistry.) Cloth, 6 × 9 in., 436 pp., plates, diagrams, tables, $8.50.

This is a systematic description of the manufacture of sugar, covering all the operations and elucidating the principles that underlie them. Detailed descriptions of sugar machinery are omitted, as the book is intended to give a broad but accurate view of the whole industry, rather than to cover the technical details of manufacture.

Modern Explosives. By S. I. Levy. Sir Isaac Pitman & Sons, Ltd. London and New York, 1920. (Pitman's common commodities and industries.) Cloth, 5 × 7 in., 118 pp., frontispiece, illus., $1.

Upon the basis of experience gained during the war, the author of this little book gives an account, for general readers, of the modern explosive industry. Stress is laid on the interdependence of modern industry and the necessity of viewing all research and productive activity as a whole, not only for purposes of defense, but to insure the well-being of the community.

Powdered Coal as a Fuel. By C. F. Herington. Second edition, revised and enlarged. D. Van Nostrand Co., New York, 1920. Cloth, 6 × 9 in., 340 pp., frontispiece, illus., diagrams, tables, $4.50.

In the two years that have elapsed since the first appearance of this work, the use of powdered coal has been greatly extended, and the book is therefore reissued in order to present the economies that have been effected and the various uses to which powdered coal has been applied. The processes for powdering coal, the suitable coals and the methods of using it are described in the introductory chapters. The remainder of the book gives the results obtained in various industries. A twenty-page bibliography is included.

Power Wagon Reference book, 1920. Edited by Stanley L. Phillips. The Power Wagon Publishing Co., Chicago. Cloth, 9 × 21 in., 880 pp., illus., tables, diagrams.

This volume is a combination buyers' directory, encyclopedia, and engineering handbook of motor trucks. The first section, on motor trucks, comprises lists of makers of trucks and truck parts, both gas and electric, tables of specifications, blueprints and articles on the use of trucks in various industries. Trailers, bodies and tractors are given similar treatment in succeeding sections, and these are followed by a collection of articles of a general nature. The book concludes with a classified buyers' directory.

Pumping by Compressed Air. By Edmund M. Ivens. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 270 pp., illus., tables, charts, diagrams, $4.

The intent of the book is to provide the student with a comprehensive theoretical study of the subject and the operating engineer with information on the economic essentials of the actual installation. The present edition has been enlarged by thirty pages of reliable operative data.

Rapid Methods for the Chemical Analysis of Special Steels, Steel-Making Alloys, Their Ores and Graphites. By Charles Morris Johnson. Third edition, revised and enlarged. John Wiley & Sons, Inc., New York, 1920. Cloth, 6 × 9 in., 563 pp., illus., tables, $6.

This collection of analytical methods, by the chief of a large steel-works laboratory, represents the results of long experience in the rapid examination of steel-works materials. Many methods are original. The present edition has been expanded to include a considerable number of new methods which have been developed since the last revision of the book.

Relativity; The Special and the General Theory. By Albert Einstein. Translated by R. W. Lawson. Henry Holt & Co., New York, 1920. Cloth, 6 × 9 in., 181 pp., port., $3.

Dr. Einstein has attempted, as far as possible, to give an exact insight into the theory of relativity to those readers who are interested in it, from a general scientific and philosophical viewpoint, but who are not conversant with the mathematical apparatus of theoretical physics. The book assumes more than an elementary education and, despite the shortness of the book, a fair amount of patience and force of will, will be necessary to comprehend it. The author, however, has spared no pains in the endeavor to present the main ideas in the simplest and most intelligible form.

(Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Building Construction. Keeping Track of Construction Accidents. Contract Rec., vol. 34, no. 45, Nov. 10, 1920, pp. 1078–1081. Describes systematic method of checking safety. Report adopted by Construction Section of Nat. Safety Council.

AERONAUTICAL INSTRUMENTS

Bearings, Efficiency of. The Efficiency of Small Bearings in Instruments of the Type Used in Aircraft, F. H. Norton. Nat. Advisory Committee for Aeronautics, report no. 94, 1920, 10 pp., 18 figs. Research at laboratory of Nat. Advisory Committee for Aeronautics, Langley Field, Virginia. Static and running friction for thrust and radial loads, was determined for several conical pivots and for plain cylindrical and ball bearings. It was found that for given small load conical pivots give less friction than any other type. When load exceeds 1000 grams ball bearings give less friction than pivots and stand shocks and wear better.

Inclinometers. Airplane Flight Instruments, Kurt Bennewitz. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 346–348, 8 figs. Inclinometers with stationary system of references, and with moving system of reference. Translated from Technische Berichte.

AERONAUTICS

Standard Atmosphere. Standard Atmosphere (Sur l'atmosphère standard), P. Grimault. Aéronautique vol. 2, no. 14, July 1920, pp. 93–96, 6 figs. Standard adopted by Ministry of Aeronautics and Aerial Transport of France for official testing of aeroplanes.

Tests. Distribution of Pressure on Cylinder Whose Generatrix is Perpendicular to the Air Current (Sur la distribution des pressions autour des cylindres dont les génératrices sont perpendiculaires au courant d'air) A. Toussaint. Aéronautique, no. 11, April 1920, pp. 493–500, 19 figs. Records of experiments. (Concluded.)

AEROPLANE ENGINES

Aeromarine U-8. Aeromarine U-8 180 Hp. Engine. Aviation, vol. 9, no. 12, Dec. 6, 1920, pp. 387–388, 3 figs. Water-cooled 8-cylinder V-type. Total weight of engine, 550 lb.

American. Modern Aviation Engines—VI, K. H. Condit. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1042–1044, 6 figs. Representative American designs for commercial aviation.

Carburetors. See CARBURETORS.

German Diesel. A German Diesel Airplane Engine Aviation, vol. 9, no. 9, Nov. 15, 1920, pp. 287–288, 2 figs. Engine operates on two-cycle principle. It has no carburetor, fuel being injected directly into cylinders. It has no valves. There are two opposed pistons per cylinder and two crankshafts connected by gearing at one end.

Italian. Modern Aviation Engines—V, K. H. Condit. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 936–938, 5 figs. Italian types.

Pressure Gages. Pressure Gages for Airplanes. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 357–8, 2 figs. Instructions for installing gages.

Starters. Comparative Test of Auxiliary Starting Devices for the Liberty Engine. Air Service Information Circular, vol. 2, no. 3, Sept. 25, 1920, 7 pp., 6 figs. Object of test was to compare ease of starting of 12-cylinder Liberty engine equipped with two auxiliary starting devices designed by Engineering Division, Air Service.

New Ignition End Bijur Airplane Engine Starter. Automotive Manufacturer, vol. 62, no. 8, Nov. 1920, pp. 31–32, 2 figs. Details of new self-contained starter, particularly adapted to Liberty motors.

Wright. New Wright Aeronautical Engine. Aviation, vol. 9, no. 13, Dec. 13, 1920, pp. 420–423, 7 figs. Latest design manufactured by Wright Aeronautical Corp'n, manufacturers of Wright-Hispano engine.

AEROPLANE PROPELLERS

Blade-Screw Theory. A Few Remarks Concerning Some Fundamentals of the Theory of Blade-Screws, George de Bothezat. Aeronautical Jl., vol. 24, no. 119, Nov. 1920, pp. 595–600, 1 fig. Generalized form of fluid resistance met in case of blade screw.

Design. Screw Propellers, M. A. S. Riach. Aeronautics, vol. 19, nos. 368, 370, 371 and 372, Nov. 4, 18, 25 and Dec. 2, 1920, pp. 327–328, 362–365, 377–378 and 401–402, 6 figs. Nov. 4: Design formulas. Nov. 18: Equations of motion. Nov. 25: Formulas for determining stresses. Dec. 2: Relation between "momentum" and "aerofoil" theories of propeller, assuming "inflow" as theory basis. (Continuation of serial.)

Variable-Pitch. The Oddy Variable Pitch and Reversing Propeller, A. M. Buckwald. Aerial Age, vol. 12, no. 11, Nov. 22, 1920, p. 299, 1 fig. Propeller exhibited at London Aero Show.

Variable-Pitch Propeller for Flying at High Altitudes (Hélices à pas variable pour le vol aux grandes altitudes), J. Stroescu et D. Cusmanovici. Aérophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 272–273, 4 figs. Patented design.

AEROPLANES

Aerofoils. The Wragg Adjustable Compound Aerofoil, C. A. Wragg. Aerial Age, vol. 12, no. 13, Dec. 6, 1920, p. 346, 2 figs. Device for enabling wider speed variation. It consists of using two aerofoils suitable for very high speed and placing them at low incidence, one behind and a little below the other so that there is a small gap between them.

Avro "Baby." Two-Seater Avro "Baby" Biplane, Type 543. Flight, vol. 12, no. 45, Nov. 4, 1920, pp. 1145–1147, 6 figs. Also Aeronautics, vol. 19, no. 368, Nov. 4, 1920, p. 326, 2 figs. Dimensions: Span of top plane 25 ft. Span of bottom plane, 23 ft.; gap between planes, 4 ft. 3 in.; length overall, 20 ft.; height overall, 7 ft. 6 in.; area of planes and ailerons, $176\frac{1}{2}$ sq. ft.; weight loaded, 970 lb.; maximum speed sea level, 82 m.p.h.; cruising speed at 1000 ft., 70 m.p.h.

Balancing. A Method for Determining the Angular Setting of a Tail Plane to Give Balance at any Given Condition, L. V. Kerber and W. F. Gerhardt. Aerial Age, vol. 12, no. 14, Dec. 13, 1920, pp. 370–373, 1 fig. Method includes determination of proper angular setting of horizontal tail plane to give longitudinal balance at level flight at any given speed, climbing flight at best rate of climb and when gliding at any angle with power off.

Bischoff. The Bischoff Small Aeroplane (L'avionnette de Pischoff), R. Esnault-Pelterie. Aerophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 266–268, 2 figs. Dimensions: Length, 3.52 m.; height, 1.3 m.; width, 5.2 m.; total weight, empty, 102 kgr.; speed, 90 kw. per hr.

Centering. Centering Aeroplanes (Centrage des Avions), L. Huguet. Vie Technique et Industrielle, vol. 1, no. 9, June 1920, pp. 207–210, 6 figs. Influence of various elements of aeroplane upon its longitudinal stability in flight. (Continuation of serial.)

Design. Some Requirements of Modern Aircraft. Eng., vol. 110, no. 2864, Nov. 19, 1920, pp. 683–684, 6 figs. Requirements of aeroplanes for commercial aviation service.

Elevator Weight. The Effect of Elevator Weight, F. H. Norton. Aviation vol. 9, no. 14, Dec. 20, 1920, pp. 458–459, 3 figs. Effect of stability and controlability of elevator weight.

F.I.A.T. The F.I.A.T. Twelve-Seater Biplane. Flight, vol. 12, no. 47, Nov. 18, 1920, pp. 1189–1191, 6 figs. Characteristics: Span, top plane, 68 ft. 10 in.; span, lower plane, 69 ft. 9 in.; chord, 10 ft. 6 in.; overall length, 43 ft. 9 in.; overall height, 14 ft. 9 in.; weight, loaded, 11,000 lb.; speed range, 50–125 m.p.h.; ceiling full load, 15,000 ft.

Figure of Merit. A Figure of Merit for Airplanes, Donald W. McIlhiney. Aviation, vol. 9, no. 8, Nov. 8, 1920, pp. 254–257, 2 figs. It is suggested to use as figure of merit, ratio of the product of weight per horsepower times velocity at 90 per cent maximum times pay load times range, to product of landing velocity times total weight.

Flying Boats. See FLYING BOATS.

Fokker. Fokker Commerical Airplanes. Aviation, vol. 9, no. 12, Dec. 6, 1920, pp. 385–386, 3 figs. Cantilever monoplane type. Specifications: Engine, 185 hp. B.M.W.; span overall, 56 ft. 3 in.; length overall, 37 ft. 10 in.; height, 12 ft.; weight, fully loaded, 4125 lb.

Giant. Post-War Types of Giant Aeroplanes (Les avions géants d'après-guerre), Jean-Abel Lefranc. Nature (Paris), no. 2430, Oct. 30, 1920, pp. 276–285, 2 figs. Survey of developments. (To be continued.)

Glenn L. Martin. The Glenn L. Martin Commercial Transport Biplane. Aviation, vol. 9, no 13, Dec. 13, 1920, pp. 426–428, 2 figs. Also Aerial Age, vol. 12, no. 15, Dec. 20, 1920, pp. 392–394, 3 figs. Specifications: Span, overall, 74 ft. 2 in.; length, overall, 43 ft. $7\frac{5}{16}$ in.; height, overall, 15 ft. $6\frac{3}{4}$ in.; total weight 12,000 lb.; power plant, 2 Liberty 12-cylinder V-type engines; maximum speed 110 m.p.h.

Helicopters. See HELICOPTERS.

Hydroplanes. See HYDROPLANES.

Lincoln Standard Cruiser. The Lincoln Standard Cruiser. Aerial Age, vol. 12, no. 12, Nov. 29, 1920, pp. 319–321, 5 figs. Specifications: Length overall, 26 ft. 4 in.; span, 41 ft.; chord, 6 ft.; weight, total, 3150 lb.; motor, 220 hp. Hispano-Suiza; maximum Speed, 95 m.p.h.; range, 350 miles.

Loening. The Loening Special Monoplane. Aerial Age, vol. 12, no. 15, Dec. 20, 1920, pp. 394–395, 2 figs. Dimensions: Overall length, 24 ft. $2\frac{1}{2}$ in.; overall height, 6 ft. 7 in.; total weight, 1850 lb.

Metallic Construction. The Utilization of Metallic Structures in Aeroplanes (L'utilisation des profilés

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

métalliques dans la construction des aéroplanes). Aéronautique, vol. 2, no. 14, July 1920, pp. 52–54, 19 figs. Metals used, types of structures and methods of joining.

Model, Experiments with. Some Experiments with Model Airplanes, Albert A. Merrill. Aviation, vol. 9, no. 11, Nov. 29, 1920, p. 349, 2 figs. Experiments made in Eiffel's laboratory and National Physical Laboratory in England to determine static stability in pitch for models with elevator set in various positions.

Nieuport. The Battle Plane Nieuport (Le monoplane de combat Nieuport 29 C-1). Aéronautique, vol. 2, no. 14, July 1920, pp. 61–65, 7 figs. Characteristics: Span, 9.80 m.; length, 6.65 m.; height, 2.56 m.; engine, Hispano-Suiza, 300 hp.

Nieuport London. The Nieuport "London" Night Bomber. Flight, vol. 12, no. 49, Dec. 2, 1920, pp. 1231–1239, 23 figs. Triplane designed and built by Nieuport & General Aircraft Co., Cricklewood, England. Characteristics: Length overall, 37 ft. 6 in.; span, 59 ft. 6 in.; height, 18 ft.; engines two 320 hp. A.B.C. "dragonfly" engines mounted between lower and middle plane.

Passenger. The Unusual in Passenger-Carrying Airplanes, Alfred Longville. Sci. Am., vol. 123, no. 25, Dec. 18, 1920, p. 609, 3 figs. Recent developments in Germany and Italy.

Ranges. A Study in Aeroplane Ranges and Useful Loads, J. G. Coffin. Flight, vol. 12, nos. 47 and 48, Nov. 18 and 25, 1920, pp. 1199–1201, 2 figs., and 1214–1216, 3 figs. Nov. 18: Theory of maximum range conditions. Nov. 25: Effect of wind on range calculations.

Single- vs. Twin-Engined. A Comparison of Single- and Twin-Engined Aeroplanes, R. M. Hill. Aeronautics, vol. 19, no. 368, Nov. 4, 1920, pp. 320–321. Comparison from pilot's point of view. (Concluded.) Paper read before Royal Aeronautical Society.

Skylark. The Skylark. Aviation, vol. 9, no. 8, Nov. 8, 1920, p. 267, 1 fig. Dimensions: Average length, 22 ft. 6 in.; height, 7 ft.; total weight, empty, 730 lb.; machine, three-cylinder, 60 hp., Lawrence air-cooled engine.

Spars. The Design of Spars with Offset Pin Joints, Harris Booth. Aeronautical Jl., vol. 24, no. 118, Oct. 1920, pp. 563–574. Stresses in bay of spar under different loads. Design formulas.

Sperry Messenger. The Sperry Messenger Airplane. Aviation, vol. 9, no. 9, Nov. 15, 1920, pp. 285–286, 5 figs. Specifications: Span, 20 ft.; length, 17 ft. 9 in.; height, 7 ft.; weight, empty, 581 lb.; high speed, 95 m.p.h.; climb in 10 min., 10,000 ft.

Sport. A German Sport Monoplane. Aviation, vol. 9, no. 12, Dec. 6, 1920, p. 391. Designed by Sablatnig Flugzeughau Cie Specifications: Engine, 3 cylinder, 20 hp. air-cooled; weight, empty, 185 kg.; span, 8.40 m.; length, 5.30 m.; height, 2.20 m.; speed, 110 km. per hr.

Two American Sportplanes. Flight, vol. 12, no. 45, Nov. 4, 1920, pp. 1156, 2 figs. W.A.C.O. "Cootie" and U. S. Airplane Co.'s "L.C.7." Dimensions: "Cootie," overall span, 22 ft.; overall length, 16 ft.; total wing area, 85 sq. ft.; speed range, 35 to 65 m.p.h.; climb, 4000 ft. in 10 min. Dimensions of "L.C.7," span, 26 ft.; overall length, 20 ft. 1 in.; overall height, 6 ft. 8 in.; speed range, 26 to 85 m.p.h.

Stability. Aerodynamic Study of the Supporting Members of an Aeroplane (L'étude aérodynamique des organes sustentateurs d'avion), M. Rocca. Aéronautique, vol. 2, nos. 14 and 15, July and Aug. 1920, pp. 87–91, 3 figs., and 129–123, 8 figs. Prantl method as set forth in the German press.

Steam Turbine for. The Study of a Steam Turbine for Airplanes, Luigi Acvampora. Aviation, vol. 9, no. 8, Nov. 8, 1920, pp. 261–262. Possibilities of designing steam turbine for propeller aeroplane. Advantages of such system of propulsion over internal-combustion engine.

Testing Railway. The Aerial Testing Railway of the German Experimental Station for Aviation and Discussion of the Propeller Drive for Railroad Cars (Die Flugzeugprüfbahn der Deutschen Versuchsanstalt für Luftfahrt und über den Luftschraubenantrieb für Eisenbahnfahrzeuge), H. Bendemann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 11, nos. 17 and 18, Sept. 15 and 30, 1920, pp. 245–252 and 261, 12 figs. Description of tower supporting aeroplane to be tested which is mounted on a heavy car truck and drawn by locomotive, by means of which the aeroplane can be moved with great speed through air. Notes on method and arrangement used for measuring air forces to which aeroplane is subjected according to magnitude, direction and position. Details of car designed for carrying out aerodynamic measurements, which is driven by a 240-hp. Maybach engine with direct-coupled propeller; points out its useful possibilities for gaging speed-measuring instruments, etc.

A Railway for Testing Full Size Airplanes. Aviation, vol. 9, no. 14, Dec. 20, 1920, pp. 455–457, 7 figs. Steel tower fastened on railway car truck carries aeroplanes on top. Engine pulls structure at full speed and rating of performance of aeroplane under conditions of test are taken. Mechanism was devised to substitute for wind-tunnel model testing. Paper read before German Aeronautical Society.

Tests. Static Tests of Aeroplanes (Essais statiques des avions), Paul Boccacio. Aéronautique, vol. 2, no. 17, Oct. 1920, pp. 190–195, 8 figs. Methods of procedure.

Tests in Flight and the Laws of Aerodynamics (Les essais en vol et les lois de l'aérodynamique), Ch. Robin. Aéronautique, no. 3, Mar. 1920, pp. 431–436, 12 figs. Equipment developed for conducting aeronautical research in an aeroplane in flight.

Transport. Proposed Transport Airplane. Aviation, vol. 9, no. 100, Nov. 22, 1920, p. 321, 1 fig. Dimensions: Span, 125 ft.; overall height, 19 ft.; length overall, 75 ft.; total area, 3864, sq. ft.; maximum speed, 130 m.p.h.; total weight, 18.5 tons.

Variable-Surface. A French Variable Wing. Aeronautics, vol. 19, no. 372, Dec. 2, 1920, p. 391, 3 figs. Gastambide-Levavasseur design.

Another New Wing. Aerial Age, vol. 12, no. 11, Nov. 22, 1920, p. 297, 2 figs. Developed by Levavasseur, inventor of Antoinette monoplane.

The New Variable Surface Airplane, H. M. Buckwald. Aviation, vol. 9, no. 10, Nov. 22, 1920, pp. 314–316, 6 figs. Levavasseur and Gastambide is a tractor biplane fitted with 250 hp. Salmson engine. Pilot can vary surface, while in flight, from 345 sq. ft. to 560 sq. ft., by sliding panels in the upper plane.

Wings. The New Handley Page Aeroplane Wing. Engr., vol. 130, no. 3383, Oct. 29, 1920, p. 421, 2 figs. Slotted wing form. In trial tests, slotted machines rose at sharper angle, climbed more quickly, alighted at much slower speed and pulled up in considerably shorter distance than ordinary type.

Why the Wing of Uniform Section May Survive, Douglas Shaw. Aeronautics, vol. 19, no. 370, Nov. 18, 1920, p. 359. Because of its comparatively low cost of production. It is besides aerodynamically justified and desirable, and is a sound engineering compromise.

See also Variable-Surface.

AIR BRAKES

Defects. Car Failures Caused by Improper Brake Maintenance, E. H. Wood. Official Proc. Car Foreman's Assn., vol. 16, no. 2, Nov. 1920, pp. 21–33 and (discussion) pp. 34–71, 7 figs. Classification and discussion of principal defects in brake apparatus that cause car failures.

Swedish National Railways. The New Pneumatic Brake for Freight Trains of the Swedish National Railways (Statens järnvägsgars nya godstagsbroms), Gustaf Rydberg. Teknik Tidskrift (Veckoupplagan), vol. 50, no. 40, Oct. 2, 1920, pp. 437–443, 11 figs. Points out that a one-chamber brake does not fulfil requirements of a freight-train pneumatic brake, and describes various improvements of which the Kunze-Knorr brake, a combination of the one- and two-chamber brake, is said to be the best, the braking effect being 60 per cent greater than with a one-chamber brake of corresponding size.

AIR COMPRESSORS

High-Pressure. High-Pressure Compressors (Hochdruckkompressoren), V. v. Haaren. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 44 and 46, Oct. 30 and Nov. 13, 1920, pp. 901–906 and 959–962, 26 figs. Recent development of high-pressure compressors for recovery of oxygen and nitrogen from the air, for production of ammonia according to the Haber process, and for operation of compressed-air mine railways, etc. Notes on different types; selection and arrangement of stages; cylinders; valves; stuffing boxes; lubrication of cylinders; packings; 5-stage mine compressors; compressors for chemical industry; and vertical compressors for use on board ships.

Lubrication. Lubrication of Air Compressors, H. V. Conrad. Glass Industry, vol. 1, no. 2, Dec. 1920, pp. 41–43, 1 fig. Practice recommended by Compressed Air Society.

AIR-HOSE LINES

Couplers. Making Thor Quick-Action Air Line Couplers, J. V. Hunter. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 931–933, 10 figs. Machining operations used in producing couplers in large quantities.

AIRCRAFT CONSTRUCTION MATERIALS

Casein Glue. Failure of Casein Glue Joints in Ash Louis J. Bradford. Aerial Age, vol. 12, no. 13, Dec. 6, 1920, pp. 346–347, and 354, 4 figs. Results of tests showed that both casein and hide glues possess sufficient strength to break spruce. With ash, however, hide-glue joints showed over double strength of those made with casein glue.

Wire Cables. Wire Cables, Walter A. Scoble. Aeronautical Jl., vol. 24, no. 118, Oct. 1920, pp. 537–562, 3 figs. Tests on wire rope under tension, shock and vibration. Bearing of core diameter on strength of cables. Cables tested were of types used in aeronautics.

AIRSHIPS

Commercial. The Commercial Airship—Its Operation and Construction, Trevor Dawson. Flying, vol. 9, no. 11, Dec. 1920, pp. 665–673, 9 figs. Traffic possibilities of airships. Size of airship required. Development of mooring power. Possibilities of reducing cost of construction and operation.

German. The German Airships L 64 and L 71. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 445–447, 6 figs. Notes on their machinery installations.

Hangars. See HANGARS.

Wiring of. The Transverse Wiring of the Rigid Airship, E. H. Lewitt. Aeronautics, vol. 19, no. 372, Dec. 2, 1920, pp. 397–400, 6 figs. Theoretical investigation into magnitude and variation of tensions in transverse wires of rigid airship caused by pressure of adjoining gas bag.

ALCOHOL

See AUTOMOBILE FUELS, Alcohol.

ALLOY STEELS

Analysis. The Analysis of Special Steels, C. O Bannister. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 535–538, 5 figs. Use of electrometric titration methods.

Comparative Efficiency. A Suggested Method for Determining the Comparative Efficiency of Certain Combinations of Alloys in Steel, J. D. Cutter. Trans. Am. Soc. for Steel Treating, vol. 1, no. 3, Dec. 1920, pp. 188–190 and (discussion) pp. 190–3, 198, 7 figs. Formula for merit index is given. Efficiency is defined as ratio of effect produced to energy expended.

Effect of High Temperature. Comparative Values of Motor Valve Steels, G. Gabriel. Iron Age, vol. 106, no. 23, Dec. 2, 1920, pp. 1465–1469, 1 fig. Analysis of effects of high temperature on physical properties of tungsten, chrome and nickel steels. Translated from La Technique Automobile et Aérienne.

ALLOYS

Nickel-Chromium. See NICKEL-CHROMIUM ALLOYS.

ALUMINUM

Casting Losses. Analyze Loss in Aluminum Shops—I, Robert J. Anderson. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 989–992. Replies to questionnaires on casting losses are analyzed and study is made of causes for and prevention of defects in castings. Enumeration of principal typical faults.

APPRENTICES, TRAINING OF

Prussian-Hessian State Railways. The Training of Fitter-Apprentices in the Workshops of the Prussian-Hessian State Railways, W. J. Horne. So. African Jl. of Sci., vol. 16, no. 5, April-July 1920, pp. 411–425. List of practical exercises at training workshops for apprentices.

Systems. Programs of Apprenticeship and Special Training in Representative Corporations—V, J. V. L. Morris. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 951–952, 4 figs. System of training machinists used in plant of Sperry Gyroscope Co., Brooklyn, N. Y.

Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 53, no. 24, Dec. 9, 1920, pp. 1078–1080, 5 figs. Apprenticeship system of De La Vergne Machine Co., New York.

ASH HANDLING

German Power Plants. Ash Removal in Large Power Plants (Die Aschenbeseitigung in Grosskraftwerken), Ph. Scholtes. Elektrische Kraftbetriebe u. Bahnen, vol. 18, no. 26, Sept. 14, 1920, pp. 217–222, 13 figs. on supp. plate. Review of previous literature and summary of replies to a circular letter to large power plants in Germany; critical comparison of the different systems; practice at the Franken central station at Nuremburg; requirements of an ash-removal plant and list of firms engaged in their construction.

AUTOMOBILE ENGINES

Air Cooling. The Position of Air-Cooling, B. H. Davies. Autocar, vol. 45, no. 1310, Nov. 27, 1920, pp. 1055–1058, 12 figs. Review of present situation and possible lines of development.

British Designs. Tendencies in British Engine Design Noted at Olympia, M. W. Bourdon. Automotive Industries, vol. 43, no. 22, Nov. 25, 1920, pp. 1060–1065 and 1067, 18 figs. Most notable type observed by writer was carefully designed, small-powered car. (To be continued.)

Hot-Spot. Comparative Tests with a Hot-Spot Device, Roy E. Berg. Automobile Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1170–1173, 5 figs. Dynamometer tests made in engine laboratory of Lewis Institute showed appreciable fuel economy over wide range speed, smoother low speed, throttle operation and reduced crankcase dilution with Losee hot-spot device fitted to six-cylinder engine.

Properly Applied Heat—An Answer to the Fuel Question, Roy E. Berg. Motor Age, vol. 38, no. 20, Nov. 11, 1920, pp. 7–10, 9 figs. Tests on six-cylinder engine fitted without and then with hot-spot of replacement type.

Manufacture. Building Motors on the Pacific Coast, Fred. H. Colvin. Am. Mach., vol. 53, no. 43, Dec. 16, 1920, pp. 1117–1121, 24 figs. Methods at works of Hall-Scott Motor Car Co.

Machining Operations on the Nash Motor. Machy. (Lond.), vol. 17, no. 424, Nov. 11, pp. 171–174, 8 figs. Use of special machines and methods of equipping standard machine tools.

Nash. Nash Engine is Adapted to Four-Cylinder Practice, Roy E. Berg. Automotive Industries, vol. 43, no. 22, Nov. 25, 1920, pp. 1055–1058, 5 figs. New product closely follows six-cylinder features with latest combustion refinements. Lubrication of power plant is through positively driven gear pump. Chassis of 112-in.-wheelbase is employed for four models of cars on 1921 program. New constructional features described.

Radiators. Automotive Radiators, Karl F. Walker. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 549–553, 6 figs. Curves showing relation between core depth and heat-dissipating capacity, and effect of water flow on heat-dissipating capacity.

Ricardo Crosshead Piston. The 150 H.P. Ricardo Crosshead Piston Engines, S. Findlater. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 490–491, 2 figs. Notes on their performance on test in tanks.

Alcohol and Motive Power (L'alcool et la force motrice), Albert Ranc and Jacques Boisseau. Nature (Paris), no. 2429, Oct. 23, 1920, pp. 260–263. Survey of studies made to determine applicability of alcohol as automobile fuel.

Researches on Alcohol as an Engine Fuel, Harold B. Dixon. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 521–524. It was found that alcohol possesses most of properties required in engine fuel. As compared with gasoline its lower calorific value is claimed to be compensated by greater compression at which it can be used and this property of high ignition temperature under compression is hardly altered by admixture with 20 per cent benzine or gasoline itself. (Abstract.) Report to Fuels Section of Imperial Motor Transport Conference, London.

Benzol-Alcohol Mixtures. Benzol-Alcohol Experiments on Omnibuses, G. J. Shave. Eng., vol. 110, no. 2862, Nov. 5, 1920, pp. 623–624. Fuel experiments carried out by London General Omnibus Co. Paper read before Imperial Motor Transport Council, London.

Gasoline. See GASOLINE.

Mixtures. Fuel Mixtures on London Omnibuses, G. J. Shave. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 556–557. Experiments carried out with a view to ascertaining most suitable mixture of benzol-alcohol for use in standard buses. Mixture of composition, alcohol 65 per cent, benzol 30 per cent and ether 5 per cent, has given satisfactory results with water-jacketed intake pipe. (Abstract.) Paper read before Fuels Section of Imperial Motor Transport Conference, London.

Petroleum. Use of Petroleum in Automobile Engines. (Petroleumbetrieb), H. Praetorius. Motorwagen, vol. 23, no. 25, Sept. 10, 1920, pp. 465–472, 11 figs. Account of examination, by the Technical Commission of Automobile Club of France in collaboration with Gen. Automobile Assn. and Syndical Chamber of Petroleum Industries, of the Aldo, the Genault and the Bellem & Brégéras carburetors; and details of the Egtal pump, with which test was made using mixture of 40 per cent benzine and 60 per cent petroleum in engine of 4-cylinder automobile of latest construction with 80 mm. bore and 130 mm. stroke, and with 1800 revolutions an output of 30 hp. was achieved with fuel consumption of 270 gr. per hp-hr.

AUTOMOBILES

Bignan-Sport. The Refined Bignan-Sport, W. F. Bradley. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 956–958, 5 figs. Details of automobile of French production exhibited at Olympia Show, London. Lubrication of engine is under pressure and each bearing is fitted with oil collector which returns excess oil to base chamber. It is declared that oil consumption is only at rate of one gallon for 3000 miles.

Body Design. New Ideas in the Construction of Automobile Bodies (Neue Gesichtspunkte bei der Konstrukion von Automobil-Karosserien), Max Buch. Motorwagen, vol. 23, no. 25, Sept. 10, 1920, pp. 463–465, 6 figs. Description of automobile body constructed by author, an open car which in less than a minute can easily be transformed into a completely closed limousine or sedan.

Differential Casings. Machining Worm-driven Differential Casings. Eng. Production, vol. 1, no. 13, Dec. 1920, pp. 477–482, 17 figs. Description of methods employed.

Front-Axle Swivels. Front-Axle Swivels. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 478–479, 5 figs. Justification of vertical steering pivots.

Gear Ratio vs. Car Economy. Effect of Gear Ratio on Car Economy. J. N. Golten and Allan Neumann. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1167–1169, 8 figs. Methods of obtaining best car performance with respect to fuel economy when using various gear ratios. Graphs and experimental data.

Locking Gear. The Goodheart Differential. Motor Traction, vol. 31, no. 818, Nov. 1, 1920, pp. 513–514, 4 figs. Automatic locking gear which eliminates wheel spinning.

Olympia Show. Public at London Show Interested in Economical Car, M. W. Bourdon. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 951–954, 8 figs. Few important engineering changes are reported in automobile exhibition recently held at Olympia, London.

The Automobile Show. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 486–489, 14 figs. Trend of design as shown by exhibits in International Exhibition at Olympia and White City.

Peugot. The 11 H.P. Peugot Chassis. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 482–485, 12 figs. Light French car with 10 hp. engine.

Transmission Case. Franklin Transmission Case, Fred. H. Colvin. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 1001–1004, 10 figs. Machining operations.

AVIATION

Aerial Routes. Climatological Factors Governing the Selection of Air Routes and Flying Fields, C. LeRoy Meisinger. Aerial Age, vol. 12, no. 14, Dec. 13, 1920, pp. 368–369 and 373. Importance of meteorological studies in connection with the establishment of aerial routes and layouts of flying fields.

Canadian Air Board Report. Report of Canadian Air Board. Aviation, vol. 9, no. 8, Nov. 8, 1920,

Civil. Civil Aviation. Aeronautical Jl., vol. 24, no. 119, Nov. 1920, pp. 579–590 and (discussion) pp. 590–594. Growth and present position of air mail, passenger and goods services, specially in United Kingdom and British Dominions and Colonies. Factors contributing to successful air services, and suggestions for their successful future development.

Civil Aviation and Air Services, F. H. Sykes. Flying, vol. 9, no. 11, Dec. 1920, pp. 674–679, 2 figs. Growth and present position of air mail, passenger and goods services. Factors contributing to successful air services.

The Organization of Civil Aviation Along International Lines, William Knight. Aerial Age, vol. 12, no. 13, Dec. 6, 1920, pp. 344–345. Urges creation of powerful organization that will establish and operate aerial lines of communication between most important centers of the world, and will take initative in framing up legislation needed for governing navigation of air.

Commercial, German. Commercial Aviation in Germany. Aeronautics, vol. 19, no. 371, Nov. 25, 1920, pp. 375–376, 1 fig. Recent developments. Map of air routes established. (To be concluded.)

Course Determination. Route Correction—A New Method of Aerial Navigation (Correcteur de route; nouvelle méthode de navigation aérienne à l'estime), M. Le Prieur. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 16, Oct. 18, 1920, pp. 700–702. Aerial navigation by means of "derivograph," air apparatus which determines direction to be followed, corrected for wind, in order to reach a given place by straight line flight

Hazards. Effective Study of Aviation Hazards Begun. Automotive Industries, vol. 43, no. 21, Nov. 18, 1920, pp. 1026–1027. Preliminary reports by Committee on Aviation Hazards of National Safety Council.

Mail Service. The Air Postman, H S. Holt. Aeronautics, vol. 19, no. 370, Nov. 18, 1920, p 360. Equipment required at terminal points. Organization of mail service.

Night Flying. Night Flying, Cecil Baker. Aeronautics, vol. 19, no. 368, Nov. 4, 1920, pp. 323–325. Experience during war. Problems of low flying, finding way, and landing.

Spins. Spins. Flight, vol. 12, no. 47, Nov. 18, 1920, pp. 1192–1195, 6 figs. How to describe a spin. Precautions to take. Stresses in aeroplane. Paper read before Cambridge University Aeronautical Society.

Switzerland. Aerial Navigation in Switzerland (La navigation aérienne en Suisse), E. H. Lémonon. Aerophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 274–277, 2 figs. Development of aviation in Switzerland.

[See also FLIGHT.]

AXLES

Heat-Treating. Plant for Heat Treating Automobile Axles, L. M. Thomas. Am. Drop Forger, vol. 6, no. 11, Nov. 1920, pp. 533–536, 3 figs. Plant of Timken-Detroit Axle Co. Automatic annealing furnaces are used.

B

BALANCING

Slow-Speed vs. High-Speed. Slow-Speed vs. High-Speed Balancing, N. W. Akimoff. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 925–926, 1 fig. Balancing at low speeds is considered sufficiently conclusive, because if machine element cannot be balanced at such speeds, perfect balance will not be established at any speeds.

BLOWERS

Parallel Operation. The Operation of Blowers in Parallel for Forced Draft in Naval Service, M. C. Stuart and Arthur H. Sennet. Jl. Am. Soc. Naval Engrs., vol. 32, no. 4, Nov. 1920, pp. 688–718, 14 figs. Experimental investigation. It is concluded that fans operating in parallel should be run at the same speed because relatively small differences in speed cause an unequal division of load between fans in such a manner as to result in greater total shaft horsepower than would be required to produce same draft conditions with fans running at equal speeds.

BOILER FEEDWATER

Heating. The Mathematical Theory of Boiler Feedwater Heating in Steam Turbine-Driven Power Stations, Robert Dowson. Eng., vol. 110, nos. 2862 and 2863, Nov. 5 and 12, 1920, pp. 593–595, 4 figs., and 627–628. Nov. 5: Formula expressing total work lost by tapping off steam for feedwater heating. Nov. 12: Application of theory to design of group of surface feedwater heaters.

BOILERS

Construction. Examining a Steam Boiler Plant, Chas. F. Wade. Eng. & Indus. Management, vol. 5, no. 23, Dec. 2, 1920, pp. 706–710, 5 figs. Methods of construction and testing boilers. (To be continued.)

Largest in the World. The World's Largest Boilers. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 828, 1 fig. Boilers being installed at Ford Plant at River Rouge, Mich. Boilers are of water-tube type and have effective heating surface of 26,470 sq. ft. each. Pulverized coal and blast-furnace gas will be burned at the same time by firing coal verstallation in France, John H. Bartlett, Jr. Chem. and Metallurgical Eng., vol. 23, no. 21, Nov. 24, 1920, pp. 1033–1035, 5 figs. Description of installation and operation of producer gas-fired boiler plant at Montrambert, Loire, Coal Mines, using coked slack and mine waste for production of gas.

Rivet Steel. Standard Specifications for Boiler Rivet Steel. Boiler Maker, vol. 20, no. 12, Dec. 1920, pp. 354–355. Revised specifications of American Society for Testing Materials.

Waste-Heat. See FURNACES, OPEN-HEARTH, Waste-Heat Boilers.

BOILERS, WATER-TUBE

Ludlum. Construction of the Ludlum Watertube Boiler. Boiler Maker, vol. 20, no. 12, Dec. 1920, pp. 345–353 and 373–374, 17 figs. Methods developed by New York Engineering Company for reducing boiler production to machine-shop basis.

BRASS FOUNDING

Electric-Furnace. Electric Furnace Has Proved Value, Carl H. Booth. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 994–997 and 1004, 5 figs. Simplicity of construction, great flexibility and comparatively low cost of operation are some of advantages claimed for rotating type of electric brass melting furnace. Paper read before American Foundrymen's Association.

BUILDING CONSTRUCTION

Cost Accounting. Practical Means of Estimating Equipment Cost. Contract Rec., vol. 34, no. 49, Dec. 8, 1920, pp. 1161–1163. Rental schedule prepared by Associated General Contractors of America, that aims to give adequate charges for use of contracting plant.

Costs. Building Material and Construction Costs—I, Theodore F. Laist. Am. Contractor, vol. 1, no 22, Dec. 4, 1920, pp. 33–35. Study dealing with cost of building construction and of materials used in connection therewith. Brick is first material considered, being discussed under three heads, specifications, methods employed in quantity surveying and cost analysis.

Will Building Costs Come Down? Chas. F. Dingman. Concrete, vol. 17, no. 5, Nov. 1920, pp 144–146. Writer does not expect building costs to be reduced materially within next year.

Equipment. Rental Schedule for Estimating Construction Equipment Expense. Eng. and Contracting, vol. 54, no. 24, Dec. 15, 1920, pp. 583–584. Rental Schedule for construction equipment

Lightning Protection. Protection Against Lightning. Contract Rec., vol. 34, no. 47, Nov. 24, 1920, pp. 1132–1133. Procedure for rodding structures, based on practice in United States and Canada.

Office Buildings. Engineering Details of Newspaper Publishing Building, Charles F. Dingman, Eng. News-Rec., vol. 85, no. 23, Dec. 2, 1920, pp. 1092–1094, 4 figs. Building is of modified mill construction, basement and three stories in height and occupies entire area of plot 100 ft. square.

Railway Shops. Gypsum Tile as a Covering for Railroad Buildings, Curtis F. Columbia. Ry. Age, vol. 69, no. 23, Dec. 3, 1920, pp. 961–962, 3 figs. Principal characteristics of five large railway blacksmith shops.

C

CABLEWAYS

Design. Dedactic Study of Aerial Cableways (Étude didactique des transporteurs aériens sur câbles), Giulio Ceretti. Génie Civil, vol. 77, no. 21, Nov. 20, 1920, pp. 408–411, 7 figs. Characteristics of metallic cables. Notes on design. (To be continued.)

CAR COUPLERS

Universal. The Universal Car and Hose Coupler. Railroad Herald, vol. 24, no. 11, Oct. 1920, pp. 27–29, 4 figs. Features are: (1) Beveled engaging surfaces of coupler head, whereby "high and low" couplings are entirely removed; (2) locking or latch is always open and ready for use as soon as cars are uncoupled; (3) coil spring is held in groove or cavity, giving it snug fit; (4) one man can easily handle coupler shank; etc.

CARBURETORS

Automatic. Modern Automatic Carburetors for Volatile Fuels (Étude des carbureteurs automatiques modernes pour carburants volatils), A. Grebel. Génie Civil, vol. 77, no. 19, Nov. 6, 1920, pp. 370–375, 15 figs. Developments in design. (To be continued.)

Induction Systems. Induction Systems, T. L. Sherman Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 433–439, 28 figs. Comparative study of induction type of carburetors of principal areoplane engines.

Tests. The German Carburetter Trials, J. L. Chaloner. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 450–453, 15 figs. Account of trials carried out under control of General German Automobile Club.

CARS

Brakes. See AIR BRAKES.

CARS, FREIGHT

Steel Gondola. 50-Ton Steel General Service Car, Eng., vol. 110, no. 2862, Nov. 5, 1920, pp. 604–5

and pp. 608, 16 figs., partly on supp. plate. Gondola car constructed by Pressed Steel Car Co., Pittsburgh, for Russian Government.

CASE-HARDENING

Building for. Modern Case Hardening Building at Providence. Iron Age, vol. 106, no. 24, Dec. 9, 1920, pp. 1539–1540. Features include arrangements for maximum ventilation with minimum light and dipping and cooling tanks.

[See also CRANKSHAFTS, Case-Hardening.]

CAST IRON

Carbon in. On the Crystalline Nature of Graphite and Temper-Carbon Obtained from Cast Iron, Kei Iokibé. Sci. Reports of the Tôhoku Imperial University, vol. 9, no. 4, Aug. 1920, pp. 275–279, 4 figs on supp. plate. It is concluded from investigation that the so-called graphite carbon and the temper carbon, as found in cast iron, are both the same substance as natural graphite, and since condition of decomposition of cementite is same for both steel and cast iron, the temper carbon from carbon steels will also be graphite, and not an amorphous carbon.

Influence of Nickel and Cobalt. The Influence of Nickel and Cobalt Additions on the Physical and Chemical Properties of Cast-Iron, O. Bauer and E. Piwowarsky. Foundry Trade Jl., vol. 22, no. 228, Dec. 1920, pp. 936–937. Melting experiments with cast-iron with nickel and cobalt additions.

Sulphur in. The Sulphur Problem in Cast Iron, George K. Elliott. Foundry, vol. 49, no. 24, Dec. 15, 1920, pp. 978–979. Basic electric furnace said to produce sulphur far below 0.05 per cent. Paper read before American Foundrymen's Association.

CEMENT, PORTLAND

Testing. Japanese Standard Rules for Testing Portland Cement. Cement, Mill and Quarry, vol. 17, no. 10, Nov. 20, 1920, pp. 37–38. Issued by Department of Agriculture and Commerce on Feb. 10, 1905, revised Dec. 10, 1909 and June 20, 1919. Translated by Japan Portland Cement Association.

CENTRAL STATIONS

Economics. Central-Station Costs and Income. Elec. World, vol. 76, no. 22, Nov. 27, 1920, pp. 1067–1068, 4 figs. Tendencies that appear under present conditions. Vigorous efforts are apparent to increase plant efficiency and render larger service in face of higher costs. Larger revenue helping to meet unusual requirements.

South America. Power Development in New World and Asia, L. W. Alwyn-Schmidt. Power Plant Eng., vol. 24, no. 23, Dec. 1, 1920, pp. 1113–1115. Prospects for central station. Power development in South America.

COAL

Calorific Value. Economic Value of Coal—II. Calorific Value and Relative Plant Economy with Coal as Fuel, B. S. Murphy. Power, vol. 52, no. 24, Dec. 14, 1920, pp. 936–937, 1 fig. Laboratory tests of coal.

COAL HANDLING

Bucket Cars. How Coal is Handled in South Africa. Coal Age, vol. 18, no. 24, Dec. 9, 1920, pp. 1178–1179, 3 figs. Coal is loaded into ten-ton buckets which are lifted by crane on to specially fitted car. At receiving station bucket can be removed by crane.

Central Stations. The West Penn Power Company's New Coal-Handling System. Nat. Elec. Light Assn. Bull., vol. 7, no. 12, Dec. 1920, pp. 874–875, 1 fig. Plant will elevate, screen, pick, crush, weigh and convey to bunkers of boiler-room 500 tons of coal an hour.

Motor Trucks. Youghiogheny Coal Co. Delivers 60,000 Tons Monthly by Motor Trucks, Donald J. Baker. Coal Age, vol. 18, no. 25, Dec. 16, 1920, pp. 1234–1238, 4 figs. It costs 17.5c to move one ton of coal one mile, $3.53 to operate six-ton truck one hour, and total yearly saving made by trucks over horse-drawn wagons handling same tonnage amounts to about $43,000.

COAL STORAGE

Piling. Piling Storage Coal to Prevent Fire, W. D. Langtry. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 815–817, 7 figs. Suggestions in regard to choosing suitable place, avoidance of breakage in unloading, segregation of different sizes, outside sources of heat and mixing of combustible matter with coal.

COKE OVENS

By-Product. Modern By-Product Oven Operation, C. R. Bellamy. Gas Age, vol. 46, no. 9, Nov. 10, 1920, pp. 340–342, 4 figs. Results obtained by ovens built at Detroit, Mich., for Ford Co.

COMBUSTION

Air Supply. Air for Combustion. Power, vol. 52, no. 24, Dec. 14, 1920, p. 952, 2 figs. Chart showing pounds of air required per boiler horsepower, boiler and furnace efficiency and per cent excess air being given.

CONCRETE

Aggregates. The Strength of Fine-Aggregate Concrete, F. E. Giesecke, H. R. Thomas and G. A. Parkinson. Univ. of Texas Bul., no. 1855, Oct. 1, 1918, 17 pp., 5 figs. Experiments made to determine how compressive strength of concrete varies with relative quantity of cement when the maximum size of aggregate used in preparation of concrete is considerably smaller than that usually employed in concrete construction. Good concrete was prepared without use of coarse aggregate. It was found as general rule that to obtain concrete of given strength with given materials relative quantity of cement must be increased as maximum size of aggregate is decreased.

Crusher Screenings for. Crusher Screenings Make Stronger Concrete. Contract Rec., vol. 34, no. 48, Dec. 1, 1920, pp. 1138–1141. Tests made for Canadian Crushed Stone Corp'n.

Hydrated Lime, Effect of. Effect of Hydrated Lime in Concrete, Duff A. Abrams. Contract Rec., vol. 34, no. 50, Dec. 15, 1920, pp. 1183–1186. Answers to criticisms (see Contract Record, Nov. 24, 1920) of writer's original report which was based on researches regarding effect of various admixtures in concrete. Original paper was read before American Society for Testing Materials.

Proportioning. Proportioning Concrete Aggregates When Unscreened or Pit Run Gravel is Used, L. A. Doan. Eng. & Contracting, vol. 54, no. 22, Dec. 1, 1920, p. 534, 2 figs. Graphs for determining proportions of aggregates.

Recent Developments in Concrete Mixtures, H. C. Boyden. Ry. Rev., vol. 67, no. 21, Nov. 20, 1920, pp. 778–783, 7 figs. Graphs showing relations between strength of concrete and water content, relation between fineness, modulus of aggregate and strength of concrete, diagram for determining quantity of sand required in concrete mixers, and Abram's table of proportions and quantities for one cubic yard of concrete.

Tests. Pouring and Pressure Tests of Concrete, W. A. Slater and A. T. Goldbeck. Technologic Papers of Bur. of Standards, no. 175, Oct. 11, 1920, 13 pp., 4 figs. Maximum pressure against forms during pouring of concrete was found to be equivalent to that of liquid weighing about 124 lb. per cu. ft. Maximum pressure was found to be that due to head of concrete existing at end of about 40 min. After that time pressure gradually decreased in spite of increasing head of concrete.

Ten-Year Tests Showing the Effect of Age and Curing Conditions on the Strength of Concrete, M. O. Withey. Wisconsin Engr., vol. 25, no. 2, Nov. 1920, pp. 19–21, 2 figs. It is concluded that humidity of surrounding medium in which portland cement concrete is cured exercises marked effect upon its crushing strength. It was found that portland cement could be kept without deteriorating for several years when stored in tight tanks, or cylindrical galvanized-iron grain bins.

CONCRETE CONSTRUCTION

New System. A New System of Concrete Construction Making Use of Standard Wood Forms. Building Age, vol. 42, no. 12, Dec. 1920, pp. 23–25, 5 figs. Wooden permanent forms developed and patented by Samuel S. Colt.

Slabs. Diagram for Flat Slabs, O. Wolpert. Concrete, vol. 17, no. 5, Nov. 1920, pp. 142–143, 1 fig. Diagram for estimating quantity of steel and total thickness of slab required for square interior flat slabs, with drop panels, based on regulations of City of New York.

Reinforced Concrete Design Standards, C. A. P. Turner. Concrete, vol. 17, no. 5, Nov. 1920, pp. 152–155, 6 figs. Standards proposed by several associations which are criticized on basis that their reasoning is not verified by experimental evidence. It is emphasized that mathematical theory to be acceptable should be substantiated by experiment.

Reinforced Concrete Saw-Tooth Slab Design, J. W. Pearl. Concrete, vol. 17, no. 5, Nov. 1920, pp. 163–164, 2 figs. Chart for designing slabs.

Safe Loads and Deflections for "Gunite" Slabs. Can. Engr., vol. 39, no. 21, Nov. 18, 1920, pp. 525–529, 10 figs. Tests on 43 slabs at Lehigh University disclose high flexural strength, bending stress of 1800 lb. per sq. in. on $1:2^1/_2$ gunite with factor of safety of 4. Deflections were less than those for poured slabs. Reinforcement tables run up as results of experiments are included.

Standards. Proposals for New Standards for Concrete and Reinforced Concrete Construction (Entwürfe neuer Normblätter). Beton u. Eisen, vol. 19, no. 15, Sept. 20, 1920, pp. 174–180, 9 figs. Proposed standards of the German Industry Committee on Standards for cable conduits, concrete slabs for walls, holding capacity of concrete mixing machines (grinding mill and drum mixers); railway ties and coping stones of natural stone and of concrete; concrete flagstones.

Subaqueous. Experiences in Subaqueous Concrete Work, Henry R. Lordly. Cornell Civil Engr., vol. 28, no. 6, March 1920, pp. 254–263, 4 figs. Successful instances of placing concrete under water are related. It is held there is no further need of building expensive cofferdams.

CONCRETE, REINFORCED

Wood Reinforcement. Reinforcing Concrete with Wood (Le béton armé de bois). Génie Civil, vol. 77, no. 20, Nov. 13, 1920, pp. 394–396, 8 figs. Methods of reinforcing developed in experiments.

CONDENSERS, STEAM

Selection. Application of Steam Condensers, F. A. Burg. Elec. Jl., vol. 17, no. 12, Dec. 1920, pp. 583–587, 6 figs. Factors bearing on selection of type of condenser.

Surface. Surface Condensers, Luther D. Lovekin. Twenty-eighth General Meeting, Soc. Naval Architects & Mar. Engrs., Nov. 11 and 12, 1920, no. 7, 5 pp., 10 figs. Progress in design of surface condensers as applied to power plants in U. S. Navy Ships.

CONVEYORS

Cable. The Roe Cable Conveyor, George Frederick Zimmer. Eng., vol. 110, no. 2864, Nov. 19, 1920, pp. 665–667, 37 figs. partly on supp. plate. Wire rope conveyor for medium distances, designed by J. Pearce Roe.

Combined Skip Hoist and Conveyor. Combined Skip-Hoist Elevator and Conveyor, George Frederick Zimmer. Eng. and Indus. Management, vol. 4, no. 19, Nov. 4, 1920, pp. 597–598, 5 figs. Device patented by Warren Travell, of Exeter Machine Works, New York City. It combines skip hoist with band conveyor and with tipping trolley on wheels.

Pneumatic. Pneumatic Conveyors of Fine Materials. Contract Rec., vol. 34, no. 51, Dec. 22, 1920, pp. 1218–1220. Examples of English installations for the pneumatic lifting and conveying of coal and other materials.

CORE OVENS

Electrically Heated. Core Baking in Electrically Heated Ovens, J. L. Jones, Iron Age, vol. 106, no. 22, Nov. 25, 1920, pp. 1385–1387, 3 figs. Results of comparative tests of electric and fuel heated core ovens. New Westinghouse thermostat control.

Electrifying the Foundry Core Room, J. L. Jones. Elec. World, vol. 76, no. 25, Dec. 18, 1920, pp. 1203–1204, 3 figs. Cores baked in electrically heated ovens shown to have 50 to 200 per cent greater strength than those baked in fuel-fired ovens.

CORK

Substitute for. A Substitute for Cork. Commerce Reports, no. 283, Dec. 2, 1920, p. 978. Turf treaded by special patented process developed by chemical works at Bruenn-Koenigsfeld, Prague.

CORROSION

Iron and Steel. Experiments on the Corrosion of Iron and Steel, William D. Richardson. Can. Chem. Jl., vol. 4, no. 11, Nov. 1920, pp. 299–307. Passivity of iron as oxidation phenomenon. (Concluded.)

COST ACCOUNTING

Factory. Factory Costs, L. T. Konopak. Jl. of Accountancy, vol. 30, no. 5, Nov. 1920, pp. 329–337. Describes cost system designed for factory manufacturing transmissions, and forms provided for reporting the various transactions of factory designed to facilitate handling clerical work in a routine manner with least consumption of time.

COSTS

Relation to Selling Prices. The Determination of Costs and Their Relation to Profit and Selling Prices. Eng. & Indus. Management, vol. 4, no. 23, Dec. 2, 1920, pp. 713–715. Predetermination of prices.

CRANES

Floating. Two-Hundred Ton Mammoth Floating Crane at Gusto Shipyard, Schiedam, Holland [Grue Flottante "Mammoth," de 200 tonnes, des Chantiers Gusto, de Schiedam (Hollande)]. Génie Civil, vol. 77, no. 19, Nov. 6, 1920, pp. 365–367, 3 figs. Crane can lift 200 tons 52 m. high above surface of water. Radius of action is 34 m.

CRANKSHAFTS

Case-Hardening. Case-Hardening Process for Crankshafts Successfully Developed, Norman G. Shidle. Automotive Industries, vol. 43, no. 21, Nov. 18, 1920, pp. 1016–1019, 5 figs. Process developed from tests made by H. H. Franklin Manufacturing Co.

CRIPPLES

Artificial Limbs. The Muscular Strength in an Amputated Arm and Its Utilization (Die Muskelkräfte im Innern des amputierten Armes und ihre Nutzbarmachung), G. Schlesinger and K. Meyer. Werkstattstechnik, vol. 14, no. 17, Sept. 1, 1920, pp. 457–463, 24 figs. Results of experiments carried out at the Charlottenburg Testing Inst. for Substitute Limbs. Abstract of report of investigations of about 30 men who had undergone the Sauerbruch operation, and of a large number of artificial hands and arms with apparatus especially constructed therefore, description and illustrations of which are given.

CUPOLAS

Charges, Determining. Method for Determining Cupola Charges, H. L. Campbell. Foundry Trade Jl., vol. 22, no. 227, Nov. 1920, pp. 856–857, 1 fig. Chart for determining mixtures.

CYLINDERS

Automobile Engines. How Cylinders are Made in England, H. Cole Estep. Foundry, vol. 48, no. 23, Dec. 1, 1920, pp. 933–939, 13 figs. Standardization of operations and extensive use of molding machines have aided quantity production.

D

DIES

Double-Flanged Shell. Dies for Double-Flanged Shell, J. Bingham. Machy. (Lond.), vol. 17, no. 424, Nov. 11, 1920, pp. 176–178, 10 figs. Procedure for designing drawing dies.

DIESEL ENGINES

Busch-Sulzer. Diesel Engines in a Modern Flour Mill. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 808–810, 5 figs. Busch-Sulzer and Fulton-Tosi types used.

Fuel Injection. Air-Injection or Mechanical-Injection, J. L. Chaloner. Motorship, vol. 5, no. 12, Dec. 1920, pp. 1084–1085, 8 figs. Technical study of fuel injection in Diesel engines. (To be continued.)

28 figs. Experiments carried out at British Admiralty Engineering Laboratory in connection with development of high-speed engine for naval purposes. Both solid-injection and air-injection systems were taken up.

Marine. Building Diesel Marine Engines for Merchant Vessels—I, Fred B. Jacobs. Mar. Rev., vol. 50, no. 12, Dec. 1920, pp. 640–647, 12 figs. Manufacturing methods at Busch-Sulzer Bros.-Diesel Engine Co., St. Louis.

Opposed-Piston. British Admiralty Experiments with Diesel Engines—III, C. J. Hawkes. Motorship, vol. 5, no 12, Dec. 1920, pp. 1086, 3 figs. Tests on Doxford opposed-piston submarine Diesel engine. (Concluded.)

DRILLING

Automobile Plants. Multiple Drilling in Automobile Plants. Machy. (Lond.), vol. 17, no. 426, Nov. 25, 1920, pp. 225–229, 10 figs. Multiple-spindle drilling machines.

Deep-Hole. Some Experiences in Deep-Hole Drilling, Charles J. Starr. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1023–1026, 9 figs. Requirements of Drill.

DRILLING MACHINES

Multiple-Spindle. A Multiple Spindle Drilling Machine, G. L. Bohannon. Boiler Maker, vol. 20, no. 11, Nov. 1920, pp. 321–323, 5 figs. Machine built by Thomas Spacing Machine Co., Pittsburgh, Pa. Chief feature is chain drive which gives direct pull on spindles and is said to eliminate power losses.

Semi-Automatic. A New Type of Semi-Automatic Drilling Machine. Machy. (Lond.), vol. 17, no. 423, Nov. 4, 1920, pp. 139–140, 5 figs. Drill is fed to work by automatic cam motion. Feature is tilting work table whereon two work-holding fixtures may be mounted, each being brought under drill spindle in turn. Machine is manufactured by S. Ratcliffe, Ltd., Manchester, England.

Universal. 5-Ft. Universal Radial Drilling Machine. Eng., vol. 110, no. 2862, Nov. 5, 1920, pp. 600–601, 6 figs. Arm can be swiveled for angle drilling and spindle swiveled on saddle. Manufactured by Niles-Bement-Pond Co., New York.

DRILLS

Electric. Portable Electric Tools, Machy. (Lond.), vol. 17, no. 427, Dec. 2, 1920, pp. 250–252, 7 figs. Electric drills.

Twist. Proper Care of Twist Drills as a Means of Economy, G. P. Blackiston. Boiler Maker, vol. 20, no. 12, Dec. 1920, pp. 360–361. Tables showing speeds and feeds for carbon and high-speed drills.

DROP FORGING

English Plant. A Modern Drop Forging Plant. Eng. Production, vol. 1, no. 13, Dec. 1920, pp. 483–486, 8 figs. Description of Abbey Works Forge of Clayton & Shuttleworth, Lincoln, England.

Practice. Drop Forging, J. H. Moore. Can. Machy., vol. 24, no. 23, Dec. 2, 1920, pp. 485–489, 9 figs. Examples of drop-forging practice, including axles and crankshafts.

DYE HOUSES

Organization and Construction. Organization and Construction of Dye Houses, A. W. Benoit. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 673–674 and p. 706, 2 figs. Machinery organization, location, construction, ventilation and piping of dye houses considered from engineering viewpoint.

DYNAMOMETERS

Farm Tractors. National Physical Laboratory Traction Dynamometer for Agricultural Tractors, J. H. Hyde. Eng., vol. 110, no. 2865, Nov. 26, 1920, pp. 693–694, 7 figs. Apparatus consists of cylinder and plunger, former being attached to drawbar of tractor, and latter through links to plow. Pull on coupling sets up pressure in oil confined in cylinder, at flexible hydraulic tube.

E

EDUCATION, INDUSTRIAL

Ford Institute of Technology. Linking Education With Factory Costs—III, T. P. Hickey. Factory, vol. 25, no. 11, Dec. 1, 1920, pp. 1726–1730, 8 figs. Organization of Ford Inst. of Technology.

ELECTRIC DRIVE

See ICE PLANTS, Electrically Driven; ROLLING MILLS, Electrically Driven.

ELECTRIC FURNACES

Booth. Booth Rotating Electric Brass Furnace, Carl H. Booth. Iron Age, vol. 106, no. 23, Dec. 2, 1920, pp. 1463–1464, 2 figs. Records recently made on 500 lb. rotating electric furnace at plant of Enterprise Brass Works, Muskegon, Mich. Paper read before Am. Foundrymen's Assn.

Combustion vs. Electric vs. Combustion Furnaces for Low Temperatures, Frank W. Brooke and George P. Mills. Chem. and Metallurgical Eng., vol. 23, Nov. 24, 1920, pp. 1008–1010. Electric furnaces are found to have advantage in temperature control, reliable and permanent source of heat and maintenance. Cost of power is counterbalanced by economy in space, auxiliaries, and operation, while quality of product is greatly enhanced.

Commercial Types. The Electric Melting Furnace, Joseph W. Richards, F. W. Brooke, R. D. Thomas,

Linings. Linings for Electric Furnaces, R. M. Howe. Iron Trade Rev., vol. 67, no. 23, Dec. 2, 1920, pp. 1541–1543. Survey is made of nine materials used as refractories for electric units. Physical characteristics compared. Fusion points are lowered by pressure. Silica and magnesia tend to spall.

Metal Industries, Use in. The Present Status of the Electric Furnace in the American Metal Industries, Robert M. Keeney. Chem. & Metallurgical Eng., vol. 23, no. 20, Nov. 17, 1920, pp. 980–984. Present technology and future possibilities of electric furnace as applied in manufacture of synthetic cast iron, steel, steel castings, ferroalloys and in heat treating, brass melting and smelting of nonferrous ores. Paper read before Nat. Elec. Light Assn.

Motion of Liquid by "Motor Effect." Nature and Explanation of the "Motor Effect" in the Ajax-Wyatt Furnace, E. F. Northrup. Jl. Franklin Inst., vol. 190, no. 6, Dec. 1920, pp. 817–834, 4 figs. When high-tension current, direct or alternating, flows in a liquid conductor, motions of liquid of considerable magnitude are always produced. Article develops formula for calculating mechanical forces which arise by interaction of triangular circuit carrying current upon short section of circuit. Numerical results are tabulated and values of forces are given in chart.

Refractories for. Refractories For Electirc Furnaces, R. M. Rowe. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 911–913. Survey of different materials and tables of their physical characteristics. Paper read before Elec. Furnace Assn.

Repelling Arc. Electric Furnace with a Repelling Arc. Iron Age, vol. 106, no. 24, Dec. 9, 1920, pp. 1556–1557, 4 figs. Electric furnace for steel and nonferrous operations developed by Industrial Electric Furnace Co., Chicago. When current flows electrodes are forced apart, thus drawing arc.

Steel Manufacture. English and American Types of Electric Iron and Steel Furnaces Compared, John B. C. Kershaw. Iron & Coal Trades Rev., vol. 101, no. 2750, Nov. 12, 1920, pp. 637–640 and 655–658, 16 figs. Based on records of operation at steel works.

ELECTRIC LAMPS, MERCURY-ARC

Cooper Hewitt. The Cooper Hewitt Quartz Lamp and Ultra-Violet Light, L. J. Buttolph. Gen. Elec. Rev., vol. 23, no. 11, Nov. 1920, pp. 909–916, 8 figs. Summary of latest developments of compilation of related technical data.

ELECTRIC LOCOMOTIVES

Driving Gears. Driving-Gear Arrangements in Electric Locomotives (Treibwerksanordungen bei elektrischen Lokomotiven), A. Marschall. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 43, no. 39, Sept. 24, 1920, pp. 299–302, 3 figs. Discussion of various types, including the Brown, Boveri & Cie and the Tschantz driving gear, but with special consideration of the latest Lentz construction, with which it is said to be possible to render gear ratio between motor- and driving-wheel shaft variable, as with automobile gears.

ELECTRIC WELDING

Development. Practical Applications of Electric Welding, F. P. Vaughan. Jl. Eng. Inst. Canada, vol. 3, no. 12, Dec. 1920, pp. 556–564, 5 figs. Survey of electric welding methods, resistance, carbon arc, metallic arc and quasi-arc; methods of application, tables of power consumption, etc.; training welder, protection devices.

Electropercussive. Recent Developments in Electro-Percussive Welding, Douglas F. Miner. Welding Engr., vol. 5, no. 11, Nov. 1920, pp. 27–28 and 32, 7 figs. Describes apparatus used, which consists essentially of device for producing a percussive engagement of parts to be welded, practically simultaneous with discharge of electrical energy. Gives examples of electropercussive welding and photomicrographs.

ELECTRIC WELDING, ARC

Overhead. Overhead Arc Welding—Theory and Practice, O. H. Eschholz. Power, vol. 52, no. 20, Nov. 16, 1920, 776–780, 11 figs. Also results of tensile tests made on sections cut from overhead welds.

EMPLOYMENT MANAGEMENT

Psychotechncal Tests. Apparatus for Adaptability Tests (Apparate fur Eignungsuntersuchungen), R. Thun. Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 24–29, 7 figs. Gives certain guiding rules which should be taken into consideration in development of apparatus and describes various apparatus.

Psychotechnical Adaptability Tests (Psychotechnische Eignungsprüfungen), H. Heilandt. Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 16–21, 12 figs. Describes method of examination employed in the admission of industrial apprentices in the works school of the German General Electric Co.'s factories in Berlin.

The Reliability of the Psychological Adaptability Tests (Bewährung der psychologischen Eignungsprüfungen), H. Rupp. Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 1–8, 7 figs. It is shown that the reliability of an adaptability test can be accurately determined and what degree of reliability according to described method can be ascribed to the most important tests so far developed. Points out certain requirements which are necessary for the proper application and improvement and extension of tests.

ENGINEERING SOCIETIES

Relationship to Public Service. Some Phases of Relationship of Engineering Societies to Public Service, Herbert Hoover. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 12, Dec. 1920, pp. 1073–1075. Address before Federated American Engineering Societies.

ENGINEERS

Registration. Report of Ontario Committee on Legislation. Can. Engr., vol. 39, no. 26, Dec. 23, 1920, pp. 631–635. Text of bill for official registration of engineers, proposed by Ontario Advisory Committee.

Remuneration. Manitoba Engineers Pledged to Salary Schedule. Can. Engr., vol. 39, no. 20, Nov. 11, 1920, pp. 505–508. Work being done by Remuneration Committee of Manitoba Branch, Engineering Institute of Canada, in enforcing Salary Committee's recommendations. Branch has decided that "any engineer who fails to receive salary adequate to his class as recommended by the Remuneration Committee will be assisted by the Engineering Institute of Canada to obtain other employment at adequate remuneration and will receive the moral, and, if necessary, financial support of all other engineers in the province." Classification of engineers and schedule of salaries prepared by Salary Committee are included.

ENGINEHOUSES

Electrical Equipment. Electrical Equipment of New Engine Terminal. Ry. Elec. Engr., vol. 11, no. 12, Dec. 1920, pp. 437–439, 4 figs. Motors used in machine shops and on turntable at terminal on New York Central at Minerva, Ohio.

F

FACTORIES

Layout. Economy of Horizontal Space by the Machine Layout. J. Edward Schipper. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 964–967, 6 figs. Description of Holley carburetor factory. Light work is arranged on continuous table with machines spaced by requirements of workmen.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT

FANS, CENTRIFUGAL

Design. The Design and Construction of Fans—I, F. G. Whipp. Mech. World, vol. 68, no. 1768, Nov 19, 1920, pp. 354–355, 3 figs. Calculation of efficiencies of propeller fans.

FATIGUE

Industrial. An Experiment with Rest Pauses, J Loveday. Eng. & Indus. Management, vol. 4, no 23, Dec. 2, 1920, pp. 716–718. Experiment in British shoe factory. Double presses were worked with team of three girls each operative working 40 min. in each hour and resting 20 min. Output was increased from 57 to 75 per cent.

FLIGHT

Man-Power. The Problem of Flight with Man-Power (Das Problem des MS-Fluges), Rudolph Waschmann. Luftfahrt, vol. 24, no. 9, Sept. 2, 1920, pp. 133–135. Discussion of R. Nimführ's new but already tested, theory of the dynamic flight, according to which, the pressure of air is utilized as the supporting force. Describes how a constant atmospheric pressure wave is generated on which the airplane sails with much less consumption of power than would be the case with propeller drive. Describes how with the Nimfuhr flight theory, gravity can be overcome with employment of a single man power (equivalent to $^1/_5$ hp.).

FLYING BOATS

Controls. Sand Test of Flying Boat Controls. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 350–352, 7 figs. Account of tests on controls of aeromarine model 40 flying boat.

FOREMEN

Training of. Adopt Methods to Develop Foremen, M. C. Evans. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 1001–1004. Detailed description of foreman's development course which was conducted during six months of last fall and winter at plants of International Harvester Co. Paper read before American Foundrymen's Association.

FORGING

Gas for. Gas for Forging. Gas Industry, vol. 20 no. 11, Nov. 1920, pp. 257–260. Requirements and advantages.

Why Gas Excels for Forging. Gas Rec., vol. 18, no. 9, Nov. 10, 1920, pp. 67–69. Experience of Henry L. Doherty Co.

Norfolk Navy Yard Shop. Forge Shop at the Norfolk Navy Yard, J. S. Glover. Am. Drop Forger, vol. 6, no. 11, Nov. 1920, pp. 555–558, 3 figs. Size, layout and equipment of plant. Compressed air used to operate hammers. Design of forges and oil atomizers. Butt-weld machine. Reclaiming propellers.

FOUNDRIES

Air Furnace for. Air Furnace Iron for Big Castings, H. E. Diller. Foundry, vol 48, no. 24, Dec. 15, 1920, pp. 973–977, 8 figs. Air furnace used in

one of foundries of Westinghouse Electric & Mfg. Co.

Equipment. Choosing Correct Plant Equipment, Joseph J. Wilson. Foundry, vol. 48, no. 24, Dec. 15, 1920, pp. 985–988. Selection of machines and appliances exemplified in case of foundry of Saginaw Products Co., Saginaw, Mich. Paper read before National Founder's Association.

Germany. The G. Krautheim Foundry Plants in Chemnitz for Production of Cast Steel, Malleable and Gray Iron Castings (Die Stahl-, Temper- und Graugiesserei-Anlagen der Firma G. Krautheim in Chemnitz.) Stahl u. Eisen, vol. 40, nos. 39 and 43, Sept. 30 and Oct. 28, 1920, pp. 1293–1300 and 1443–1448, 22 figs. Description of works employing 1600 men, including original plant in Chemnitz-Altendorf, in which malleable and gray-iron castings are produced, and the new steel foundry in Chemnitz-Borna, with notes of arrangement of plant, small Bessemer plant, the open-hearth furnaces, the electric steel furnaces, the cleaning shop, molding, shop, etc.

Organization. Training Executives for Foundries, Bruce W. Benedict and Robert E. Kennedy. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 903–907, 5 figs. Suggested organization for foundries. Shop training course at University of Illinois. Paper read before Am. Foundrymen's Assn.

[See also CORE OVENS.]

FOUNDRY EQUIPMENT

Developments. Foundry Equipment in Modern Plants, Joseph J. Wilson. Iron Age, vol. 106, no. 22, Nov. 25, 1920, pp. 1392–1397, 10 figs. Survey of recent developments.

FUELS

Colloidal. The Case for Colloidal Fuel, Lindon W. Bates. Chem. Age (Lond.), vol. 3, no. 75, Nov. 20, 1920, pp. 558–559. Economic advantages. Paper read before Instn. Petroleum Technologists.

[See also OIL FUEL; PULVERIZED COAL; RESEARCH, Liquid Fuels.]

FURNACES

Heat Flow Through Walls. Heat Flow Through Furnace Walls—II, E. F. Davis. Trans. Am. Soc. for Steel Treating, vol. 1, no. 2, Nov. 1920, pp. 128–140, 17 figs. Experimental measurements.

FURNACES, BOILER

Forced-Draft. Forced Draft Furnaces (Unterwindfeuerungen), L. Schmitt. Tonindustrie-Zeitung, vol. 44, no. 106, Sept. 7, 1920, pp. 938–939. Discussion of the relative value of forced-draft furnaces and steam-jet blowers, writer favoring the former.

Recommendations for the Development of Forced-Draft Furnaces (Vorschläge für den Ausbau der Unterwindfeuerungen), E. Nies. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 39, Sept. 24, 1920, pp. 297–299. Writer makes following suggestions: (1) The free surface of grate with use of under-grate draft should be reduced to from 4 to 6 per cent as against 35 to 40 per cent in plain horizontal grates; (2) grate bars and plates should be inserted accurately, and free surface of grate should not be changed, (3) in external furnaces the circulation of air through the side grate bars should be reduced; (4) in flue boilers, end of grate should be provided with a plate upon which the red coals can be shoved while cleaning the fire.

The "Turbine" Forced-Draught Furnace. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 639–640, 8 figs. Arrangement consists of series of troughs which lie side by side and form base of furnace. Front of each trough forms air injector and is fitted with steam jet.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEATING

Labor-Saving Features. Heating Furnaces and Annealing Furnaces, W. Trinks. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 671–675, 12 figs. Labor saving features of different types of furnaces.

FURNACES, HEAT-TREATING

Electric Heaters. Electric Heaters for Heat Treating Furnaces—II, H. O. Swoboda. Am. Drop Forger, vol. 6, no. 11, Nov. 1920, pp. 540–543, 9 figs. Carbon and graphite resistors are used with success in several types of furnaces. Furnace charge is used as heater in special cases. Temperature control.

Oil-Burning. Annealing and Heat Treatment Furnaces, James E. Wilson. Jl. Engrs. Club of Phila., vol. 37–12, no. 192, Dec. 1920, pp. 488–489. Design, regulation of cost of oil-burning steel heat-treating furnaces.

FURNACES, OPEN HEARTH

Waste-Heat Boilers. Application of Waste Heat Boilers to Open Hearth Furnaces, Thomas R. Tate. Jl. Engrs. Club of Phila., vol. 37–12, no. 192, Dec. 1920, pp. 485–487. Design of proper size and type boiler for any installation. Paper read before Assn. Iron & Steel Elec. Engrs.

G

GAGES

Indicating. Indicating and Contour Gauges. Machy. (Lond.), vol. 17, no. 427, Dec. 2, 1920, pp. 259–263, 11 figs. Classification and description.

Limit. Limit Gauges. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 643–644. Developments in standardization.

Limit Gauging, Richard T. Glazebrook. Jl. Instn. Mech. Engrs., no. 8, Dec. 1920, pp. 1075–1088, 5 figs. Diagram of grades of fit, and chart of limits. (To be continued.)

Limit Plug. Quantity Production of Combination Limit Plug Gauges. Machy. (Lond.), vol. 17, no. 423, Nov. 4, 1920, pp. 151–153, 4 figs. Combination limit plug gage introduced by Taft-Pierce Mfg. Co., Woonsocket, R. I.

Screw-Thread. Hardening Screw Gauges with Least Distortion, Wilfred J. Lincham. Can. Machy., vol. 24, no. 22, Nov. 25, 1920, pp. 472–476, 14 figs. Method developed at Goldsmith's College, London.

GAS ENGINES

Castings. Problems Encountered in Gas Engine Castings, Pat Dwyer. Foundry, vol. 49, no. 24, Dec. 15, 1920, pp. 980–983, 9 figs. Casting practice at plant of Rathbun-Jones Engineering Co., Toledo, Ohio.

Valveless. The Development of Two-Stroke High-Power Gas Engines (Weiterentwicklung der Zweitakt-Grossgasmaschinen), W. Bertram. Stahl. u. Eisen, vol. 40, no. 40, Oct. 7, 1920, pp. 1335–1340 and (discussion) pp. 1340–1341, 5 figs. Describes construction and operation of new valveless gas engine of the Dahlbrucher Machine Construction Corp'n. and gives operating results of engine reconstructed according to this type.

GASOLINE

Production of. Production of Gasoline. Power, vol. 52, no. 20, Nov. 16, 1920, pp. 788–789. Statistics of refinery production of gasoline for period of sixteen years, 1904 to 1919, inclusive. Advance publication of Bureau of Mines Bulletin No. 191.

Specifications. Aviation Gasoline Specifications and Methods for Testing. Air Service Information Circular, vol. 1, no. 46, Aug. 30, 1920, 8 pp. 3 figs. Specifications cover three grades of gasoline known as domestic aviation gasoline, export gasoline and fighting gasoline. Distillation test is required for determining grade of gasoline. Procedure and details of manipulation in conducting distillations are explained.

GASOLINE ENGINES

Two-Cycle. The Two-Cycle Lutin Motor (Le moteur à 2 temps Lutin), H. Petit. Vie Automobile, vol. 16, no. 717, Nov. 10, 1920, pp. 420–421, 3 figs. Piston is enlarged at base and fits in larger cylinder. Lower element of piston is used for compressing mixture before charging into upper cylinder.

GEARS

Bevel. A New Development in Bevel Gear Cutting. Machy. (Lond.), vol. 17, no. 425, Nov. 18, 1920, pp. 199–203, 8 figs. Attachments applicable to ordinary shaping machine.

Design. Graphical Method for Designing a Set of Complex Gears (Méthode graphique par anamorphose pour l'établissement des trains d'engrenages complexes), Luc Denis. Vie Technique et Industrielle, vol. 1, no. 9, June 1920, pp. 221–222, 3 figs. Examples. (Concluded.)

Involute. Involute Teeth, Richard Gardner. Eng., vol. 110, no. 2864, Nov. 19, 1920, pp. 659–660, 2 figs. Design formulas.

Machining Blanks. Machining Friction Gear Blanks and Friction Cones, J. H. Moore. Can. Machy., vol. 24, no. 17, Oct. 21, 1920, pp. 371–373, 8 figs. Examples of work performed according to practice of Foster Machine Co., Elkhart, Ind.

Pitch-Measuring Machine. The Wickman Pitch Measuring Machine. Automobile Engr., vol. 10, no. 145, Dec. 1920, p. 481, 4 figs. Machine is designed to measure tooth spacing at pitch line as well as concentricity of pitch circle with bore.

Reduction. See REDUCTION GEARS.

Spur. Backlash Standards for Spur Gears, Charles H. Logue. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1040–1041, 2 figs. Formula for determining proper backlash for spur gears, and tables computed from formula.

Welding of. The Art of Welding Gears and Pinions, F. H. Sweet. Blast Furnace & Steel Plant, vol. 8, no. 12, Dec. 1920, pp. 684–685. Advisability of welding each tooth separately or of welding several teeth en bloc. Selection of proper welding tip and filler rod.

GIRDERS

Design. Reduction of Girder and Column Live Loads, C. R. Young. Can. Engr., vol. 39, no. 23, Dec. 2, 1920, pp. 565–569, 2 figs. Principle of discounting improbable live loads generally observed. Intensity of floor loads for buildings varies inversely as tributary area. Review of various reduction rules. New specification suggested.

Stresses in. Notes on Impact, F. W. Gardiner. Proc. Am. Soc. Civil Engrs., vol. 46, no. 9, Nov. 1920, pp. 976–977. Relation between static and dynamic stresses in girder spans for smooth rolling loads. It was found that for speeds that obtain in railroad practice dynamic effect of smooth rolling loads may be neglected; dynamics increment of stress for single load for critical speed is given as 31.8 per cent. (Abstract.)

GLUES

See AIRCRAFT CONSTRUCTION MATERIALS, Casein Glue.

H

HANDLING MATERIALS

Railway Shops. Handling Material in Railway Shops, Frank A. Stanley. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 953–954, 7 figs. Typical labor-saving devices.

HANGARS

Design. Hangars for Dirigibles and Their Accessories (Les gares de dirigeables et leurs accessoires), M. J. Sabatier. Aéronautique, vol. 2, no. 14, July 1920, pp. 55–60, 12 figs. Scheme of turning German man hangars around on base.

HARDNESS

Instruments for Testing. Rapid Measurement of Hardness and Resilience of Metals (Mesures rapides de la dureté et de la résilience des metaux), S. Boisthorel. Nature (Paris), no. 2427, Oct. 9, 1920, pp. 230–234, 10 figs. Guillery portable apparatus for use in workshops.

Measurement of. The Measurement of the Hardness of Metals, Hugh O'Neill. Mech. World, vol. 68, no. 1769, Nov. 26, 1920, pp. 383–384, 2 figs. Classification of methods. Discussion of their relative advantages and disadvantages. (To be continued.) Paper read before Sheffield University Metallurgical Soc.

HEATING

Electric. Economic Heating by Means of Hydroelectric Energy (La produzione economica del calore mediante l'energia idroelettrica), C. Baulino. L'Elettrotecnia, vol. 7, no. 18, June 25, 1920, pp. 318–320, 1 fig. Scheme involving passage of heat at low temperature into high temperature by utilization of mechanical energy.

HEAVY-OIL ENGINES

Pistons. Piston and Rings for Heavy Oil Engines, W. D. Forbes. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 1002–1003, and p. 1013. Solid and forged pistons discussed. Method of forming piston rings from castings. Assembling forged pistons.

HELICOPTERS

Hewitt-Crocker. The Hewitt-Crocker Helicopter, Francis Bacon Crocker. Aerial Age, vol. 12, nos. 11 and 12, Nov. 22 and 29, 1920, pp. 295–297, 4 figs., and 323–325, 1 fig. Machine comprises upper propeller revolving in normally horizontal plane and propeller in parallel plane 7 ft. below. Each propeller is 51 ft. in diameter. Propellers revolve in opposite directions.

Problem of. The Problem of the Helicopter, Louis Damblanc. Aeronautics, vol. 19, nos. 371 and 372, Nov. 25 and Dec. 2, 1920, pp. 379–381 and 392–394. Also Flight, vol. 12, no. 48, Nov. 25, 1920, pp. 1219–1223, 10 figs. Comparative study of two proposed types of helicopters, (1) machine with single axis and (2) that with separate axis. Paper read before Royal Aeronautical Soc.

Propellers of. Note on Supporting Propellers (Note sur les hélices sustentatrices), M. Lamé. Aérophile, vol. 28, nos, 17–18, Sept. 1–15, 1920, pp. 269–270, 1 fig. Characteristics of propeller which would permit by its free rotation safe falling of helicopter.

HOISTING ENGINES

Emergency Governor. An Emergency Governor with Hoist Recorder Gives Data on Safety and Efficiency, G. F. Royer. Coal Age, vol. 18, no. 22, Nov. 25, 1920, pp. 1079–1084, 4 figs. Emergency governor for control of clutch-drum hoisting engines.

HOISTS

Drum Design. Calculation of Stresses in Winding-Drum Flanges. Am. Mach., vol. 53, no. 25, Dec. 16, 1920, pp. 1130–1131, 2 figs. Diagrams of forces acting.

Rational Design of Hoisting Drums, Everett O. Waters. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 675–679, 9 figs. Theoretical formula is deduced for total pressure against drum flange caused by winding-on of rope to given depth and under given initial tension. Two other formulas are also deduced, which relate total pressure to flange thickness and maximum allowable tensile and shearing stresses in material. By means of these formulas flange of usual mushroom type may be designed to withstand safely pressure of rope wound upon drum.

HOUSING

England. Concrete Cottage Building. Concrete and Constructional Eng., vol. 15, no. 11, Nov. 1920, pp. 737–742, 5 figs. Meanwood housing scheme, Leeds.

Industrial. Solving the Housing Problem, Herbert Hoover, Leslie H. Allen, Philip W. Blake and W. Gibbs Astle. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 425–436, 8 figs. Why industrial executives must do it and how it is being done.

Legislation in England. The Garden City and English Housing Laws, Leonard S. Smith. Eng. and Contracting, vol. 54, no. 21, Nov. 24, 1920, pp. 510–513, 2 figs. Resolutions adopted at World Congress on Housing and Town Planning held in London, June, 1920.

Schemes. Housing and Community Planning, John Irwin Bright. Jl. Am. Inst. of Architects Supp. 8 pp., 4 figs. Scheme developed by Committee on Community Planning of American Institute of Architects.

HYDRAULIC TURBINES

High-Head. Turbines for Niagara's High-Head Plant. Iron Age, vol. 106, no. 23, Dec. 2, 1920, pp. 1453–1457, 11 figs. Normal operating capacity will be 52,500 hp. and net effective head, 305 ft.

das gesamte Turbinenwesen, vol. 17, no. 27, Sept. 30, 1920, pp. 318-320, 5 figs. Writer describes his new regulation for full-jet turbines which consists of a changeable width of rim for centrifugal and inward radial-flow turbines; and his hydraulic regulator which is equipped with two separate regulating valves, one for opening and the other for closing main inlet. Abstract of address delivered before Austrian Assn. of Engrs. & Architects.

Theory of. New Analytical Theory of Water Turbines. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 689-692, 1 fig. Formulas combining various elements of turbines. Translated from Technique Moderne.

HYDROELECTRIC PLANTS

Abitibi River. Twin Falls Development on Abitibi River, Harold L. Trotter. Can. Engr., vol. 39, no. 25, Dec. 16, 1920, pp. 605-609, 9 figs. New plant for Abitibi Power & Paper Co. to have five 6000-hp. vertical turbines. Concrete dam across river raises headwater 57 ft. Reinforced-concrete power house. Description of construction methods and plant.

Auxiliary Equipment. Efficiency of Installing Energy Accumulators of Small Output in Hydroelectric Central Stations (Sur l'efficiacité de l'adjonction de systèmes accumulateurs d'énergie même à bas rendement aux centrales hydrauliques), A. Della Riccia. Revue générale de l'électricité, vol. 8, no. 17, Oct. 23, 1920, pp. 555-564, 7 figs. Special reference is made to installation of a heat accumulator suggested by M. Del Proposto, which consists of a set of boilers heated by the flow of hot oil, in combination with ordinary water-tube boiler. Oil is heated electrically in special cylinder. Steam from system operates turbine directly coupled with generator.

Brazil. Development of Hydroelectric Plants. Commerce Reports, no. 43b, Nov. 24, 1920, p. 10. Developments in Brazil.

France. The Eget Plant of the French Southern Railway (L'usine d'Eget de la Compagnie des Chemins de Fer du Midi). M. Barbillion. Industrie Électrique, vol. 29, no. 678, Sept. 25, 1920, pp. 345-350, 7 figs. Details of conduits. (Concluded.)

The Hydroelectric Plants at Rioupéroux (L'usine de Rioupéroux), M. Barbillion. Industrie Électrique, vol. 29, no. 679, Oct. 10, 1920, pp. 363-370, 19 figs. Hydroelectric central station producing single-phase current at 8200 volt and three-phase current at 63,000 volt. Power is supplied to metallurgical industries in neighborhood.

Hydrographic Studies. Hydrographic Study Preliminary to Utilizing the Water Power of a Mountain Basin (Étude hydrographique et aménagement d'un bassin montagneux), G. Malforn. Électricien, vol. 36, no. 1262, Oct. 15, 1920, pp. 433-436, 3 figs. Plan for utilization of basin in Italian Alps. (To be continued.)

Ice Protection. Ice Protection for Hydroelectric Plant, John S. Carpenter. Power Plant Eng., vol. 24, no. 23, Dec. 1, 1920, pp. 1125-1126, 2 figs. Methods of deflecting ice jams.

Kerckhoff Development. Kerckhoff Power Development—A western Achievement, J. M. Buswell. Power, vol. 52, no. 24, Dec. 14, 1920, pp. 926-934, 14 figs. Project includes concrete, constant-angle arch dam across main San Joaquin River; 18 x 18 ft. unlined pressure tunnel 16,875 ft. long; steel triple-penstock line; reinforced-concrete power house, housing three 15,000-hp. vertical-shaft turbines to operate under head of 315 to 340 ft. and directly connected to 14,200-kva. vertical-shaft generators.

New Brunswick. Hydro-Electric Power Development in New Brunswick, C. O. Foss. Can. Engr., vol. 39, no. 23, Dec. 2, 1920, pp. 576-578. Two plants of 8000 hp. capacity each. Paper read before Eng. Inst. of Canada.

Norway. The Hydroelectric Plant at Vamma, Norway (L'usine hydroélectrique de Vamma (Norvège). Génie Civil, vol. 77, no. 21, Nov. 20, 1920, pp. 414-416, 3 figs. Total capacity will be 200,000 hp. Head varies from 25 to 27 m. and flow is about 220 cu. m. per sec.

Nova Scotia. Sheet Harbour Hydro-Electric Powers, Harold S. Johnston. Jl. Eng. Inst. Canada, vol. 3, no. 12, Dec. 1920, pp. 565-575, 4 figs. Schemes proposed with tables of run-off, etc.

Seattle, Wash. Seattle Building Large Municipal Hydro-Electric Development, C. F. Uhden. Eng. News-Rec., vol. 85, no 21, Nov. 18, 1920, pp. 994-996, 2 figs. Project for development of Upper Skagit River where ultimately about 500,000 hp. can be obtained.

South America. Survey of Power Plant Projects in South America. Power Plant Eng., vol. 24, no. 24, Dec. 15, 1920, pp. 1171-1173. Prepared by Guaranty Trust Co. of New York.

Surplus Water. Wasting Surplus Water at Hydroelectric Plants, L. W. Wyss. Power Plant-Eng., vol. 24, no. 23, Dec. 1, 1920, pp. 1126-1128, 3 figs. Description of various kinds of gates used to regulate overflow in hydroelectric stations.

Sweden. Utilizing Hydro-Electric Energy in Sweden. Elec. World, vol. 76, no. 24, Dec. 11, 1920, pp. 1167-1170, 2 figs. Experience with extensive high-tension system of Swedish Government. Method of grading station insulation and studies of lightning trouble. Plans for 200,000-volt transmission lines.

Switzerland. The Great Modern Hydroelectric Plants in Switzerland (Grandi impianti idroelectrici moderni in Isvizzera), Giovanni Rodio. Industria, vol. 34, no. 17, Sept. 15, 1920, pp. 425-431,

Utilization of Freshet Water. Utilizing Freshet Water for Power Generation, Clemens Herschel. Power, vol. 52, no. 22, Nov. 30, 1920, pp. 861-862, 1 fig. With properly designed venturi tube installed in discharge of hydraulic turbine power output can be increased maximum of 30 per cent by utilizing freshet water that would otherwise run to waste over dam.

HYDROPLANES

French. The French Hydroplanes at Antwerp (Les Hydroglisseurs Français a Anvers). Aéronautique, no 16, Sept. 30, 1920, pp. 152-154, 5 figs. Boats operated by aeroplane and propeller. Diagrams showing power required and resistance to traction.

I

ICE PLANTS

Electrically Driven. Electric Driven Raw Water Ice Plant, George B. Bright. Ice and Refrigeration, vol. 59, no. 6, Dec. 1920, pp. 246-248. Data and cost of operation.

Freezing Tanks. Ice Tank of New Design Gives Remarkable Results, C. Wilkie. Power, vol. 52, no. 21, Nov. 23, 1920, pp. 823-826, 8 figs. Ice tank is 114 ft. long, holding 856 cans, freezing 400-lb. blocks. Direct-expansion coils are in one end, flooded coils with horizontal accumulator in other end. 7 in. of agitation is produced by one propeller, 36 in. in diameter, at center of tank.

IGNITION

Battery Systems. A Compact Battery Ignition System. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1162-1163, 4 figs. System designed by Vital Paquit, Belgian engineer Arrangement combines usual battery ignition units into small assembly resembling magneto in appearance and method of connection with engine.

INDUSTRIAL MANAGEMENT

Exposed Records. The Influence of Exposed Records on Output, F. M. Lawson. Eng. & Indus. Management, vol. 4, no. 20, Nov. 11, 1920, pp. 615-617. Permanent advantages are said to be (1) there is less stock carried, which means shorter investment period and consequent saving in money; (2) a smaller staff is required owing to ease with which information can be obtained; and (3) there is less switching men off from one job to another, owing to ease with which accurate decisions can be made.

Inspection. How the Inspection Department Helps the Factory, George S. Radford. Industrial Management, vol. 60, no. 6, Dec. 1920, pp. 418-421. Coordination of inspection with cost, assembling, routing and productivity.

Machine Shops. Finds Efficiency Lacking in Many Shops, H. M. Fitz. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1609-1611. Inspection trip of 70 shops and factories revealed fact that large percentage has only partial or no system of management.

Opinion of Workers. What the Workers Think About Management—II, Albert Fry. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 437-440. Opinions from ironworkers, carpenters, inspectors, blacksmiths, machinists, patternmakers and others on individual responsibility, mental and physical tests and coöperation.

Organization Plan. Organization Plan that Typifies Modern Management, S. H. Bullard. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 441-444, 1 fig. Production system and organization plan of Bullard Machine Tool Co.

Production Method. Small-Quantity Production Methods, Earle Buckingham. Machy. (Lond.), vol. 17, no. 426, Nov. 25, 1920, pp. 213-215, 4 figs. Application of interchangeable manufacturing principles to methods employed when producing machines in limited quantities.

Routing Materials. Routing Considered as a Function of Up-to-Date Management—III, H. K. Hathaway. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 445-451, 12 figs. Method of routing assembled, multi-part mechanism.

Statistical Control. Making Statistics Talk—I, M. C. Rorty. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 394-398, 6 figs. Elements of statistical control. Application of statistical graphics to forecasting future trends.

Time Study. See TIME STUDY.

INDUSTRIAL RELATIONS

Business Organization of Labor. Labor as a Business, Not a Commodity—New Plan Proposed to Secure Industrial Peace, George H. Cushing. Manufacturers Rec., vol. 78, no. 21, Nov. 18, 1920, pp. 131-132. Suggests as basic solution for labor difficulty organization of labor on business basis. According to plan suggested capital would contract with labor for a certain amount of work to be done and would pay for it as a unit. Workmen would unite and sell their labor through representatives.

Closed Shop vs. Closed Shop Principles Paramount, James A. Emery. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1606-1608. Attitude and policy of labor unions during war. (To be continued.) Address delivered before National Founders' Association.

The Closed Union Shop Versus the Open Shop: Their Social and Economic Value Compared, Ernest F. Lloyd. Nat. Indus. Conference Board, no. 11,

Industrial Democracy. What Makes a Labor Policy Successful? Norman G. Shidle. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 970-973, 1 fig. Industrial relations policy of Greenfield Tap & Die Corporation.

New Zealand. Conciliation and Arbitration in New Zealand. Nat. Indus. Conference Board, no. 23, Dec. 1919, 46 pp. Features of New Zealand legislation, and its operation in practice.

Open Shop. The Last Stand of the Open Shop, Roy W. Hinds. Coal Age, vol. 18, no. 21, Nov. 18, 1920, pp. 1037-1040, 2 figs. Developments of strike in coal fields of southern West Virginia and Kentucky.

The Open Shop Fight is a Fight for American Independence—The Closed Shop un-American and Destructive of all Individual Independence. Manufacturers Rec., vol. 78, no. 21, Nov. 18, 1920, pp. 106-108. Progress of movement for open shop throughout the United States.

Works Councils. A Works Council Manual. Nat. Indus. Conference Board, no. 26, Feb. 1920, 32 pp. 4 figs. Procedure for establishing works council.

Works Councils in the United States. Nat. Indus. Conference Board, no. 21, Oct. 1919, 135 pp. Results of studies of works councils in 225 American industrial establishments. Information, is brought down to August 1, 1919.

INDUSTRIAL TRUCKS

Transveyor. The Cowan Transveyor. Eng. and Indus. Management, vol. 4, no. 19, Nov. 4, 1920, pp. 598-600, 3 figs. Type of industrial truck for interdepartmental conveying, used in various British works.

INDUSTRY

Germany. Industrial Technique in Germany During the War (La technique et l'industrie de. l'Allemagne pendant la guerre), M. C. Lemaire. Annales des travaux publics de Belgique, vol. 21, no. 12, Oct. 1920, pp. 707-779. Developments of substitutes for raw material. Recuperation of industrial wastes. Experiments of riveting processes. Briquetting of coke. Production of lignite.

Problems of Labor and Industry in Germany. Nat. Indus. Conference Board, no. 15, Sept. 1920, 65 pp. Open shop principle has been recognized as basis for all relations between employer and employee, in spite of the fact that labor is almost completely organized and the Government has been encouraging organization among employers and employees.

INSULATORS, HEAT

Diatomaceous Earth. Diatomaceous Earth, Norris Goodwin. Chem. & Metallurgical Eng., vol. 23, no. 24, Dec. 15, 1920, pp. 1158-1160. Origin and uses. Bibliography of articles in technical magazines and list of patents bearing on use of diatomaceous earth as heat insulant and building material.

Hot-Air-Pipe Coverings. The Insulating Value of Various Coverings for Hot Air Pipes as Determined by Tests at the University of Illinois. Am. Architect, vol. 118, no. 2343, Nov. 17, 1920, pp. 648-652, 4 figs. It is concluded that use of thin sheets of asbestos paper on bright tin heat pipes result in waste of heat. Uncovered bright tin pipes were found to be more efficient carriers of heated air. Accumulation of dust and dirt on pipes does not greatly alter amount of loss. It is advised that unless insulation excels uncovered bright tin in heat insulation properties it should not be used.

INTERNAL-COMBUSTION ENGINES

Developments. Improvements in the Field of Internal-Combustion Engines (Neuerungen auf dem Gebiet der Verbrennungskraftmaschinen). Wirtschafts-Motor, no. 10, Oct. 1920, pp. 18-20, 8 figs. Details of recently patented engines and auxiliary devices.

Fuel Combustion. The Combustion of Fuels in the Internal-Combustion Engine, Thomas Midgley, Jr. Jl. Soc. Automotive Engr., vol. 7, no. 6, Dec. 1920, pp. 489-497 and (discussion) pp. 497-499, 18 figs. Recently developed optical gas-engine indicator. Indicator cards obtained with different fluids. Theory of knock and of knock suppressors.

Ignition. See IGNITION.

Lubrication. Castor Oil (L'huile de ricin), M. Martinot-Lagarde. Aéronautique, vol. 2, no. 17, Oct. 1920, pp. 187-190. Its value as lubricant for internal-combustion engines.

Water Injection. Water Injection in Gas and Oil Engines. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 492-494. Consideration of application and effect.

[See also AEROPLANE ENGINES; AUTOMBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; HEAVY-OIL ENGINES.]

IRON

Electrodeposited. The Industrial Future of Electro-Deposited Iron, W. E. Hughes. Elecn., vol. 85, no. 2216, Nov. 1920, pp. 530-532, 4 figs. Developments in Europe.

Plates. Standard Specifications for Wrought-Iron Plates. U. S. Dept. Commerce, Bur. Foreign and Domestic Commerce, Industrial Standards, no. 27, 1918, 13 pp. Adopted by American Society for Testing Materials.

IRON ORE

World Supply. The Iron Ore Supplies of the World, F. H. Hatch. Geol. Mag., vol. 57, no. 677, Nov. 1920, pp. 504–517. Statistics by countries. From Lond. Times Trade Supp.

K

KINEMATICS

Acceleration Determinations. Acceleration Determinations—I, Henry N. Bonis. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 977–981, 3 figs. General solution for Whitwork quick-return motion as generally applied to shaper mechanism.

Rolling Couples. Kinematic Study of Rolling Couples (Étude cinématique des couples de roulement), P. Massot. Technique Moderne, vol. 12, no. 4, April 1920, pp. 161–169, 20 figs. Application to design of machines of principles and formulas developed in previous installments. (Concluded.)

L

LABOR

Conservation of. Conservation of Labor, L. W. Wallace. Am. Mach., vol. 53, no. 24, Dec. 9, 1920, pp. 1104–1106. Address delivered at first meeting of American Engineering Council of Federated American Engineering Societies.

Hours of Work. Unwarranted Conclusions Regarding the Eight-Hour and Ten-Hour Workday. Nat. Indus. Conference Board, no. 14, Aug. 1920, 21 pp. Critical review of "Comparison of an Eight-Hour Plant and a Ten-Hour Plant," United States Public Health Bul. no. 106. It is claimed that conclusions presented therein are unscientific and unjustified by data offered, because the two plants from which data were obtained are not fairly comparable and basis of experience is too small to justify complete conclusions applicable to industry in general.

Strikes. See STRIKES.

Two-Shift vs. Three-Shift Day. The Development of the Technique of Changing from the Two-Shift to the Three-Shift Day in a Continuous Process, Robert B. Wolf. Jl. Engrs. Club of Phila., vol. 37–12, no. 192, Dec. 1920, pp. 463–469 and (discussion) pp. 469–478, 6 figs. Results obtained in three plants where change was made are illustrated and interpreted and suggestions are given in regard to change in management policy which should accompany change to three shifts.

LABOR TURNOVER

New York City. Labor Turnover in New York City. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 933–935. Statistics

LABORATORIES

Aerodynamic. The New Testing Apparatus at the Airdynamic Institute at Saint-Cyr (Les Nouveaux Apparels D'Essais de l'Institut Aérotechnique de Saint-Cyr. Nature (Paris), no. 2426, Oct. 2, 1920, pp. 213–219, 10 figs. Airdynamic balance, wind tunnel and apparatus for testing propellers.

LAPPING

Modern Practice. Modern Lapping Practice. Machy. (Lond.), vol. 17 no. 423, Nov. 4, 1920, 129–137, 19 figs. Developments in lapping practice, including abrasives used in lap-charging methods, lapping thread gages, snap gages, measuring wires, flat surfaces, ring gages, die-casting dies and T-slots.

LATHES

Automatic. Recent Machine Tool Developments—XVII, Joseph Horner. Eng. vol. 110, no. 2864, Nov. 19, 1920, pp. 660–664, 10 figs. Types of automatic lathes.

Double-Carriage. Hamilton Double Carriage Production Lathe, J. V. Hunter. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1021–1022, 3 figs. Lathe equipped with two independent carriages, recently placed on market by Hamilton Machine Co., Hamilton O.

Turret. Efficient Automatic Machine Tool Records, F. Scriber. Can. Machy., vol. 24, no. 24, Dec. 9, 1920, pp. 513–514, 6 figs. Skeleton set-ups on turret chucking lathe are explained.

Using Turret Lathes in Railroad Shops, J. H. Moore. Can. Machy., vol. 24, no. 21, Nov. 18, 1920, pp. 447–451, 7 figs. Examples of their application to various kinds of work.

Universal Relieving Type. A New Universal Relieving Lathe. Machy. (Lond.), vol. 17, no. 426, Nov. 25, 1920, pp. 217–220, 5 figs. Final drive is by means of worm gearing. Built by Ward, Haggas & Smith, England.

LIGHTING

Factories. The Lighting of Shoe Factories, A. L. Powell and J. H. Kurlander. Trans. Illuminating Eng. Soc., vol. 15, on. 8, Nov. 20, 1920, pp. 603–630, 18 figs. Analyzes lighting requirements for individual machines and specifies what arrangement of illuminating apparatus best meets these needs.

Industrial. Some Out of the Ordinary Applications of Industrial Lighting, Samuel G. Hibben. Trans. Illuminating Eng. Soc., vol. 15, no. 8, Nov. 20, 1920, pp. 591–598 and (discussion) pp. 598–602, 17 figs. Recommendations in regard to method of mounting lamps.

New Incandescent Method. A New Incandescent Lighting Method (Ein neues Verfahren zur Glühlichtbeleuchtung). K. Bube. Zeit. für Beleuchtungswesen, vol. 26, nos. 15–16, Aug. 15–31, 1920, 116–117. Describes new patented method, in which a glower is brought into contact with solid fuel in the form of a paraffin core so that it absorbs the melting fuel and carries the flame. Points out advantages and economy of method.

LOCOMOTIVES

Articulated. Recent Types of Articulated Locomotives (Types récents de locomotives articulées), Lionel Wiener. Revue générale des Chemins de Fer, vol. 39, no. 3, Mar. 1920, pp. 155–210, 16 figs. European and American developments.

Australian. Standard Type Locomotives, New South Wales Government Railways Ry. Gaz., vol. 33, no. 20, Nov. 12, 1920, pp. 645–646, 2 figs. Express engine is of 4–6–0 type and freight engine of 2–8–0 type, both with outside cylinders.

Austrian. Four-Cylinder Compound Locomotive, with Six Coupled Driving Wheels and Superheaters, of the Württemberg State Railways (La locomotiva A 6 assi accoppiati (I–VI–O) A 4 cilindri compound, con surpriscaldamento del vapore, delle ferrovie dello stato del Württemberg. Industria, vol. 34, no. 19, Oct. 15, 1920, pp. 476–480, 6 figs.

Driving Box Shoes. Lining Driving Box Shoes and Wedges, J. McAllister. Ry. Mech. Engr., vol. 94, no. 12, Dec. 1920, pp. 788–791, 1 fig. Shoe and wedge layout. Pedestal jaw grinding machine.

Inspection. Report of the Bureau of Locomotive Inspection. Ry. Age, vol. 69, no. 25, Dec. 17, 1920, pp. 1071–1073, 1 fig. Outstanding feature of report of chief inspector of locomotives to Interstate Commerce Commission for fiscal year ending June 30, 1920, is increase in number of accidents and casualties resulting from failures of parts of locomotives and tenders. Application of water columns and other devices advocated.

Mikado. Mikado Type Locomotive for C.M. & St.P. Ry. Ry. Rev., vol. 67, no. 20, Nov. 13, 1920, pp. 729–731, 4 figs. Design is characterized by straightforwardness and follows closely details for light Mikado-type engines prepared by mechanical standards committee of United States Railroad Administration.

Mine. Flywheel Motor-Generator for the Drive of Mine Locomotives in Grängesberg (En svänghjulsomformare för gruvlokomotivdriften i Grängesberg), Gustaf Hjertén. Teknisk Tidskrift (Kemi & Bergsvetenskap), vol. 50, no. 9, Sept. 22, 1920, pp. 186–192, 14 figs. 225-hp. induction motor directly coupled with a d.c. dynamo, which is connected with the separately mounted flywheel having diameter of 2100 mm. and weighing 4800 kg. Formulas are presented for calculation of weight of wheel. Calculation of the losses in motor-generator and friction losses of flywheel.

Repairing. The Zwilling Staybolt (Der Stehbolzen "Zwilling"), H. de Neuf. Annalen für Gewerbe u. Bauwesen, vol. 87, no. 5, Sept. 1, 1920, pp. 35–38, 5 figs. Economic advantages of new type are said to be that it (1) reduces time required to repair locomotives, (2) increases life of locomotives, (3) diminishes work in shop, (4) affords possibility, with equipment and personnel of existing workshops, to reconstruct many more locomotives than heretofore, and (5) greatly reduces number of bolts required because of its durability.

Steam vs. Electric. Relative Advantages of Modern Steam and Electric Locomotives. Jl. Am. Inst. Elec. Engrs., vol. 39, no. 12, Dec. 1920, pp. 1044–1048. Comparison of two types, based on actual method of operation. Discussion at joint meeting of New York Sections of American Institute of Electric Engineers and Am.Soc.M.E.

Steam vs. Electric Locomotives, John E. Muhlfeld, F. H. Shepard, A. H. Armstrong. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 680–687 and (discussion) pp. 687–688 and p. 726, 1 fig. Comparison in regard to initial and maintenance costs, reliability of service, efficiency of operation, and suitability of design. Data obtained in actual service of both types are presented and discussed.

Superheater. Steam Distribution with Superheated Steam. Ry. and Locomotive Eng., vol. 33, no. 12, Dec. 1920, pp. 368–370. Experiments made by French engineers in use of rotating valves. Translated from Génie Civil.

Technique. The Technique of Steam Locomotives (La technique des locomotives a vapeur), P. Drosne. Technique Moderne, vol. 12, no. 4, April 1920, pp. 145–150, 8 figs. Dynamic studies of steam locomotives. Graph comparing resistance curve obtained by calculation and by actual measurements of Pacific, Atlantic and 0–4–0 types.

LUBRICANTS

Requirements for. Anisotropic Fusion—Ideal Lubricants (Fusion anisotrope-lubréfiants idéaux), Marcel Brillouin. Journal de Physique, vol. 6, no. 2, Aug. 1920, pp. 33–38. Technical. It is held that unilateral or bilateral fluidity, rather than isotropic constitution, is ideal requirement for lubricant.

M

MACHINE TOOLS

Electric Equipment, Standardization of. Standardization of Electrical Equipment on Machine Tools. Iron Age, vol. 106, no. 21, Nov. 18, 1920, pp. 1322–1324 and pp. 1369–1371. Advantages of individual drive. Suggestions in regard to standardization.

Frame Design. The Stiffening of Machine-Tool Frames (Betrachtung über die Versteifung von Werkzeugmaschinenbetten), Ernst Peters. Betrieb, vol. 3, no. 2, Oct. 25, 1920, pp. 38–39, 3 figs. It is claimed that in machine-tool frames up to present time the twisting stress has not received sufficient consideration, and it is this that causes perceptible deformations and vibrations. Describes the zigzag rib constructed by author which, without increasing weight, is said to reduce the elastic deformation to fraction of its former value.

Glasgow Exhibition. The Glasgow Shipbuilding, Engineering, and Electrical Exhibition. Eng. Production, vol. 1, no. 13, Dec. 1920, pp. 475–476. Survey of most important tool and machine-tool exhibits.

Lead Screws. Precision Lead Screws. Machy. (Lond.), vol. 17, no. 423, Nov. 4, 1920, pp. 125–128, 5 figs. Grinding and inspection methods of Drummond Bros., Guildford, England.

Sawmill Machinery. Building Saw Mill Machinery, Fred H. Colvin. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1030–1032, 7 figs. Machine-tool equipment in typical plants in Pacific Coast States.

Small Machines. Small Machines for Building Optical Instruments, J. V. Hunter. Am. Mach., vol. 53, no. 23, Dec. 2, 1920, pp. 1045–1047, 6 figs. Miniature machines for use in manufacture of delicate instruments.

MACHINERY

Foundations. Foundations for Machinery, N. W. Akimoff. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 671–672 and p. 699, 3 figs. Theory of causes leading to vibrations of machinery. Means for localizing expected vibration and of controlling resulting periods.

MALLEABLE IRON

American Industry. American Malleable Cast Iron—I, H. A. Schwartz. Iron Trade Rev., vol. 67, no. 23, Dec. 2, 1920, pp. 1536–1540, 4 figs. Series of related articles dealing with development of industry. Modern methods of manufacture, metallurgical principles involved and properties of American malleable iron.

Research. See RESEARCH, Malleable Iron.

MARINE BOILERS

Manufacture. Conference on the Unification of Rules for the Construction of Marine Boilers and Steam Pipes. Steamship, vol. 32, no. 378, Dec. 1920, pp. 153–155, 3 figs. Standard conditions for design and construction of marine boilers issued by British Board of Trade, 1920. (To be continued.)

MATERIALS

Substitutes for Various. German War Substitutes, A. Belter. Sci. Am Monthly, vol. 2, no. 4, Dec. 1920, pp. 333–336. Substitutes for metals, gasoline and benzine, lubricants and rubber. Translated from Industrie Chimique.

Testing. See NOTCHED-BAR TESTS.

MILLING

British Practice. Milling Operations on Herbert Lathes, I. W. Chubb. Am. Mach., vol. 53, no. 21, Nov. 18, 1920, pp. 945–950, 22 figs. Practice in British shops.

Thread. The Side Angle of Milled Threads (Ueber Flankenwinkel gefräster Gewinde), H. Friedrich. Werkstattstechnik, vol. 14, no. 17, Sept. 1, 1920, pp. 464–468, 16 figs. Experiments carried out in the machining of long screw spindles with square thread on the thread-milling machines of the Schuttoff & Bässler Corp'n, Chemnitz, show that with the calculated side angles correct a very accurate thread can be produced, but if side angle is in the slightest degree smaller than calculated, imperfections result.

MILLING CUTTERS

Helical. Making "Curvex" Milling Cutters. Machy. (Lond.), vol. 17, no. 425, Nov. 18, 1920, pp. 188–196, 17 figs. Methods and equipment employed by Pratt & Whitney Co. in manufacture of formed milling cutters with helical flutes.

MILLING MACHINES

Continuous. Continuous Miller Does Facing Work. Iron Trade Rev., vol. 67, no. 23, Dec. 2, 1920, pp. 1548–1549, 2 figs. Continuous type milling machine for facing to length crankshafts, camshafts and work of similar character. Built by Newton Machine Tool Works, Philadelphia.

Tables. Making Milling Machine Tables, Leroy M. Sherwin. Foundry, vol. 48, no. 23, Dec. 1, 1920, pp. 953–956, 7 figs. Molding and melting practices. Paper read before Am. Foundrymen's Assn.

MOLDING METHODS

Flasks for Locomotive Frames. How a Long Steel Flask is Assembled, Geo. W. Childs. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 923–925, 5 figs. Method of assembling sections of flasks used in molding locomotive engine frames.

MOTOR PLOWS

British-Made. Improved Mechanical Ploughing Appliances. Engr., vol. 130, no. 3383, Oct. 29, 1920, pp. 428 and 434–435, 6 figs. Motor cable plowing outfit manufactured by John Fowler & Co., Leeds, England.

MOTOR-TRUCK TRAFFIC

Legislation. The Automobile Should Be Major Factor in Highway Traffic. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920, pp. 1179–1180. Plea that legislation be directed toward making traffic safe for vehicles.

MOTOR TRUCKS

Body Standardization. Now is the Time for Standardization in Truck Body Measurements, J. Edward Schipper. Automotive Industries, vol. 43, no. 20,

ENGINEERING INDEX (Continued)

Nov. 11, 1920, pp. 962–963, 2 figs. Advantages of standardization. It is said that in addition to making lower price, it will be possible to make more competent and stable body building industry.

British Design. British Truck Show Reveals New Tendencies in Design, M. W. Bourdon. Automotive Industries, vol. 43, no. 24, Dec. 9, 1920. pp. 1154–1161, 16 figs. Decided changes in practice are noted since exhibition in 1913. Majority of trucks use overhead worm drive and pressed-steel frames are employed in three-fourths of models. T-head engine is being replaced by L-head type.

German. German Mechanical Transport Vehicles. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 466–477, 35 figs. Notes on collection of captured vehicles at Aldershot, England.

Radiators and Cooling Fans on the German War Trucks, Karl F. Walker. Automotive Industries, vol. 43, no. 20, Nov. 11, 1920, pp. 960–961, 4 figs. Based on reports of examinations made by Motor Transport Corps of U. S. Army. Practically all radiators of German war trucks contained sheet steel shell with ribbon type of core.

Olympia Show. The Commercial Motor Exhibition. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 440–444, 11 figs. Trend of design in heavy vehicles as shown in exhibition at Olympia Show.

Specifications. Internal-Combustion Truck Specifications. Power Wagon, vol. 25, no. 193, Dec. 1920, pp. 42–59. Principle characteristics of 504 makes.

Tipping Gears. Tipping Gears for Lorries—II. Colliery Guardian, vol. 120, vo. 3122, Oct. 29, 1920, pp. 1230–1232, 10 figs. British design.

MOTORCYCLES

German Designs. German Motorcycles and Auxiliary Motors for Cycles (Deutsche Fahrradhilfsmotoren und Motorfahrräder), H. Bernhard. Wirtschafts-Motor, no. 10, Oct. 1920, pp. 5–9, 11 figs. Details of various German construction types, including those with motors above and in front wheel, above and in back wheel, within cycle frame, with motor on an extra wheel, etc. Distinction is made between motor cycles and auxiliary motors attachable to any cycle.

Springing. The Springing of Motor Cycles, C. H. Savage. Automobile Engr., vol. 10, no. 144, Nov. 1920, pp. 457–462, 17 figs. Discussion of experiments made in France. From results obtained suggestions are made in regard to position of springs and their dimensions.

N

NICKEL-CHROMIUM ALLOYS

Types. Nickel-Chromium Alloys, Leon O. Hart. Min. and Metallurgy, no. 168, Dec. 1920, p. 39. Properties of various types used. (Abstract.)

NOTCHED-BAR TESTS

Impact Tests. Experimental Study of Impact Tests on Notched Bars (Étude experimentale sur les essais au choc des barreaux entaillés), André Cornu-Thenard. Revue de Métallurgie, vol. 17, no. 9, Sept. 1920, pp. 584–614, 40 figs. Influence of speed of impact on results of tests. (Continuation of serial.)

NOZZLES

Coefficient of Discharge. The Coefficient of Discharge of Elementary Nozzles, A. A. Jude. Jl. Instn. Mech. Engrs., no. 8, Dec. 1920, pp. 977–1017 and (discussion) pp. 1018–1037, 10 figs. Discusses potentialities of series apparatus and clears up unsatisfactory features relating particularly to variability of coefficient over supercritical range.

Theory of. The Theory of Steam-Turbine Nozzles (Zur Theorie der Düsen von Dampfturbinen), Aug. Wewerka. Zeit. für das gesamte Turbinenwesen, vol. 17, nos. 23, 24 and 25, Aug. 20, 30 and Sept. 10, 1920, pp. 265–268, 277–280 and 294–297, 15 figs. Deals with following problems: (1) Change in values of condition of flowing medium when flowing through nozzle; (2) weight or volume of steam flowing through a given nozzle; and (3) maximum final velocity under different steam conditions in front and back of nozzle. Gives most important equations for flow in nozzles, and it is shown how curves of normal and inclined nozzles with reduction of back-pressure can be derived, and graphic solutions for development of the curves are given.

O

OIL FUEL

Burner for. New System for Burning Fuel Oil, Charles W. Geiger. Power Plant Eng., vol 24, no. 24, Dec. 15, 1920, p. 1167, 1 fig. Burner in which air is introduced in burning oil.

Burning in Steam Cars. Liquid Fuel on Steam Waggons. Motor Traction, vol. 31, no. 819, Nov. 8, 1920, pp. 527–528, 3 figs. Application of Scarab liquid fuel system to Foden steam car.

Ships. Fuel Oil for Steamers, C. H. Peabody. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 997–998. Grades of oil available for merchant vessels and their use.

Recent Advance in Oil Burning, Ernest H. Peabody. Twenty-eighth General Meeting, Soc. Naval Architects & Mar. Engrs., Nov. 11 and 12, 1920, no. 9, 11 pp., 8 figs. Progress in oil burning in ships of U. S. Navy. Graphs showing present efficiency obtained in boiler and furnace are included.

ORDNANCE

U. S. Navy Plant. Armor-Plate and Gun-Forging Plant of U. S. Navy, Roger M. Freeman. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 657–668, and p. 726, 15 figs. Attention is called to arrangements of stockyard alongside open-hearth building, 30-ton electric furnaces for duplexing, electric traveling cranes to carry 400,000-lb. ingots, original "H" type of forge shop and treatment plant combined, 14,000-ton steam-intensified hydraulic press, twenty 15-ft. wide Carbottom furnaces, machine shop with three 106-ft. wide aisles and gun-treatment building, high portion of which contains 75-ton crane of 104-ft. span on rails 165 ft. above floor level.

OXY-ACETYLENE CUTTING

Cast Iron. Cast Iron Cutting with Oxweld Blowpipe. Acetylene Jl., vol. 22, no. 6, Dec. 1920, pp. 318–322, 8 figs. Procedure.

Cutting Cast Iron with the Oxy-Acetylene Torch, Alfred S. Kinsey. Welding Engr., vol. 5, no. 11, Nov. 1920, pp. 34 and 36–37, 4 figs. Following points are emphasized: Cast iron can be "cut" by combined melting-oxidizing action of oxy-acetylene torch; cutting of cast iron, even though rather roughly done, will be of fine advantage to shop practice in several ways; special cutting torch is unnecessary provided one is used which operates with excess acetylene, etc.

OXY-ACETYLENE WELDING

School for. Michigan State Auto School's Special Welding and Brazing Course. Acetylene Jl., vol 22, no. 6, Dec. 1920, pp 315–317, 4 figs. Methods of instruction at oxy-acetylene welding school.

OXYGEN CUTTING

Jet-Cutting Machine. The Godfrey Jet-Cutting Machine. Machy. (Lond.), vol. 17, no. 425, Nov. 18, 1920, pp. 185–187, 4 figs. Machine tool using jet of oxygen as cutting medium. Manufactured by Godfrey Engineering Works, England.

P

PAPER MANUFACTURE

Pope Patent. A Description of the Pope Patent. Paper, vol. 27, no. 10, Nov. 10, 1920, pp. 28–30, 8 figs. Invention relates to means for winding web of paper produced by paper-making machine onto winding-roll.

PARACHUTES

Postal. Postal Parachutes (Les parachutes posteax), L. P. Frantzen. Aerophile, vol. 28, nos. 17–18, Sept. 1–15, 1920, pp. 280–282, 10 figs. Models developed in England, France and United States.

Release. The Van Meter Parachute Release. Aviation, vol. 9, no. 11, Nov. 29, 1920, pp. 344–345, 2 figs. Release is automatic in action after release rod is pushed and in addition incorporates many safety features in its constructioo. It is applicable to all open cockpit machines. Jumper is lifted from seat and carried clear of machine.

PATTERNMAKING

Shops. Rehabilitate Shop in Record Time. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp 897–901, 7 figs. Organization and equipment of patternmaking shop of Bryan Pattern & Machine Co., Bryan, Ohio.

PISTON RINGS

Design. Piston-Rings, L. G. Nilson. Jl. Soc. Automotive Engrs., vol. 7, no. 6, Dec. 1920, pp. 525–531 and (discussion) pp. 531–536, 22 figs. Survey of developments in design. Specifications for material for piston rings.

PLANERS

Sellers 16-ft. The Sellers 16-ft. Planer. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 973–976, 3 figs. Planer weighs nearly one-half million pounds and was recently completed by William Sellers & Co., for large shipbuilding company.

POWER TRANSMISSION

Sonic Waves. Transmission of Energy by Vibrations of Liquids in Conduits (Sur la transmission de l'énergie par les vibrations de liquides dans les conduits), C. Camichel, D. Eydoux and A. Foch. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 17, Oct. 26, 1920, pp. 783–786. Technical study of power transmission by Constantinesco system of sonic waves.

PRESSES

Briquetting Cast-Iron Turnings. The "Boreas" Briquetting Press for Cast-Iron Turnings. Eng., vol. 110, no. 2863, Nov. 12, 1920, p. 638, 3 figs. Made in Copenhagen by Danish Machine Co. Finished briquets are in form of truncated cones and each weighs about $6^1/_2$ lb.

Safety Device. Making the Punch Press Safe and Efficient, Norman G. Shidle. Automotive Industries, vol. 43, no. 23, Dec. 2, 1920, pp. 1118–1120 and 1133. Examples of safety devices used.

Tools. Press Tools for Caterpillar Parts, Frank A. Stanley. Am. Mach., vol. 53, no. 22, Nov 25, 1920, pp. 987–988, 5 figs. Processes in manufacture of articles made from sheet metal or tubing.

PROFIT SHARING

Experience. Practical Experience with Profit Sharing in Industrial Establishments. Nat. Indus. Conference Board, no. 29, June 1920, 88 pp. Causes and circumstances which make some profit-sharing plans fail and others succeed.

Lyons Congress. Profit Sharing Recommended at Congress of Lyons (La participation aux bénéfices.—Le congrès de Lyon), F. Bayle. Revue générale de l'Électricité, vol. 8, no. 21, Nov. 20, 1920, pp. 735–739. Discussion of profit sharing as means for remedying industrial situation at Congress held at Lyon, October 1–2, 1920.

PULVERIZED COAL

Combustion. Pulverised Coal as Fuel. Lawford H. Fry. Eng., vol. 110, no. 2863, Nov. 12, 1920, pp. 628–631, 5 figs. Principles involved in combustion.

Grindle Burning System. For Burning Powdered Coal. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1614–1615, 2 figs. Grindle equipment for burning powdered coal, manufactured by Combustion Economy Corporation, Chicago.

PUNCHING MACHINES

Tooling Arrangement. Two Light Punching-Machine Jobs, John Simon. Am. Mach., 53, no. 24, Dec. 9, 1920, pp. 1075–1077, 7 figs. Tooling practice in Austrian Machine Shop.

R

RADIOMETALLOGRAPHY

Methods. Examination of Materials by X-Rays (Emploi des rayons X pour l'examen des materiaux). Ouvrier Moderne, vol. 3, no. 8, Nov. 1920, pp. 309–314, 11 figs. Apparatus employed and results obtained.

RAILS

Electrical Properties. Behavior of Rails as Conductors of Electricity (Sul comportamento delle rotaie impiegate come conduttori di corrente elettrica), Lino Sandonnini. Rivista Tecnica delle Ferrovie Italiane, vol. 18, no. 3, Sept. 15, 1920, pp. 94–103, 13 figs. Laboratory determinations of resistence, coefficient of self-inductions, and other electrical properties of rails.

Failures. Decrease in Rail Failures Confirmed by Latest Statistics. Eng. News-Rec., vol. 85, no. 23, Dec. 2, 1920, p. 1071, 1 fig. Statistics of rail failures for principal carriers.

Wheel Pressures and Steel Rail Failures. Iron Age, vol. 106, no. 22, Nov. 25, 1920, pp. 1399–1400. Report of Committee on Safety of Railroad Operation to convention of National Association of Railway and Utilities Commissioners. Heat treatment suggested as remedy for failures.

Sink-Head vs. Ordinary Ingots. Steel Rails from Sink-Head and Ordinary Rail Ingots—III, George K. Burgess. Chem and Metallurgical Eng., vol. 23, no. 21, Nov. 24, 1920, pp. 1017–1022, 10 figs. Physical tests, metallographical examinations and chemical surveys. Comparison rails performed much better under drop test, and showed less abrasion under service tests.

RAILWAY ELECTRIFICATION

France. French Railways Electrifications—I. Elec. Ry. & Tramway Jl., vol. 43, no. 1055, Dec. 10, 1920, pp. 280–282. Translation of report issued by Ministry of Public Works. (To be continued.)

Holland. Electrification in the Netherlands (L'électrification des Pays-Bas), J.-C. Van Staveren. Vie Technique et Industrielle, vol. 1, no. 9, June 1920, pp. 204–206, 1 fig. Résumé of report of high tension committee appointed by association of directors of electric companies in the Netherlands.

Switzerland. Railway Electrification of the Erstfeld-Bellinzone Railway (Electrification de la ligne Erstfeld-Bellinzone). Bulletin Technique de la Suisse Romande, vol. 46, no. 21, Oct. 16, 1920, pp. 241–246, 5 figs. General description of works with notes on electric locomotives used.

The Electrification of the Gothard Railway. Ry. Gaz., vol. 33, no. 21, Nov. 19, 1920, pp. 668–670, 3 figs. Line is $139^1/_2$ miles long.

RAILWAY OPERATION

Emergency Car Service. Annual Report of Interstate Commerce Commission. Ry. Age, vol. 69, no. 24, Dec. 10, 1920, pp. 1019–1023. Review of year's activities under new law, including exercise of emergency car-service powers.

Payment of Wages. The Payment of Wages by Divisional Paymasters, T. W. Mathews. Ry. Age, vol. 69, no. 25, Dec. 17, 1920, pp. 1061–1064, 5 figs. Prompt and efficient payments effected on Seaboard Air Line by use of new check system.

RAILWAY REPAIR SHOPS

Chile. The New Railroad Shops at San Bernardo, Chile, Carlos Valenzuela Cruchaga. Am. Mach., vol. 53, no. 22, Nov. 25, 1920, pp. 982–986, 8 figs. Shops and equipment for repairing rolling stock of trunk line railway. Translated fron Ingenieria Internacional.

Great Northern Railway. Car Repair Shops for the Great Northern Ry., P. P. Barthelemy. Ry. Rev., vol. 67, no. 20, Nov. 13, 1920, pp. 725–726, 3 figs. Standard type of frame construction, car repair shed.

RAILWAY SIGNALING

Angereau System. Repetition of Signals on the Locomotive (Répétition des signaux sur les locomotives), F. Limon and C. Lebaupin. Annales des Mines, vol. 10, no. 9, 1920, pp. 245–256, 1 fig. Angereau radio-telegraphic system, employed by French railways, for repetition of signals on locomotive.

Automatic Block. Passenger Terminal Facilities at Richmond, Va., C. J. Kelloway. Ry. Signal Engr., vol. 13, no. 12, Dec. 1920, pp. 490–494, 4 figs. Interlocking and automatic block signaling system.

RILEY UNDERFEED STOKERS — MURPHY AUTOMATIC FURNACES

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ENGINEERING INDEX (Continued)

Three-Position Automatic System. The Signaling of the Ealing & Shepherd's Bush Railway. Ry. Gaz., vol. 33, no. 18, Oct. 29, 1920, pp. 571–577, 13 figs. Installation of three-position automatic signaling system, including special features with regard to control and working of signals and operation and detection of points.

RAILWAY TRACK

Construction. On the Question of the Construction of the Road Bed and of the Track (Subjected for Discussion at the Ninth Congress of the International Railway Association), Mr. Henry and Mr. Candelier. Bul. Int. Ry. Assn., vol. 2, no. 10, Oct. 1920, pp. 639–664, 20 figs. Based on replies to questionnaire sent out to railway companies in Belgium, Bulgaria, Spain, France, Protugal and Switzerland. Questions referred to deformation noticed in track, amount of traffic carried, measures adopted and results obtained.

Design. Railway Track Design. Ry. Gaz., vol. 33, no. 20, Nov. 12, 1920, pp. 637 and 644. Compares bull-head with flat-bottom track, and suggests that advantages of latter justify its adoption in England.

Standardizing Work. Methods of Standardizing Track Work, Earl Stimson. Ry. Rev., vol. 67, no. 22, Nov. 27, 1920, pp. 813–816. Experience of Baltimore & Ohio Railroad.

RAILWAYS

Equipment Performance. A Remedy for Our Transportation Ills, O. W. Stiles. Freight Handling & Terminal Eng., vol. 6, no. 8, Aug. 1920, pp. 291–294. Organization of equipment performance as means for increasing service.

Interstate Commerce Commission. Annual Report of Interstate Commerce Commission. Ry. Age, vol. 69, no. 25, Dec. 17, 1920, pp. 1075–1078. Review of year's activities under new law, with references to work of several bureaus.

REDUCTION GEARS

Design. Propelling Machinery for the New Cunarders. Shipbuilding & Shipping Rec., vol. 16, no. 22, Nov. 25, 1920, pp. 631–633, 4 figs. Double-reduction geared turbines for "Scythia," "Laconia" and other vessels.

REFRIGERATING PLANTS

Fish Storage. Plant for Refrigerating Fish at Lorient, France (Le frigorifique à poissons de Lorient, Morbihan), M. Verrière and M. Tayon. Génie Civil, vol. 77, no. 13, Sept. 25, 1920, pp. 245–250, 16 figs. partly on supp. plate. Data: Storage capacity, 2000 tons of fish; ice-making capacity, 120 tons of ice per day.

RESEARCH

Heating and Ventilating. Heating and Ventilating Research Work. Domestic Eng. (Lond.), vol. 40, no. 23, Nov. 1920, pp. 167–168. Investigations carried out for Manchester Corporation Air Pollution Advisory Board. (Abstract.)

Liquid Fuels. The Proposed Research Association for Liquid Fuels. Steamship, vol. 32, no. 377, Nov. 1920, pp. 122–126. Suggestions in regard to general scheme of research association. Address delivered before Diesel Engine Users' Association.

Malleable Iron. British Grey and Malleable Cast-Iron Research Association. Foundry Trade Jl., vol. 22, no. 227, Nov. 1920, pp. 839–846. Account of inaugural meeting held at Birmingham, England, on Sept. 30, 1920.

Steel Research Committee. Notes on the Report of the Steel Research Committee, J. H. S. Dickenson. Automobile Engr., vol. 10, no. 145, Dec. 1920, pp. 495–501, 7 figs. Committee was founded in 1916 jointly by Institution of Automobile Engineers and Society of Motor Manufacturers and Traders, to establish mechanical properties of ten standard automobile steels scheduled in B.E.S.A. Report No. 75.

RIVETED JOINTS

Stresses in. Determining True Net Sections of Riveted Tension Members by Diagrams. Can. Engr., vol. 39, no. 20, Nov. 11, 1920, pp. 512–513, 4 figs. Graphs give theoretically correct deductions of rivet holes for various gages and staggers.

RIVETING

Machines. English Type Electric Riveting Machine. Boiler Maker, vol. 20, no. 11, Nov. 1920, pp. 317–318, 5 figs. Manufactured by Mada Engineering Co.

Oiltight Work. Notes on Rivets and Spacing of Rivets for Oil-Tight Work, Hugo P. Frear. Twenty-eighth General Meeting, Soc. Naval Architects and Mar. Engrs., Nov. 11 and 12, 1920, no. 5, 10 pp. Rules and recommendations of American Bureau of Shipping, Bureau Veritas and Lloyd's Register.

Notes on Rivets and Spacing of Rivets for Oil-tight Work, Hugo P. Frear. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 1008–1009. Information concerning oiltight practice of riveting for oiltight work. (Abstract.) Paper read before Soc. Naval Architects & Mar. Engrs.

ROLLING MILLS

Alloy-Steels. New Rolling Mill for Alloy Steels. Iron Age, vol. 106, no. 25, Dec. 16, 1920, pp. 1597–1599, 6 figs. Installation of Pennsylvania Forge Co., Bridesburg, Philadelphia. Five stands are served by tilting table on one side and traveling lifting table on other with runout over transfer table.

Brass. New Plant of the West Virginia Metal Products Corp. Metal Industry (N. Y.), vol. 18, no. 12, Dec. 1920, pp. 543–548, 4 figs. Plant has eight-hour minimum capacity of 80,000 lb. of finished brass and 20,000 lb. of finished copper.

Electrically Driven. Electric Rolling-Mill Equipment for Messrs. Steel, Peech & Tozer, Ltd. Elec. Rev. (Lond.), vol. 87, no. 2244, Nov. 26, 1920, pp. 675–677, 5 figs. Billet mill is of Morgan type and consists of four stands of 21-in. rolls and six stands of 18-in. rolls, and is driven by 1200 hp., 6300-volt, 3-phase, 50-cycle B.T.H. slip-ring type induction motor. (Concluded.)

Electric Rolling-Mill Equipment for Messrs. Steel, Peech & Tozer, Ltd. Elec. Rev. (Lond.), vol. 87, no. 2243, Nov. 19, 1920, pp. 643–646, 7 figs. Substation and cogging-mill equipment. (To be continued.)

Factors which Determine the Selection of Motors for Main Roll Drive, G. E. Stoltz. Proc. Engrs. Soc. Western Pa., vol. 36, no. 7, Oct. 1920, pp. 492–507 and (discussion) pp. 508–517, 17 figs. Examination of types used in various steel mills. Suggestions in regard to selecting type of motor for proposed installation.

Motor Equipment for Main Drive of Rolling Mills. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 541–547. List giving particulars of British electrically driven rolling mills.

Notes on Rolling Mill Drives, L. Rothera. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 514–517, 5 figs. Examples showing progressive increase in motor size.

Sheet and Tin Mills, A. B. Holcomb. Assn. Iron & Steel Elec. Engrs., vol. 2, no. 11, Nov. 1920, pp. 1–11 and (discussion) pp. 11–27. Advantages of electric drive for sheet and tin mills.

The Electric Drive of Rolling Mills, W. E. Taylor and C. E. Raeburn. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 524–528, 3 figs. Comparative economy of steam and electric drives. Based on records of operation of Canadian mill by steam drive and after its conversion to electric drive.

The Electric Reversing Mill Considered from the Standpoint of Tonnage, K. A. Pauly. Gen. Elec. Rev., vol. 23, no. 11, Nov. 1920, pp. 886–892, 6 figs. It is shown that increase in production can be secured by electric drive with less than same percentage increase in first cost of equipment. Paper read before Assn. Iron & Steel Elec. Engrs.

Variable Speed Rolling Mill Drives, W. E. Swale. Elecn., vol. 85, no. 2216, Nov. 5, 1920, pp. 522–523, 3 figs. Relative advantages of direct and alternating current.

Furnaces. Repairs Involve Unique Problems. Iron Trade Rev., vol. 67, no. 21, Nov. 18, 1920, pp. 1401–1403, 5 figs. Complete reconstruction of Columbus furnaces of American Rolling Mill Co. carried out in short time.

American Rolling Mill Furnaces Remodeled. Iron Age, vol. 106, no. 21, Nov. 18, 1920, pp. 1318–1319, 5 figs. Remodeling included increase in volumetric sizes and entire reconsideration of hot stoves.

S

SAFETY

Shop, Organization for. Safety Work Must be Well Planned, R. A. Salisbury. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 895–896. Devise organized committees under direction of safety engineers and changing membership of committees frequently in order to educate workmen in safety.

Steel Works, Organization for. "Safety First" in a Steel works, H. S. Burn. Eng. and Indus. Management, vol. 4, no. 19, Nov. 4, 1920, pp. 589–590. Organization in large British Steel Works employing about 4000 workers.

SAND, MOLDING

Analysis. Judging Sands for Foundry Use—IV, Henry B. Hanlet and Herbert R. Simonds. Foundry, vol. 48, no. 22, Nov. 15, 1920, pp. 921–922. Methods of testing.

Testing. Investigates Steel Sand Properties, R. L. Lindstrom. Foundry, vol. 48, no. 23, Dec. 1, 1920, pp. 940–943, 18 figs. Methods of testing. Qualities required. Paper read before Am. Foundrymen's Assn.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW THREADS

Specifications. Report on Coarse and Fine Threads. Can. Machy., vol. 24, no. 17, Oct. 21, 1920, pp. 374–377. Tables of tolerances, and specifications.

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 2, Oct. 25, 1920, pp 17–21, 5 figs. Proposal of Board of Directors for flange joints, round threads and flat hexagonal threads. Proposed standards for sink-water traps with opening for cleaning.

SCREWS

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie), Betrieb, vol. 3, no. 1, Oct. 10, 1920, pp. 1–14, 17 figs. Proposals of the Board of Directors for special standard dimensional values and for driver's seat in agricultural machines. Proposed standards for square and hexagon head Whitworth cap screws, bolts and nuts, lag screws; sink-water traps, etc. Rules of the Committee for standards and formula values.

SHAFTS

Critical Speeds. Calculation of the Critical Speeds of Shafts (Die Berechnung kritischer Drehzahlen von Biegungswellen), H. Lorenz. Zeit. für das gesamte Turbinenwesen, vol. 17, nos. 20 and 21, July 20 and 30, 1920, pp. 229–232 and 245–249, 5 figs. Gives method for calculating critical speed of a shaft under a given load and arrangement of bearings which, however, can be applied only in simple cases. The employment of the Kull approximative formula is recommended for calculation of complicated cases.

Critical Speed and Gyroscopic Action (Kritische Drehzahl und Kreiselwirkung), R. Grammel. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 44, Oct. 30, 1920, pp. 911–914, 2 figs. Based on newly derived differential equation of a uniformly revolving vertical shaft, it is shown that, as a result of the gyroscopic action of the disks, there are no longer such unlimited number of critical revolutions; their number is determined according to the surface conditions; and it is explained how they can be altogether prevented. It is also explained how critical speeds vary when length of shaft or diameter of disk is changed. The critical speeds of the second class are investigated in same manner.

SHIPBUILDING

Great Britain. The Relation Between Shipbuilding Production, Prices, and the Freight Market, Maxwell Ballard. Trans. Northeast Coast Instn. Engrs. & Shipbuilders, Advance paper no. 3224–O, 17 pp., 8 figs. Economic position of shipping and shipbuilding industries of Great Britain.

Production Systems. Production Methods in Shipbuilding—V, William B. Ferguson. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 409–412, 2 figs. Discusses piece work in its application to shipbuilding and shows how varied nature of work involving many trades makes it necessary to depart from any one hard and fast system of bonus payment. Application of Halsey premium systems and 100-per cent time-premium plan and results obtained therefrom in increasing output of yard are set forth.

SNOW PLOWS

Rotary. The Development of Snow Fighting Equipment, W. H. Winterrowd. Ry. Maintenance Engr., vol. 16, no. 12, Dec. 1920, pp. 458–462, 8 figs. Rotary plows of Canadian Pacific Railways.

SOLAR ENERGY

Utilization of. Utilization of Solar Energy (Le soleil générateur de force motrice), Emmanuel Zoude. Revue Universelle des Mines, vol. 7, no. 4, Nov. 15, 1920, pp. 255–278, 12 figs. Method for generation of steam by solar rays invented by Frank Shuman of Philadelphia, and its application in installation at Meadi, Egypt, by British Corporation, owner of Shuman patents.

STEAM

Formulas. Steam Formulas, Robert C. H. Heck. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 669–670, 4 figs. Critical comparison of various existing formulations and development of new set of general equations. Formulas are developed for temperature, pressure and heat content.

Generation by Solar Rays. See SOLAR ENERGY.

Superheated, in Textile Mills. Superheated Steam in Textile Power Plants, Pell W. Foster, Jr. Textile World Jl., vol. 58, no. 23, Dec. 4, 1920, pp. 113–117, 4 figs. Its adaptability to the problems of textile-mill engineer.

STEAM-ELECTRIC PLANTS

Oshkosh, Wis. Electric Power at Oshkosh, Wis., T. J. Lucas. Power Plant Eng., vol. 24, no. 24, Dec. 15, 1920, pp. 1155–1161 and pp. 1186–1189, 15 figs. Replacement of reciprocating units by two vertical Curtis 500-kw. turbine units and later supplemented by 500-kw. horizontal Allis-Chalmers Parsons unit.

Unit Systems. Electrical Features of Springdale Plant, George S. Humphrey. Elec World, vol. 76, no. 23, Dec. 4, 1920, pp. 1114–1118, 8 figs. Details of 30,000-kw. unit of West Penn Power Co. Plant is arranged on unit system, main generator having its own boilers, auxiliaries, transformers and bus sections.

STEAM ENGINES

Piston Displacement. Piston Displacement, Velocity and Acceleration for Reciprocating Engines, John L. Bogert. Mar. Eng., vol. 25, no. 12, Dec. 1920, pp. 983–989, 10 figs. Table and graphs giving piston displacement, velocity and acceleration for various rations of connecting rod to crank.

Uniflow. Further Tests of the Uniflow Pumping Engine, D. A. Decrow. Jl. New England Water Works Assn., vol. 34, no. 3, Sept. 1920, pp. 195–199. Results of tests indicate that permissible speeds of this type of pumping engine are much higher than considered advisable for familiar types of crank and flywheel pumping engines; results as to speed economy indicate higher economy for higher speeds and temperatures.

STEAM POWER PLANTS

Test Codes. Power Test Codes. Mech. Eng., vol. 42, no. 12, Dec. 1920, pp. 718–719 and p. 725. Preliminary draft of first of 19 codes which the American Society of Mechanical Engineers Committee on Power Test Codes is formulating.

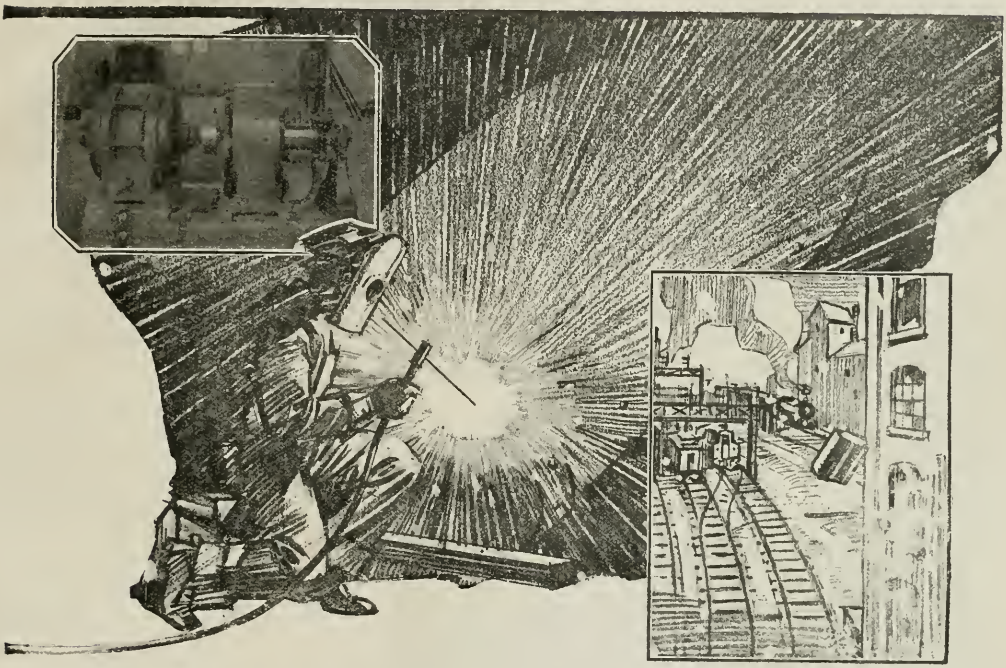
STEAM TURBINES

Operation and Adjustment. Operation and Adjustment of Turbine Machinery—XII—Oil Pumps, Eustis H. Thompson. Power, vol. 52, no. 22, Nov. 30, 1920, pp. 863–864, 3 figs.

STEEL

Aircraft. Some Notes on Aircraft Steels and Their Inspection, R. K. Bagnall-Wild. Flight, vol. 12,

Sometimes the producer is so absorbed with the task of producing, that he overlooks means which might make his plant more productive



A Welded Seam with All the Strength of the Original Metal

Full of oil and sealed tight a tank was dropped from a four-story building onto a railroad track, and nothing but a dent in the tank! A real test of strength, and yet the electric arc welded seam did not leak or show a sign of weakness. Electric welding makes every seam a part of the product itself, rather than a connection which merely holds it together.

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ENGINEERING INDEX (Continued)

T

TEMPERING

Reheating. Tempering and Reheating of Metallurgical Products (La Trempe et le revenu des produits métallurgiques), Léon Guillet. Revue générale des Sciences, vol. 31, nos. 17–18 and 19, Sept. 15–30 and Oct. 15, 1920, pp. 564–581, 34 figs, and 614–620, 5 figs. Influence of different methods of reheating on resulting hardness of alloy steels and bronzes. Diagrams and photomicrographs. Theory of tempering.

TERMINALS, MARINE

Mechanical Handling Equipment. Mechanical Handling Equipment as a Means of Reducing Expensive Terminal Costs, G. F. Nicholson. Freight Handling and Terminal Eng., vol. 6, no. 10, Oct. 1920, pp. 377–384. Type of equipment required. Paper read before Pacific Coast Port Authorities Annual Convention.

TIDAL POWER

Severn Barrage Scheme. The Severn Barrage Scheme. Elecn., vol. 85, no. 2220, Dec. 3, 1920, pp. 659–660, 1 fig. Scheme for utilizing over one-half million horsepower of tidal energy. Designs have been worked out by civil engineering department British Ministry of Transport.

Utilization of. Utilization of the Tides (Utilisation des marées), Amiral Amet. Revue générale de l'Électricité, vol. 8, nos. 16 and 17, Oct. 16 and 23, 1920, pp. 531–542, 11 figs., and 565–575, 9 figs. Scheme for utilizing tidal power at Saint-Malo, France.

TIME STUDY

Small-Part Manufacture. Time Study in Small Part Manufacture, Philip Bernstein. Indus. Management, vol. 60, no. 6, Dec. 1920, pp. 401–406. Practical procedure on drilling, profiling, hand and power milling, automatic screw machine and other operations.

TOOLS

Grinding. Grinding Expedites Tool Building, Douglas T. Hamilton. Iron Trade Rev., vol. 67, no. 22, Nov. 25, 1920, pp. 1472–1475, 11 figs. Practice at plant of Fellows Gear Shaper Co., Springfield, Vt.

TRADE UNIONS

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Oxy-Acetylene. See OXY-AXCETYLENE WELDING.

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WIND TUNNELS

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Volume 43 March, 1921 Number 3

Industry's Supply of Energy

A Survey of the Available Supplies of Coal, Oil, and Water, Together with a Discussion of the Engineer's Part in the Economic and Efficient Utilization of Energy Units

By GEORGE OTIS SMITH,[1] WASHINGTON, D. C.

EDWARD EVERETT HALE charted the course of industrial development when he said that the extent to which the world had changed the laborer who uses his body into the workman who uses his head was the index of civilization. That distinction between laborer and workman is the contrast between the old and the new order. The formula for modern industry is man plus mechanical energy, or, better expressed, it is man multiplied by his machines. The true measure of industrial progress is found in the amount of mechanical power used to supplement man power. As mechanical engineers you may have been so devoted to the task of perfecting the application of power to man's use that you have had little time to think of the sources of the energy you use or to estimate the supply of energy available. The present scope and future possibilities of your profession take on larger dimensions if we survey the whole field and so appreciate better its vast extent. As I see the task of the mechanical engineer, he is the guide who best knows the routes by which mankind must travel in order to take full possession of the stores of energy that await utilization.

For contrast with the present era of machine-aided civilization we naturally turn to the days of ancient Rome or Greece or Egypt, when hordes of slaves toiled both in the erection of those great monuments that have been called the "wonders of the world" and in the performance of the daily tasks of providing the necessities and luxuries of that age. Man power then made use of only the simplest laws of mechanics. Far less depressing is it to go still further afield and recall those tales of the Arabian Nights wherein the slaves of the lamp performed their work with the ease and dispatch that accords more nearly with the methods of today. To what extent is it granted to us of this day and generation to rub the modern Aladdin's lamp and summon the genii to do our bidding? How many servants have we working for us?

I find that several writers on the subject of power have estimated the number of energy servants in our employ, and these estimates are based upon the installed capacity of our prime movers, which is approximately 100 million horsepower, or nearly one horsepower to each man, woman, and child in the United States. Using the equivalent of ten man-power hours to the horsepower-hour we find in this the suggestion that we each have the equivalent of ten servants to do our bidding. But even mechanical power has some of the frailties of human power: capacity and performance are rarely equal. So, if we take the statistics of the energy output that we really utilize we discover that these energy servants work very short days, for, with the exception of the electric utilities, our prime movers do not give us anything like the equivalent of an 8-hour day in terms of their rated capacity. The steam locomotives, which represent perhaps 60 per cent of the total installed capacity, average only about a 7 per cent use factor, which brings down the average load factor to not much over 14 per cent.

These workers, represented by the water turbine and the steam engine, are tireless, it is true, and they are able to render continuous service as man power cannot, yet the fact is that we do not so use them. We may figure that we each have ten energy servants to help us in the world's work, but as they average only about 23½ hours a week a better statement would be that we each of us have the equivalent of five slaves working for us day by day. You will note that this estimate is arrived at by figuring that with a 14 per cent load factor it takes nearly two installed horsepower to equal one continuous horsepower for the human week of 44 hours. This quota of five energy servants for each of us is far in excess of what the Greeks possessed in the form of human slaves, five helots being, I understand, the power equipment of the average Greek freedman's family, or nearer one apiece, when Greek culture rested on a substratum of slave labor.

The census of our energy slaves I have just taken does not include the millions of automotive engines in our pleasure cars, trucks and tractors, which may in rated capacity far exceed that of the prime movers I have mentioned. Yet it might be difficult to figure the load factor of these engines and so to calculate in horsepower the service they render to us. Horsepower is indeed the appropriate measure of the work these automotive engines perform, as they are substitutes for the horses on our city streets, on our interurban highways, and more and more on our farms. With an average of one automobile car or truck to every two or three families the contrast is great between our civilization and that of the ancients, in which long lines of slaves carried on their backs the wealth of that day. Indeed, we have only to go to the Orient of today to see man labor in its simple terms, with little of the multiplication by machinery that characterizes our Occidental world.

In contrast, then, with the Greek civilization of the past or even with Oriental life of today is daily life and work as we know it, and we can clearly see that the Anglo-Saxon dominance of industry and commerce is founded largely on coal and iron. It was the steam engine that gave birth to modern industrialism and to modern distribution of the products of industrialism. The centralization of power units, which took place nearly half a century earlier in England than in the United States, resulted in the centralization of industry in factory towns and put large plants in the place of small workshops and home looms. So the industrial change in the century just past was greater than in all the earlier centuries recorded in history. Indeed, the development of industry was so rapid that the industrial scheme changed more in a few years than it had in the 18 centuries since the boy Jesus worked at the carpenter's bench in his father's shop. All this is only the story of the application of mechanical power to the aid of the human worker.

Present Supply of Energy and Its Distribution

The estimates I have already used for last year's utilization of power give a good starting point for our review of the present and future supply of energy. The engineers who are making the special power investigation under the United States Geological Survey figure 125 billion horsepower-hours as last year's output in the United States. Of this total of primary power more than 82 per cent is credited to steam, a little over 15 per cent to water, and the remainder—less than 3 per cent—to internal-combustion engines. As to the uses, the division of this power is, roughly, public utilities 42 per cent; manufacturing industries, not including rented electric power, 28 per cent; and steam railroads, 30 per cent. The statistical basis for these estimates is not all that we might wish, but they show roughly where the energy we use comes from and what we use it for.

[1] Director, United States Geological Survey.

Paper presented at the Fortieth Anniversary meeting of The American Society of Mechanical Engineers held by the Chicago Section at Chicago, Ill., November 22, 1920.

Much of the work that is done for us by these servants is done so far away that we are unconscious of what it involves. At least four of the five slaves in whose work each of us can claim the larger share owe their strength to coal; their power is that of the steam engine turning this wheel and that wheel the country over. Here in the United States our per capita consumption of coal exceeds that of any other country, and we ourselves may sometimes wonder what becomes of the annual 6 tons or more allotted to each man, woman and child. You and I well appreciate how many tons of coal we buy each year for our own household use, but we can only guess in a general way where the rest goes—to the railroads and furnaces and factories. Recently, in speaking to some steel men, I stated the facts of coal distribution somewhat as follows:

The figures of our coal resources, millions of millions of tons, or even the few hundred million tons of our annual output, are too large to be grasped, and it becomes necessary to express the facts in smaller quantities. Roughly speaking, 1000 tons of coal is what a mine worker mines in a year—the measure of what he contributes to the world's work and well-being. This human measure of 1000 tons also has the advantage of being easily visualized as a short train load (20 cars) of coal on its way to serve the varied needs of the consumer, and in our brief review of the subject we may well note first what are these needs—the principal uses of coal, among which this unit of 1000 tons is divided. Broadly stated, the largest use of coal is in furnishing motive power and heat for our industries and public utilities, 350 tons out of every 1000 tons mined going to the boiler house of factory, mill, shop or power plant. But next to these 7 carloads of coal distributed throughout the country are 5 cars, or 250 tons of coal, that the railroads burn for their own use. The domestic demand for coal comes next, 165 tons out of each 1000 tons of anthracite and bituminous coal being used in the homes of the land for heating and cooking. The coke ovens take nearly as much as the homes, or 130 tons; and the rest of our miner's contribution includes the coal for export and bunker use, 60 tons; the 35 tons of coal used in operating the coal mines themselves, which of course does not make up a part of our train load; and the 10 tons that goes to the gas works.

Coming back for a moment to the personal service which we receive from coal through steam, I can perhaps illustrate how close home this service may come and how silently it may be rendered by reference to our electric lights—new only yesterday but commonplace today. Here in a special sense coal is the slave of the lamp. To learn how much coal comes into my house over the wire, I recently reviewed my electric-light bills and converted kilowatt-hours back into pounds of coal, with the result that I found that my household had used $1^1/_5$ tons of coal in a year simply to provide illumination. This annual per capita consumption of 400 pounds of coal for illumination is probably not far from an average figure, for even if my record is high in kilowatt-hours, the Washington central station is much lower in coal consumption than the average station. Nor do our coal requirements for illumination stop in our homes: in Washington, where our streets are far from being "white ways" at night, our street lighting, such as it is, with part electric and part gas lamps, costs each of us 33 pounds of coal and a gallon or two of gas oil each year. If we add to these figures something for the lighting in the buildings where we work, it probably costs each of us considerably more than a quarter of a ton of coal a year for our artificial light—to that extent are we drawing upon the sunshine of another geologic era.

To give perspective to our review of our present supply of energy, let us simply glance at our increasing use of coal. In 1918 we used nearly $6^1/_2$ tons per capita, but a century ago the country's output of perhaps 40,000 tons of coal amounted to less than 8 *pounds* per capita, or hardly more than is used in the central station to furnish my home with light for a single evening. Even fifty years ago when this country was on a coal basis, our per capita consumption had reached only about 1700 pounds, which would mean a real coal shortage today. This rate of increase in demand for coal alone does not make prophecy easy, yet in planning for the future you engineers should perhaps start off with an inventory of the world's supply of energy in the form of flowing water and the two mineral fuels, coal and oil, and, first of all, a glance at the way these are allotted to the continents.

The World's Sources of Energy

One of the by-products of the coöperative efforts by the Government scientific bureaus in aid of our Peace Commission was an inventory of the water-power resources of the world, and this is now being prepared for publication by the United States Geological Survey. It shows that only about one-twentieth of the potential power of the world's rivers has been utilized, and over half of this in North America, with Europe credited with one-third and the rest divided between Asia, South America, Oceanica, and Africa, in the order named. In its potential resources, however, Africa ranks not last but first; it has over 40 per cent of the world's supply of water power and is followed in turn by Asia, North America, South America, Europe and Oceanica.

In the division of coal resources among the continents, at least of the better grades of coal, similar inequalities are seen: North America has more than half, Asia about a quarter, Europe a sixth, and the rest is divided between Oceanica, Africa, and South America, in the order named.

The present realization of the world's interest in its supply of petroleum has led to similar estimates of the recoverable resources, first in the United States and then in other countries; and whether we dignify these quantitative measurements of oil reserve by terming them official estimates or describe them by calling them scientific guesses, they are the best we have, and they will serve fairly well in guiding national and international action.

It may be noted that the United States Geological Survey's estimate of the petroleum resources of the world shows that the distribution, while unevenly balanced among nations, is evenly balanced between the eastern and the western hemispheres, although the northern hemisphere appears to have at least five times as much oil as the southern. This preponderance of the oil supply of the northern hemisphere should, however, be discounted by a fact and a possibility; the land area of the northern hemisphere is three times that of the southern and the larger unexplored areas are in South America, Africa, and Oceanica.

Accepting the Stebinger-White distribution of the world's oil reserves, we may roughly set down the continents in order of wealth in oil in North America, Asia, South America, Europe, Oceanica, and Africa. In terms of regional distribution, more than half the world's oil reserves are believed to be concentrated in two intercontinental areas; one of these oil-rich provinces includes the North American and South American countries bordering the Caribbean Sea, and the other includes the countries of western Asia and southeastern Europe, with the Caucasus as an axis. On these two areas, then, each comprising only about 2 per cent of the earth's surface and each containing about 30 per cent of the world's future supply of oil, is focused the attention of the great nations that most need oil.

The resources of the world's oil shale are far too large to be lost sight of as a substitute source of oil. The United States alone is believed to possess deposits of oil shale that contain at least ten times as much oil as there is natural petroleum available in North America, but oil won by mining and distilling these shales, situated in the interior of a continent, cannot enter the world's markets as labor-cheap as the petroleum that flows from Mexican wells close to the coast. Such resources must therefore be regarded as a rear line of economic defense and as a source of power that will be of greater value to other generations than to this, even if a more general utilization of oil shales begins in the near future. No other continent is known to have resources of oil shale at all comparable with those of North America.

In this rapid review of the world's sources of energy we see North America taking first rank among the continents, with Asia a close second and Europe a poor third, although we should remember that Europe has a much smaller area than either of the other two.

Relative Importance of Coal, Oil and Water as Sources of Energy

Next, in considering how the world may best manage its ever-increasing power load, some aid may be found in a few comments on the differences between these three sources of energy—water, coal, and oil. Man has learned how to harness flowing water with

(*Continued on page 188*)

The Development of Artillery Materiel

By MAJOR G. F. JENKS,[1] WASHINGTON, D. C.

The first portion of this paper is a consideration of artillery-materiel development before the war and the effect of the war upon it, both in this country and abroad. Mechanical traction, it is stated, permits the increased weights required for long-range artillery; increased speed permits rapid strategic concentration of artillery; high-grade steels permit greater power in guns. All of these factors are important to the artilleryman. The efforts of the ordnance engineer since the war have been devoted for the most part to the development of pieces of greater range, greater elevation and greater mobility. The author points out the lines of development which are being followed, outlining gun-construction methods now in use and showing the value of the research work now being carried on. He describes different models of howitzers, guns and mounts, and discusses some of the details of design of recuperators, carriages, and sighting systems. The paper closes with a survey of the development of antiaircraft materiel and coast-defense work.

ALL wars have stimulated the development of the implements of warfare. Especially during the past war have the minds of engineers been fertile. New implements of war have been conceived and developed. Old ones have been given the supreme test and found capable of further development. Of the problems arising from the war none is more important or more interesting than the development of artillery matériel. In analyzing it a brief consideration of its state before the war and the effect of the World War upon it, both in this country and abroad, is necessary.

The field gun with which our service was equipped prior to 1917 was developed about 1902 to meet the demands for a stable gun carriage—one in which the aiming of the piece was not disturbed by the shock of firing. No marked developments in design then took place until the invention of the split-trail carriage, by which large increase in both traverse and elevation of the piece was made possible. In 1912 the Ordnance Department initiated the design of such a carriage, which, after exhaustive proving-ground tests, was put into production in September, 1916.

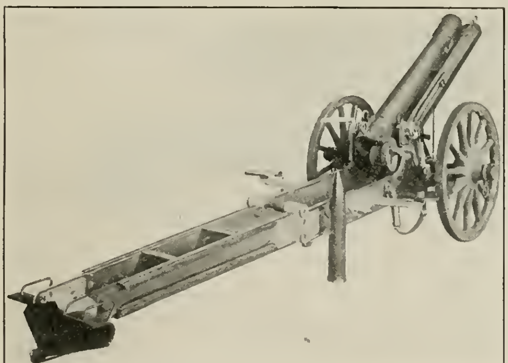

Fig. 1 75-mm. Pack Howitzer, Model of 1920

The design of howitzers and medium-caliber guns was limited by road conditions in this country. In these pieces power was sacrificed to obtain the necessary mobility. It had been considered impracticable to use heavy siege guns and howitzers on this continent and none had been provided for our troops.

For war manufacture French and British designs were adopted for all calibers of guns and howitzers except the 4.7-in. field gun. The French 75-mm. field gun was put into production because the American split-trail carriage had not been thoroughly tried out in service and the British 75 was ordered because production facilities were available.

The United States entered the war with neither an adequate engineering force to develop new designs nor a trained production force to organize manufacture. It had merely a handful of matériel and practically no facilities to produce it. Our allies not only furnished us matériel, but gave us their designs and detail drawings

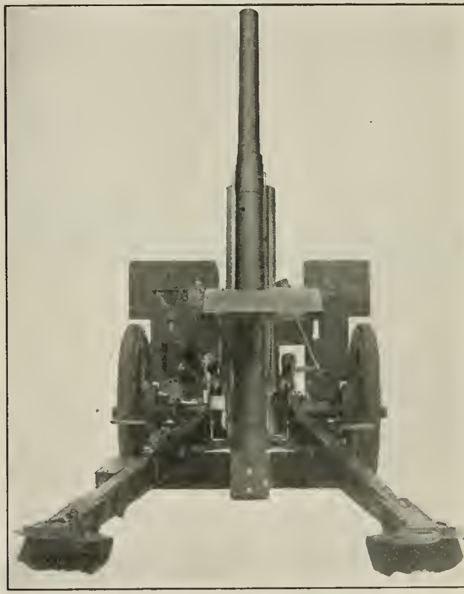

Fig. 2 75-mm. Gun, Model of 1920

and their design and production engineers to assist us in organizing production. Most of our own engineering talent was required to solve the problems of production. Considerable new development work was initiated during the war. Although working under war pressure, time was too short to secure results. Had the war continued, some real development work might have been accomplished with the large, earnest organization built up during the war.

On the other hand, much was accomplished abroad in the development of artillery matériel. The French developed long-range siege artillery and were about to bring out the design of a new field piece. They also succeeded in increasing the mobility of siege guns. The British gradually improved the range characteristics of their artillery during the war and had under manufacture an excellent design of a new field gun.

The Germans easily ranked first in the development of artillery during the war. They developed and manufactured greatly improved pieces of all calibers. They recognized the value of range, not only in the design of more powerful guns of a given caliber, but also in mounting these guns on carriages so that their maximum range could be secured. By the use of these pieces in the spring offensive in 1918, the Germans caused much concern to the allied artillery commander. This statement does not refer to the "big Bertha" fired against Paris, which was of little or no direct military value.

One well-known American artillery commander reported under date of October 8, 1918, after remarking on the changed German tactics made possible by the introduction of their improved artillery in the spring of 1918:

[1] Ordnance Department, U.S.A. Mem.Am.Soc.M.E.

Paper presented at a meeting of the Washington Section of The American Society of Mechanical Engineers at Washington, D. C., December 2, 1920.

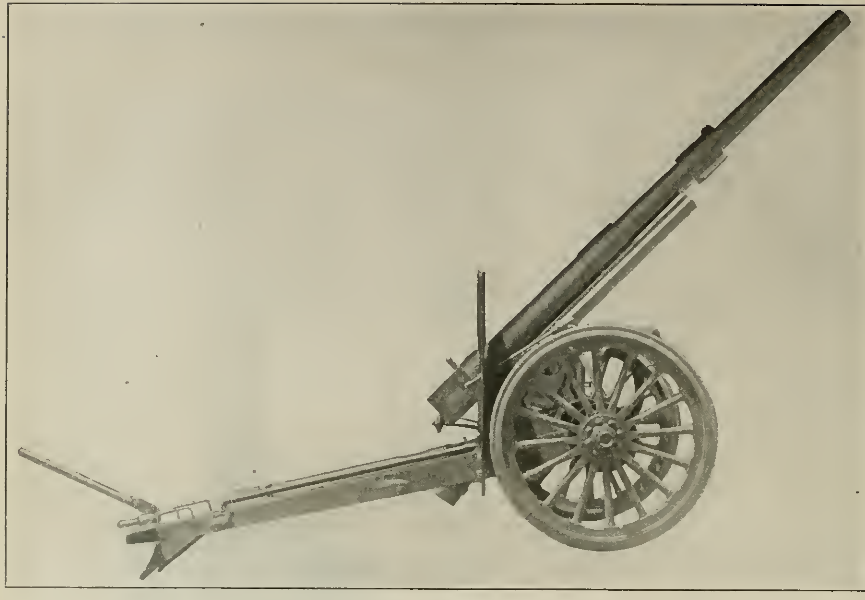

Fig. 3 75-mm. Gun, Model of 1921

Under these circumstances, the trench mortars and short-range antiquated French guns that we install and supply with ammunition with so much labor, are of little or no use. They pound an empty space and we cannot move them forward over No-Man's Land and supply them with ammunition...... For the present phase of the war, then, range is a most vital consideration. The Germans have increased the range of their guns. ... To contend with these German guns, or in other words, to meet the condition, in the existing phase of the war, we must have guns and howitzers of long ranges.

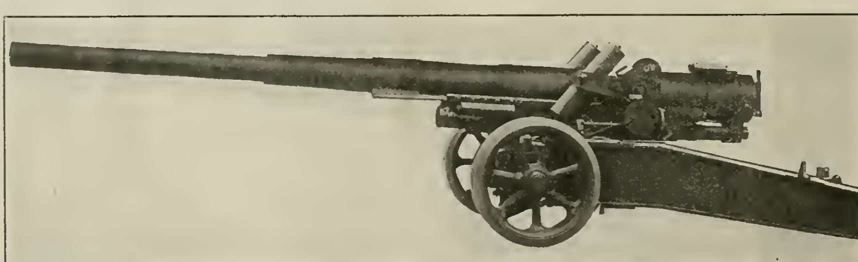

Fig. 4 155-mm. Gun, Model of 1920

Prior to the war the marvelous progress in the mechanical arts caused by the development of the gas engine had had no appreciable effect upon the design of artillery matériel. The field piece had been conceived in terms of the horse, the mountain howitzer in terms of the pack mule. Very little progress had been deemed possible as the horse was a fixed quantity. But the perfection of the gas engine has removed the horse as a limiting factor. The development of the automobile industry has given us high speeds of vehicle propulsion, and a demand for and supply of alloy steels of high physical properties. All these factors are important to artillerymen. Mechanical traction permits the increased weights required for long-range artillery. Increased speed permits rapid strategic concentration of artillery; high-grade steels permit greater power in guns.

Development of the Long-Range Gun

After the armistice the sentiment of our artillerymen was unanimously in favor of pieces of greater range, greater elevation, and greater mobility. This sentiment found expression in the reports of the various service boards and especially in that of the Westervelt Board appointed by the War Department, December 11, 1918. The report of this Board was approved by the Chief of Staff on May 23, 1919, and its recommendations have become the fundamental specifications for mobile artillery matériel.

The efforts of the ordnance engineer since the war have been devoted mostly to the development of design under the Westervelt Board program. Under that program the same calibers of pieces as used during the war will be developed, but they will have greater range, greater flexibility of mount, and greater mobility.

The longer range will be attained partly through ammunition development, but also by increase in the length and muzzle velocity of the gun. As mobility requires lightness, the weight of the gun must be reduced as much as possible. To secure this, three lines of development are being followed: first, by using material of higher

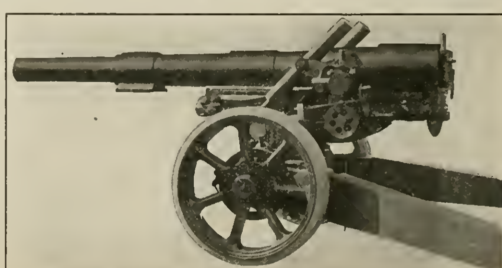

Fig. 5 155-mm. Howitzer, Model of 1920

second, by wire-wrapping the tube; and third, by the "auto-frettage" process.

The nickel steel specified during the war was of the following physical qualities: elastic limit, 65,000; tensile strength, 95,000; elongation, 18 per cent; contraction, 30 per cent. Gun forgings for some experimental matériel are being made of nickel-chrome steel with the following physical qualities: elastic limit, 80,000; tensile strength, 105,000; elongation, 18 per cent; contraction, 30 per cent. Such forgings have been produced, but many problems have arisen in their production. Some of the first produced were extremely brittle and under stress behaved like cast iron. One small gun which seemed to be made of excellent metal according to the usual methods of test, failed under less-than-service interior pressure. Impact tests developed the fact that an improper heat treatment had been given. This brittleness has apparently been overcome by quenching the forging from the "draw." But, although impact tests have shown excellent results, yet the metal is full of internal stresses and the gun finisher experiences considerable difficulty in keeping the bore straight. What effect these internal stresses will produce at the proving ground is not known. Laboratory tests made upon the steel of captured German guns indicate that this kind of steel was used successfully and that it was tough, free from internal stresses, and remarkably uniform. Much work still remains to be done in developing a satisfactory steel of this quality.

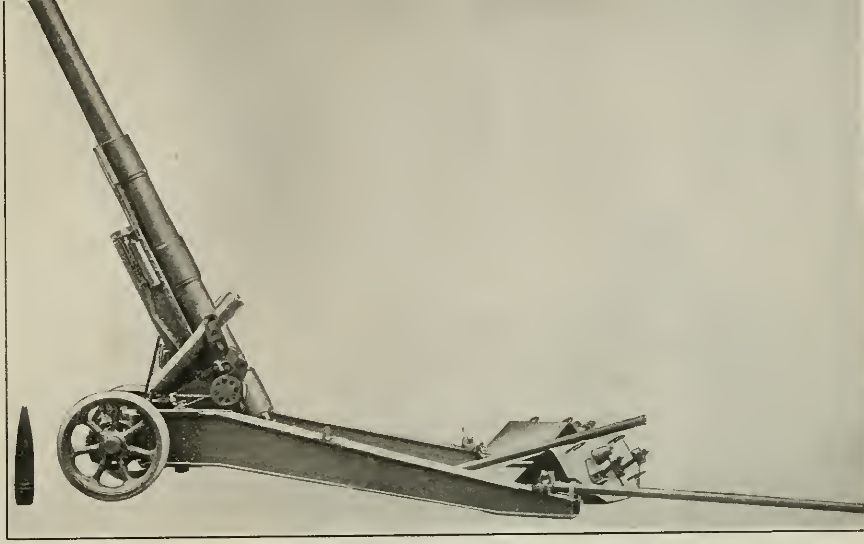

Fig. 6 8-in. Howitzer, Model of 1920

No new problems are involved in the construction of the wire-wrapped gun. By the use of wire, lower-grade metal can be utilized in the forgings. Guns made by this process are slightly heavier than those made of chrome alloy steel. At present, however, it is a more conservative method of construction.

In the auto-frettage method of construction the gun is built up of a few pieces of steel of medium physical qualities. The walls of the gun are internally stressed beyond their elastic limit by internal hydraulic pressure. The condition set up is similar to that produced by the shrinking process. It can be applied to the whole gun, whereas the effect of shrinkage is limited to the hooped portion. For a given strength thinner walls are sufficient. This assures minimum weights. The process is also a cheaper one than either the built-up or the wire-wrapped method of construction.

Gun-Construction Research

A research program has been undertaken at Watertown Arsenal to determine the laws underlying the auto-frettage process. One 155-mm. howitzer is now ready for auto-fretting. Although others have constructed and tested guns built up by auto-frettage, our program covers an investigation of the principles and theory rather than hasty proving-ground tests.

Much research work still remains to be done in determining the proper form of rifling, the effect of variation of elements of the bore upon the life of the gun, the production and heat-treating of metals used in gun construction, and in checking the fundamental formulas of gun design. Our knowledge of the theory of gun construction is rather unsatisfactory.

For pack howitzers and field and siege pieces of 75-mm. and greater caliber, the hydropneumatic recuperator is being employed. The St. Chamond type is used for 75-mm. and 105-mm. calibers and the Filloux type for 4.7-in. to 8-in. calibers. No new developments have been made in these types since the armistice. They have been merely adapted to meet the new conditions imposed.

During the war great difficulty was experienced in the production of recuperators. Because of the use of oil and air under high initial pressure extremely fine workmanship was required in the finishing of the bore of cylinders and the manufacturing of pistons. If possible a recuperator which is simpler to manufacture should be developed.

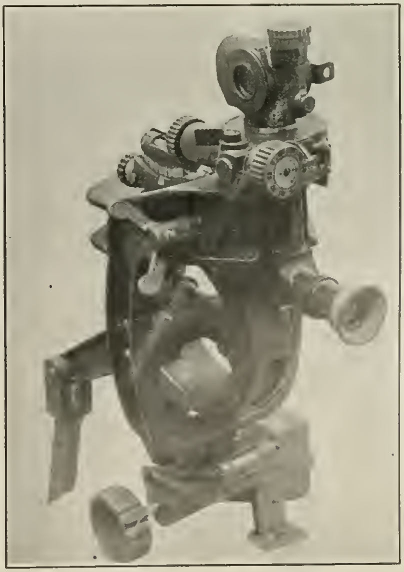

Fig. 7 Sight for 75- and 105-mm. Materiel, Model of 1920

Such a development is being carried on. In this system the air is confined in a metal bellows. Complex pistons to hold pneumatic and initial hydraulic pressures are eliminated. Such a system offers much simpler production problems.

Carriage Developments

Two independent lines of carriage development are being pursued: the wheel type and the caterpillar type. Common desirable charactristics are high elevation, wide traverse, a minimum depth of pit for clearance of recoil parts at high elevation, and, of course, stability at all elevations.

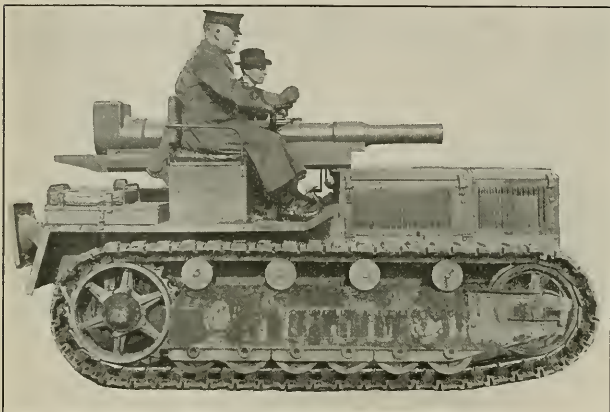

Fig. 8 Self-Propelled Caterpillar Mark VI for 75-mm. Gun and for 105-mm. Howitzer, Model of 1920

The condition of high elevation and minimum depth of pit has necessitated placing the center of trunnions of the tipping parts in rear of their center of gravity, and equalizing the force required to elevate and depress by an equilibrating system. In most pieces it requires variable recoil. Although the equilibrating system adds weight and complexity to the gun carriage, yet it tends to improve the accuracy of fire as the pressure on the elevating gears does not change in direction during the recoil. This should keep the backlash of gearing in the same direction and reduce the jump.

Bringing the center of rotation of the gun to the rear and the use of variable recoil also permits lowering the axis of the gun. This is advantageous in permitting lightness of construction and shortening the trail.

Wide traverse has resulted from the use of the split trail at the expense of weight and simplicity of construction. The split-trail 75-mm. matériel weighs about 700 lb. more than the box-trail matériel. This is due partly to the greater elevation—80 deg. compared with 40 deg. It is believed that the simpler, lighter and more rugged single-trail is by far the preferable design for the 75-mm.

The provision for elevating pieces beyond that required for maximum range is causing complication of design and increased weights. The bottom carriage must be built out farther from the axle to permit clearance at high elevations. This is expensive in weight.

The Westervelt Board report contemplates a gun and a howitzer mounted on the same carriage. This simplifies production and supply, but it complicates the design of the carriage. It is difficult to secure the same reactions in the carriage from both gun and howitzer. For example, the 4.7-in. gun matériel is heavier than it need be because the 155-mm. howitzer demands a heavier carriage. It appears preferable not to attempt the use of exactly the same carriage for both pieces, but merely to make them as nearly alike as practicable. The ideal of the artilleryman is the reduction of the number of calibers to a minimum and the standardization of mounts. The desirability of such a program is apparent to the supply department charged with production and maintenance. However, the mission of the piece—not the desirability of standardization—must fix its characteristics.

In the development of the wheel-type mount it is probable that in some cases we have overstepped the boundary of conservative design, and that later we will be content to reduce the severity of some of our specifications in order to simplify and lighten our designs. However, the present designs incorporate characteristics that seem desirable. Until pieces embodying them are constructed and tested, the engineer will not be content that these characteristics are feasible, and the service will not be satisfied that they cannot be embodied in their matériel.

Sighting Systems

No marked development is being attempted in sighting systems. Of course panoramic sights or suitable telescopic sights will be used for all calibers. The field-gun sight follows that developed for the 75-mm. model-of-1916 matériel and the sight for heavier guns will be a modified quadrant sight like that used on the 155-mm. howitzer, but with a panoramic sight. For accompanying fire-control instruments only minor improvements are now contemplated.

Caterpillar Mounts

In the war models of caterpillar mounts, little attention could be given to reduction in weight and to refinement in design. The possibilities of development of these types of gun mounts should not, therefore, be judged by the matériel built under war contracts, nor even by that now being constructed. Especially, such essential characteristics as accessibility of parts for maintenance and elimination of mechanical weakness in details of construction must be worked out by experience. In considering any model the possibilities of perfecting the design into a desirable machine must be given the greatest weight. Mechanical imperfections can be eliminated.

Caterpillar-mount development is now proceeding along two lines: first, the track-laying type found in tractors; and second, a combination wheel and track-laying type in which the mount may be operated on wheels on good roads, or on tracks where road conditions are bad.

Fig. 9 Self-Propelled Caterpillar (Christie) for 155-mm. Gun, Model of 1918

Both types are self-propelled and have similar gun characteristics. Weights are about the same and speeds are similar. Because of the promise of both types, light and heavy-gun pilot matériels of both are being built. The 75-mm. gun and 105-mm. howitzer matériels are being designed and built by the Holt Caterpillar Company and by the Front-Drive Motor Company. Good compara-

Some 155-mm. gun caterpillar mounts designed by Mr. Christie of the Front-Drive Motor Company are nearing completion for a service test. Six caterpillar mounts for the same gun made according to a Holt design are now in the hands of the service. No decision should be drawn, however, from a comparative test of these two current models, as the Holt Company is now designing and constructing an improved mount. For the 4.7-in. gun and 155-mm. howitzer the Holt type only is being developed at this time.

The specifications of the Westervelt Board report for range of the heavy howitzer and gun for caterpillar mounts are very severe. The howitzer required is about the same length in calibers as the 155-mm. gun used during the war, while the gun is the same as for railway mounts. While it is possible to handle such guns in the field on self-propelled or trailer caterpillar mounts, yet it appears probable that the service prefers greater mobility and ease of getting into firing position at the expense of range. No decision has yet been reached in the characteristics of these pieces.

The ideal traverse as expressed by the Westervelt Board report is 360 deg. This is being secured only in anti-aircraft mounts in which the gun is pivoted on a pedestal. Mechanism will be provided in caterpillar mounts to traverse the whole mount by hand power. Of course this is a compromise, but the best practicable at this time. Mounting guns on a pivot like that in the anti-aircraft mount requires increased height of trunnions and heavy mounts—both undesirable features.

Infantry Howitzers

In the infantry-accompanying howitzer an attempt is being made to develop a piece which can be used either as a direct-fire gun aginst tanks or as a howitzer, taking the place of the 3-in. trench mortar. Guns of the 1.8-in. and 2.24-in. caliber are under construction. The caliber suitable for an anti-tank gun is too small for an efficient howitzer projectile. It is believed more logical to recognize the difference in mission of the two pieces and to develop efficient designs for both missions. The piece will be capable of being broken up into man loads.

Anti-Aircraft and Coast-Defense Work

For anti-aircraft matériel the development of a satisfactory fuze for high-muzzle velocities is a limiting factor. Two calibers

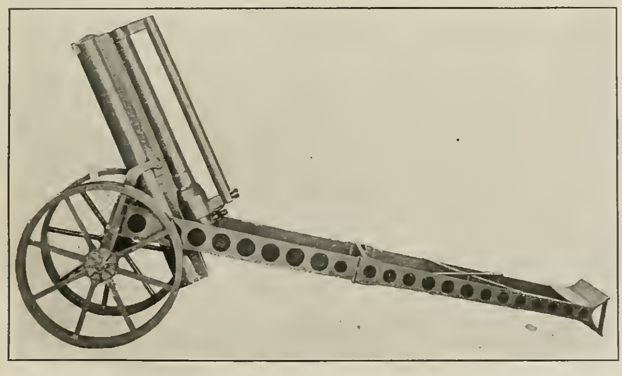

Fig. 10 2.24-in. Infantry Howitzer, Model of 1920

of guns are being developed, 3-in. and 4.7-in. The mounts will be capable of being leveled on the caterpillar base. The sighting system permits the application of azimuth and elevation corrections and superelevation without disturbing the pointing of the sight. Compressed air will be used for loading. In the heavier gun a muzzle brake will be developed in order to lessen the load on the recuperator. With other guns almost 85 per cent of the recoil energy has been absorbed in a muzzle brake, but only about half that efficiency is expected in this case. For anti-aircraft work,

For coast-defense work the 16-in. 50-caliber gun and the 25-caliber 16-in. howitzer are now standard. Only one disappearing carriage for the gun is being built. Both guns and howitzers will be mounted on barbette carriages capable of 65 deg. elevation. Hydropneumatic recuperators permit this use of increased elevation. The

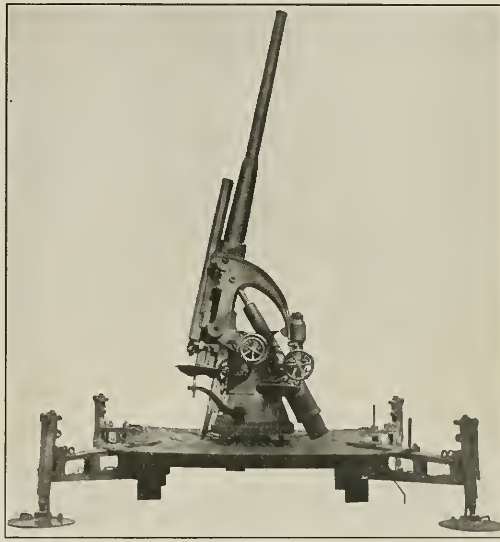

Fig. 11 3-in. Anti-Aircraft Gun Mount, Model of 1920

14-in. 50-caliber gun is also standard for coast defense. For it a new type of railway mount suitable for both field and coast-defense work is under manufacture. For coast defense a concrete foundation permits of 360 deg. traverse, while for field work traverse can be obtained from a curved track. The same railroad mount will take the 16-in. howitzer. A railway mount for a 12-in. 20-caliber howitzer is now under test. The howitzer is capable of all-around fire from the car body. The same type of carriage can be developed for an 8-in. 50-caliber gun, but lack of funds has not permitted the undertaking of this work. Studies have not yet advanced sufficiently to warrant a definite statement as to whether it is practicable to mount guns of larger caliber than 14-in. on railway mounts.

The present tendency is toward more powerful guns for seacoast defense. Some gain in power may be obtained by increasing the length and muzzle velocity, but the logical step is an increase in caliber. If economy is to be exercised in the construction of fortifications, they should be armed with guns which are at least two decades ahead of naval armament in development.

A large problem is the development of fire-control matériel for heavy coast guns. Range-finding and observing instruments set up in the neighborhood of the battery are insufficient. Guns are now capable of reaching targets which are below the horizon to our present fire-control stations. The observer is forced into the air, where the difficulties of leveling and orienting instruments are tremendous. An observation instrument leveled and oriented by gyroscopes is nearing completion. It is rather complex and no hopes can be given as to its ultimate utility. In the development of accessory instruments good progress is being made.

This rapid general survey indicates the enormous extent of the field in which artillery development work is required. It is impossible in a limited paper to indicate the depth of the program by touching upon the numerous problems which the research engi-

neer must solve in the laboratory. Needless to say, years of intensive work are required. As the stock of artillery matériel on hand is sufficient for any present needs, time should be available to perfect matériel and thoroughly test it before production should be required. Only an engineer familiar with the cost in the past of putting types of matériel into production before the design has been carefully tested at the proving ground and in the field can realize the enormous saving to the Government of fully developing artillery matériel on a small scale before equipment of armies is required.

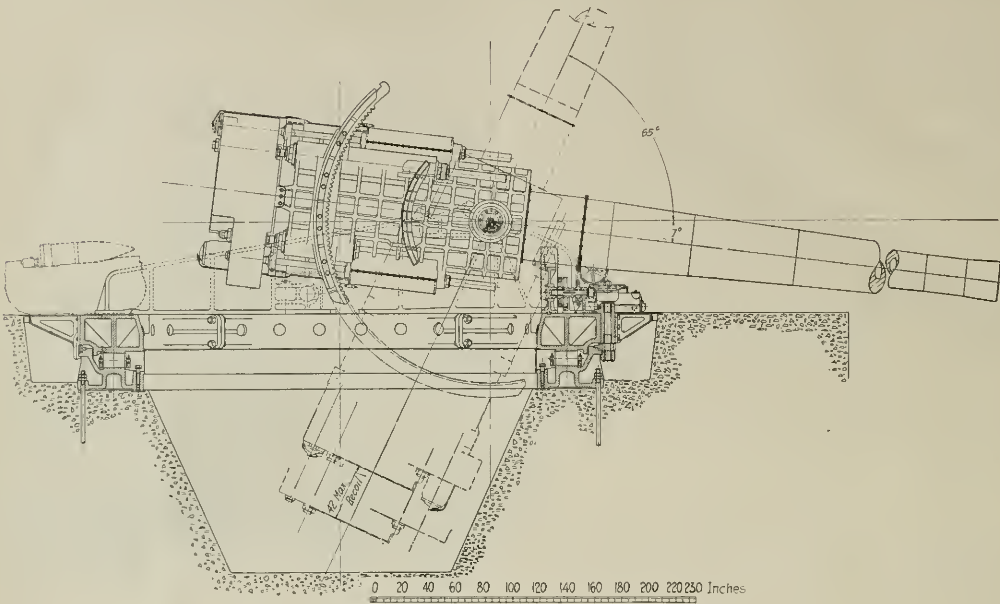

Fig. 12 16-in. Barbette Carriage, Model of 1919

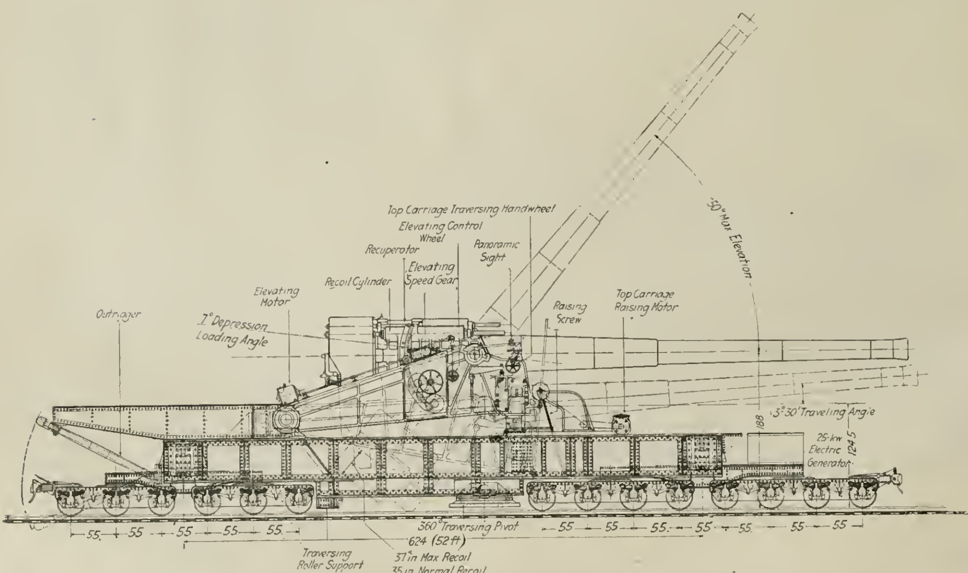

Fig. 13 14-in. Railway Mount, Model of 1920

Factor Which Determine Wheel-Wearing Action—Laws Relating to Draw-In and Traversed Cuts—Production Costs

By W. H. CHAPMAN,[1] WORCESTER, MASS.

[This paper comprises a study of the laws involved in cylindrical grinding and an analysis of grinding action both for draw-in cuts and traversed cuts. In view of the effect of wheel wear on grinding efficiency, formulas are derived for wheel wear in terms of known variables such as grain size of wheel, work speed, wheel speed, feed, etc. By calculating values for wheel wear for different conditions and comparing them with production figures calculated under the same conditions, a proper selection of wheels may be made.

The fact that the expense due to wheel wear comprises but a small item in the total cost of grinding, however, may lead to wrong conclusions if this is made the controlling factor. In the latter part of his paper, therefore, the author discusses the subject of production costs and the various factors that should be considered in securing the highest possible grinding efficiency.—Editor.]

In Fig. 1 is shown a section of wheel and work with the elements greatly enlarged. The grain paths across the work are indicated and a shaded area indicates the shape of a single chip. The grain paths are shown as straight lines tangent to the feed circle. Actually these paths are not straight lines but are epicycloidal curves. However, within the limits of probable dimensions which are actually involved in any cylindrical grinding operation, a graphical layout of the grain paths on a large scale (say $^1/_4$ in. = 0.0010 in.) will show that these curves are so nearly straight lines that the error is negligible. The mathematical relations are greatly simplified by this assumption. By actual trial it was found that there was seldom over 2 per cent difference in the values of maximum chip depth obtained by the use of the *actual* and the *assumed* forms of grain path.

Wheel-Wearing Action

The three factors to be considered as determining wheel-wearing action are (1) the frequency with which the grain is applied, (2) the average grain depth of cut as indicated by the chip dimensions, and (3) the kinetic energy of the grain due to its mass and velocity.

[In his complete paper, the author here discusses the three factors mentioned and derives the formulas given below for grain depth of cut and for wheel wear, using the following notation:

N = r.p.m. of wheel
V = surface speed of wheel, ft. per min.
u = work speed in ft. per min.
R = wheel radius in inches.
r = work radius, inches
f = depth of cut, inches on work radius
μ = interval between grains, inches
S = radius of feed circle = $r - f$, inches
G = maximum depth of chip, inches.]

Frequency of application depends upon the revolutions per minute of the wheel. Work done is measured by the dimensions of the chip removed by each grain and the total number of chips removed. Kinetic energy is proportional to the mass and square of the velocity of the cutting particles.

Frequency of application of the grain $= N = \dfrac{12V}{2\pi R}$, and volume of wheel wear $= \dfrac{12V}{2\pi R} \times 2\pi R$. Therefore wheel wear is directly proportional to $12V$; or dropping the constant, is directly proportional to V.

The formula for grain depth of cut, as derived in the complete paper, simplified by the omission of inconsequential terms, is

$$G = \frac{\mu u}{V}\sqrt{\frac{2f}{r}} \text{ (approximately)} \qquad [1]$$

From this it is deduced that grain depth of cut varies directly with grain interval, work speed, and square root of radial feed; and inversely with wheel speed, and square root of work radius.

The kinetic energy of the cutting particles increases with the square of the velocity.[1] For a certain depth of cut the resistance of the work to the grain is very nearly proportional to this depth, as the cuts are very small, even when compared to the total size of the grain. Theoretically, for some low velocity the kinetic energy of the grain should just equal the energy required to remove the chip (the feed would be reduced to maintain constant grain depth of cut under reduced wheel-velocity conditions) and wheel wear would be caused without any chip being removed up to this point. Actually the bond strength is always sufficient to prevent this condition. Our assumption is then clear that:

Wheel wear varies inversely with the *surplus* kinetic energy of cutting particles and is inversely proportional to *effective* wheel surface velocities (wheel speed minus work speed).

We are now prepared to combine factors.

a Wheel wear is proportional to the wheel speed, or to V.
b Wheel wear is proportional to the grain depth of cut, as expressed in Formula [1].

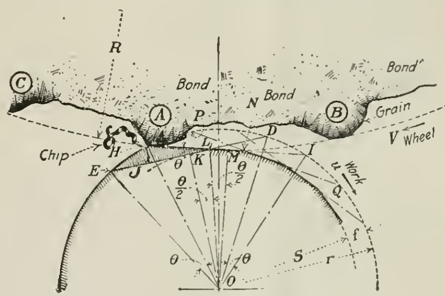

Fig. 1 Diagram Illustrating Cutting Action

c Wheel wear is inversely proportional to surplus kinetic energy of the cutting particles, or proportional to $1/(V-u)^2$. The term u is usually negligible as compared with V and it may therefore be assumed that $1/V^2 = 1/(V-u)^2$.

From these relations, *a*, *b* and *c*, an index of wheel-wearing action (WW_1) due to grinding (where the wheel face is free-cutting) may be expressed as follows:

$$WW_1 = V\frac{\mu u}{V}\sqrt{\frac{2f}{r}} \times \frac{1}{V^2}$$
$$= \frac{\mu u}{V^2}\sqrt{\frac{2f}{r}} \qquad [2]$$

Laws of Grinding for Draw-In Cuts

From this expression we may derive the following laws of cylindrical grinding, operative *within the usual limits of speeds and dimensions.* For straight-in (draw-in) cuts a free-cutting wheel will wear according to the effect of wheel-wearing action as follows:

a Wheel-wearing action increases directly as:
1 Grain interval (grain size—inversely as grade)
2 Work speed (surface)
3 Square root of diametral cut (feed).

b Wheel-wearing action increases directly as the following are decreased:
1 Square of wheel speed (surface)
2 Square root of work radius.

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[1] Norton Co.

Abstract of a paper presented at the Annual Meeting, New York, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] See Selection of Grinding Wheels for the Foundry, *Grits and Grinds*, Jan., 1915, The Norton Company, Worcester, Mass.

A soft wheel is more susceptible to wheel-wearing action than a hard wheel and will more nearly follow the theoretical conditions. It is therefore more free-cutting and will cut more nearly the full chip than a hard wheel. There is consequently a gain in production as wheels of softer grades are used, all other conditions remaining constant, up to the point where the chips are geometrically perfect for a given condition of speeds and dimensions. It is clear from this standpoint that the softest possible wheel should be used. High wheel speeds up to the safe limit are of course necessary if the soft wheels are to perform in a satisfactory manner.

To show the practical application of Formula [2] for wheel-wearing action (Index of Wheel Wear), Table 1 is given.

In column 1 of the table are the work speeds provided on a recent grinding machine, given in order so that actual values can be experimentally obtained to check with the theoretical. In the succeeding columns are two series of values as follows:

1 Following the term "Production" are *approximate* values for cubic inches of metal removed per minute for a wheel 1 in. wide. These were calculated by the formula, Production = nominal work diameter $\times \pi \times$ r.p.m. $\times$ depth of cut (assumed to be 0.0005 in.), which gives values slightly less than the true values.

2 Following the terms "Wheel Wear" are values of the *actual* wheel wear obtained by multiplying the Index of Wheel Wear, calculated by Formula [2], by a constant derived by experiment. This constant is for convenience expressed in the form 1800×10^4.

Sample Calculation. In Formula [2] assume:

u = 53 r.p.m. = 13.9 ft. per min.
r = $1/2$ in. (work diameter 1 in.)
f = 0.0005 in.
V = 6000 ft. per min.
μ = 0.05
R = 9.0 in. (wheel radius)

Substituting,

$$WW_1 = \frac{0.05 \times 13.9}{36{,}000{,}000}\sqrt{\frac{0.001}{0.5}}$$
$$= 0.0000000196 \times 0.047 = 9212 \times 10^{-13}$$

Multiplying by constant given above (1800×10^4),

WW_1 = 0.0166 cu. in. per min. for wheel 1 in. wide.

The corresponding "Production" in Table 1 is 0.0835 cu. in.

It will be seen that the wheel-wear values increase rapidly as work speed increases. The value 0.0166 for work of 1 in. diameter at 53 r.p.m. becomes 0.1040 for work of 4 in. diameter at 167 r.p.m. The same wheel cannot be properly used for both cases, as one sufficiently soft to cut freely in the first case would wear so fast as to be nearly useless in the second case. However, where wheel-wear values are nearly the same we may expect the same wheel to act properly. For instance, a wheel suitable for 1-in. work at 138 r.p.m. wears at the rate of 0.0433 cu. in. per min.; and one suitable for 4-in. work at 72.5 r.p.m. wears at the rate of 0.0450 cu. in. per min. In all probability one wheel would serve for both.

Selection of Wheels for Draw-In Cuts

From Table 1, and by experimental tests with various wheels, certain ranges of wheel-wear values may be found which correspond to definite grades of wheels of suitable grain size and abrasive for the material to be ground. Once this is done, the selection of proper wheels is no longer a question of guesswork, as wheel-wear indices may be computed for any set of conditions and the proper wheel selected. The question of the variation in wheels has been reduced to a point where it no longer can be a very large factor, and we may always change our speeds or feeds to correct the action in the proper direction if we understand the laws which have been previously pointed out. As an example of the possibilities of wheel selection, it has been found that for a certain machine the following wheels (Norton system of grade) are suitable for straight-in cuts on mild steel:

Wheel Designation		Wheel-Wear Values, Table 1
36 or 46 J	for values from	.0150 to .0250
36 or 46 K	for values from	.0250 to .0350
36 or 46 L	for values from	.0350 to .0450
36 or 46 M	for values of	.0450 and higher

Use no wheels harder than M. For hard materials use a grade softer and No. 60 grain. These values are for straight-in cuts only.

Influence of Feed. As an example of the effect of doubling the feed, let us assume the conditions as above, except that the feed is increased to 0.001 in. (on radius).

$$WW_1 = \frac{\mu u}{V^2}\sqrt{\frac{2f}{r}} = \frac{0.05 \times 13.9}{36{,}000{,}000}\sqrt{\frac{0.002}{0.5}}$$
$$= 1240 \times 10^{-13}$$

Wheel wear = $1800 \times 10^4 \times 1240 \times 10^{-13}$ = 0.0224 cu. in. per min. per inch of wheel face. Production is approximately doubled and

$$\text{Wheel-wear increase} = \frac{0.0224 - 0.0166}{0.0166} \times 100 = 35 \text{ per cent.}$$

This indicates how advantageously an increase of feed operates to obtain increased production (up to the limit of grain penetration). If we had doubled work speed we would simply have doubled both production and wheel wear.

TABLE 1 COMPARISON BETWEEN WHEEL WEAR AND QUANTITY OF METAL REMOVED AT DIFFERENT WORK SPEEDS

Work Speed in r.p.m.		Work Diameters 1 in.	2 in.	3 in.	4 in.
53	Production	0.0835	0.1670	0.2500	0.3340
	Wheel Wear	0.0166	0.0236	0.0290	0.0334
72.5	Production	0.1140	0.2280	0.3420	0.4560
	Wheel Wear	0.0226	0.0319	0.0390	0.0450
87	Production	0.1370	0.2740	0.4110	0.5480
	Wheel Wear	0.0273	0.0387	0.0475	0.0546
101	Production	0.1586	0.3172	0.4758	0.6344
	Wheel Wear	0.0316	0.0448	0.0540	0.0635
138	Production	0.2160	0.4320	0.6480	0.8640
	Wheel Wear	0.0433	0.0612	0.0645	0.0865
167	Production	0.2620	0.5240	0.7860	1.0480
	Wheel Wear	0.0522	0.0740	0.0910	0.1040

Wheel diameter 18 in.; surface speed, 6000 ft. per min.; diametral feed per work revolution (automatic feed), 0.001 in.; grain of wheel, 6646 Alundum; material, mild machinery steel.

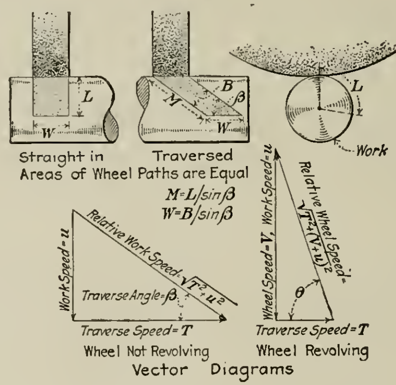


Fig. 2 Speed Relations between Work and Wheel

Traversed Cuts

The most important development in recent grinding machines is the recognition and utilization of the fact that overall operating efficiency for traversed cylindrical work *increases* as *traverse speeds are increased*. (This assumes that for a given traverse speed, width of wheel and revolution of work are so related as to cause the cutting face to just cover the lead of the work.)

Referring to Fig. 2, let

W = width of wheel face
L = length of projected arc of rotation of work
M = actual length of path of traversed cut
B = actual width of path of traversed cut
β = traverse angle

Then $B = W \sin \beta$; $M = L/\sin \beta$; areas $W \times L$ and $B \times M$ are equal. Wheel width of cut is proportional to W for straight-in cut, but reduced to B for traversed cut.

traverse angle. This relative increase does not appear in the projected (end view) relations. As these alone affect individual grain depth of cut, we have gained in relative work speed to get over the longer path M so as to cover the same area in the same time on a narrower width, B, *without* increasing grain depth of cut.

Now if the wheel rotates, each grain cuts across the work at an angle θ, resulting from speed relations shown by Fig. 2 (vector diagram for rotating wheel). Then the individual grain paths are at a much steeper angle than the wheel path to the axis of work rotation, but we have gained in relative wheel speed *without* increasing individual grain depth of cut. Our wheel width of cut is also reduced by a slight amount proportional to $\sin \theta$, which is of course much less than the reduction before the wheel was rotated. The net result is a reduction in wheel stress proportional to $\sin \theta$ and an increase in work speed proportional to $\sin \beta$, *without* increase in grain depth of cut.

The "head resistance" against the wheel as a whole is reduced by the $\sin \beta$ factor, while wheel width of cut is reduced by $\sin \theta$. These both directly affect wheel wear. For traversed-feed conditions our grain depth of cut remains the same as in straight-in feeds, but wheel wear is reduced in the proportion of $\sin \beta \times \sin \theta$.

If T = traverse speed, V = wheel speed, u = work speed, then

$$WW_1 = \left(\frac{u}{\sqrt{T^2 + u^2}}\right)\left(\frac{V + u}{\sqrt{T^2 + (V + u)^2}}\right)\left(\frac{\mu u}{rV^2}\right)\left(\sqrt{2rf}\right) \ldots [3]$$

In practical cases the second term will be so nearly 1 that it may be neglected. It is evident that T affects the quantity appreciably only when u is kept relatively low. This indicates that a wide wheel should be used to get the effect of reduced wear for a given production, traversing as rapidly as possible. The above formula assumes no overlapping of the cut.

Now by making assumptions and neglecting values whose effect is so small as to make no appreciable difference for purposes of comparison, we reduce the expressions for WW_1 exactly as we did in the case of straight-in feeds and obtain:

$$\text{Index of wheel wear } WW_1 = \frac{\mu u}{V^2}\left(\frac{u}{\sqrt{T^2 + u^2}}\right)\sqrt{\frac{2f}{r}} \ldots\ldots [4]$$

Laws of Grinding for Traversed Cuts

From this it is evident that for traversed work:

a Wheel wear increases directly with the work speed

b Wheel wear decreases directly as the decrease in the quantity which we term "traverse factor," which is work speed divided by the square root of the sum of the squares of traverse and work speeds

c Wheel wear decreases directly as square of wheel speed increases

d Wheel wear decreases directly as the square root of the work radius increases

e Wheel wear increases directly as the square root of the feed increases.

The value $\dfrac{u}{\sqrt{T^2 + u^2}}$ in our expression for index of wheel wear is our traverse factor. Where T is large with respect to u this factor will be appreciably less than unity, but as u increases the reduction in wheel-wearing action is less pronounced.

Table 2 gives values of the traverse factor for a certain machine having the work speeds previously given for draw-in cuts, and the following table (traverse) speeds: 10.02, 14.00, 17.00, 19.70, 26.90 and 32.60 ft. per min. The table shows combinations of speeds giving leads from 2.3 in. upward. As the machine was designed for a wheel $2^1/_2$ in. wide, combinations of speeds giving lesser leads of work are not given.

If we now multiply each of the traverse factors in Table 2 by the wheel-wear value for the corresponding work speed and work diameter as shown in Table 1 (draw-in cuts), we will have a table of wheel-wear values for traversed cuts. These products are given in Table 3.

By assigning certain wheels to specified ranges of wheel-wearing action, we may select the proper wheel through the use of Table 3 in the same way that we did from Table 1. Actually in the case of traversed work it is not possible to feed in the wheel to the indicated depth (as shown by the feeding mechanism) as closely for traversed work as for draw-in work, and therefore the actual cut is not so deep. This means, of course, that the "spring away" action of the work is more pronounced for traversed than for draw-in work. Careful use of steady rests is therefore very essential.

TABLE 2 TRAVERSE FACTORS

Traverse, ft. per min.	Work, r.p.m.	Lead, in.	Work Diameters 1 in.	2 in.	3 in.	4 in.
10.02	53	2.3	0.810	0.950	0.975	0.985
14.00	53	3.1	0.705	0.883	0.946	0.968
14.00	72.5	2.3	0.805	0.938	0.968	0.976
17.00	53	3.8	0.632	0.850	0.926	0.955
17.00	72.5	2.8	0.730	0.910	0.955	0.974
17.00	87	2.3	0.802	0.935	0.972	0.985
19.70	53	4.4	0.576	0.817	0.905	0.943
19.70	72.5	3.2	0.691	0.884	0.943	0.967
19.70	87	2.7	0.756	0.916	0.961	0.980
19.70	101	2.3	0.802	0.935	0.971	0.986
26.90	53	5.9	0.460	0.720	0.839	0.900
26.90	72.5	4.4	0.574	0.815	0.902	0.942
26.90	87	3.6	0.646	0.860	0.931	0.958
26.90	101	3.1	0.703	0.890	0.950	0.974
26.90	138	2.3	0.801	0.936	0.960	0.982
32.60	53	7.35	0.397	0.655	0.790	0.865
32.60	72.5	5.3	0.505	0.760	0.867	0.919
32.60	87	4.4	0.580	0.815	0.908	0.945
32.60	101	3.8	0.635	0.854	0.927	0.960
32.60	138	2.8	0.748	0.914	0.945	0.977
32.60	167	2.3	0.807	0.936	0.967	0.982

The following wheels are found to be satisfactory for our machine for traversed cuts on mild steel under the assumed conditions:

Wheel Designation		Wheel-Wear Values, Table 3
36 or 46 I	for values up to	.02500
36 or 46 J	for values from	.02500 to .04000
36 or 46 K	for values from	.04000 to .05000
36 or 46 L	for values from	.05000 to .06000
36 or 46 M	for values from	.06000

Use No. 60 grain for hard material and a grade softer; but use no wheel softer than I.

Important Note. These statements of wheel assignment are based upon assumptions of the best machine conditions and most careful operation to prevent any abuse of the wheel. Field practice will usually show harder wheels in use due to conditions which abuse the wheel. Efficiency is sacrificed where such is the case.

Production Costs

If wheel wear were the most important element of production cost, grinding efficiency might be considered on this basis without leading to the fallacy which exists today. As a matter of fact, the wheel cost is almost negligible compared with the other costs, and wheel selection should be based upon the production capacity of the wheel under the given set of grinding conditions, allowing the wheel wear to be as high as is necessary to get a free action without excessive wear (which would cause difficulty in sizing work and the need for frequent dressing). The all-important factor is the rate at which the wheel may be made to cut and still not get out of truth. This affects the grinding time, any reduction of which is of vastly more importance than an increase of wheel wear which may result from such a reduction.

TABLE 3 WHEEL-WEAR VALUES FOR TRAVERSED CUTS

Traverse, ft. per min.	Work, r.p.m.	Lead, in.	Work Diameters 1 in.	2 in.	3 in.	4 in.
10.02	53	2.3	0.01340	0.02240	0.02820	0.03280
14.00	53	3.1	0.01170	0.02080	0.02740	0.03230
14.00	72.5	2.3	0.01820	0.02450	0.03775	0.04390
17.00	53	3.8	0.01050	0.02005	0.02685	0.03185
17.00	72.5	2.8	0.01650	0.02900	0.03720	0.04370
17.00	87	2.3	0.02190	0.03620	0.04620	0.05390
19.7	53	4.4	0.00955	0.01930	0.02620	0.03142
19.7	72.5	3.2	0.01560	0.02820	0.03675	0.04350
19.7	87	2.7	0.02060	0.03540	0.04570	0.05355
19.7	101	2.3	0.02540	0.04185	0.05245	0.06260
26.9	53	5.9	0.00763	0.01695	0.02430	0.03000
26.9	72.5	4.4	0.01290	0.02600	0.03520	0.04240
26.9	87	3.6	0.01760	0.03320	0.04420	0.05235
26.9	101	3.1	0.02220	0.03980	0.05125	0.06185
26.9	138	2.3	0.03470	0.05130	0.06195	0.08500
32.6	53	7.35	0.00660	0.01545	0.02290	0.02885
32.6	72.5	5.3	0.01140	0.02420	0.03380	0.04130
32.6	87	4.4	0.01580	0.03150	0.04315	0.05160
32.6	101	3.8	0.02000	0.03820	0.05000	0.06100
32.6	138	2.8	0.03230	0.05580	0.06095	0.08450
32.6	167	2.3	0.04210	0.06940	0.08800	0.10230

In good practice the volume of wheel wear is approximately a tenth of the material removed (mild steel) during roughing operations. A conservative estimate of the cost of operating a modern cylindrical grinding machine (exclusive of wheel cost) is, say, five cents per minute, including labor at day-rate wages.[1] The useful content of the wheel may be assumed to be such that the wheel is actually worth seven cents per cubic inch. If production could be increased to 2 cu. in. per min. where previously we obtained $1^1/_2$ cu. in. and wheel wear jumped from 0.15 cu. in., say, to 0.25 cu. in. per min., our first cost would be: $(0.05 + 0.15 \times 0.07) \div 1.5 =$ \$0.0404 or 4.04 cents per cu. in. removed. In the second case, $(0.05 + 0.25 \times 0.07) \div 2 =$ \$0.0338, or 3.38 cents per cu. in. removed.

Now the overall production efficiency of the machine based upon all costs involved is indicated by production-cost factors proportional to the earning rate of the machine. In the first case this factor would be: (production) ÷ (cost) $= \dfrac{1.5}{0.05 + 0.15 \times 0.07} = 24.8$.

In the second case, $\dfrac{2.0}{0.05 + 0.25 \times 0.07} = 29.6$.

It evidently will pay to wear the wheel more in order to obtain the higher rate as the overall gain in the foregoing is about 19 per cent. The above assumed values are reasonable and the figures given might be considered as typical. Table 4 gives these production-cost factors, or relative earning rates based upon these costs and the grinding conditions previously assumed in Tables 1, 2 and 3, the variations being due to traverse and work-speed relations only, but with proper choice of wheels in each case. Then, for the machine which we have used as an illustration it is evident that for work of a certain size and a wheel of a certain width there is one speed combination which will utilize the machine to the greatest profit. If we are able to use wheels of the width needed to cover the lead under the best speed-relation conditions, we will obtain the best earning rate of which the machine is capable. If wide wheels are not available, we still have speed-relation conditions which will give very nearly as high a rate for the narrower wheels.

In Table 4 the production-cost factors are given for 1-in. and 4-in. diameters of work only. The factors may also be expressed as earnings per unit of time, or the relative amounts the machine would earn in equal lengths of time under the various conditions as given.

Note that, due to high traverse, a 2.3-in. wheel which earns \$3.68 in a certain length of time when grinding 1-in. work at low traverse and work speeds, will earn \$10.62 in the same length of time when using the high speeds. If the widest wheel (7.35-in. face) be used the machine will earn \$11.70 in the same length of time. The grade of wheel is suitable in each case according to the speed changes. This clearly shows that high traverse speeds cause a corresponding increase in earnings in spite of the necessary increase in work speed.

TABLE 4 PRODUCTION-COST FACTORS

Table Speed, ft. per min.	Work, r.p.m.	Lead, in.	Diameter of Work 1 in.	4 in.
10.02	53	2.3	3.68	13.45
14.00	53	3.1	5.16	18.80
14.00	72.5	2.3	4.95	17.85
17.00	53	3.8	6.00	21.00
17.00	72.5	2.8	6.00	21.80
17.00	87	2.3	5.85	22.00
19.70	53	4.4	6.40	23.70
19.70	72.5	3.2	6.80	23.50
19.70	87	2.7	6.84	23.45
19.70	101	2.3	6.75	23.30
26.90	53	5.9	9.05	29.80
26.90	72.5	4.4	9.34	29.85
26.90	87	3.6	9.00	29.00
26.90	101	3.1	9.03	29.10
26.90	138	2.3	9.00	29.15
32.60	53	7.35	11.70	35.70
32.60	72.5	5.3	11.30	34.60
32.60	87	4.4	11.00	33.60
32.60	101	3.8	10.90	33.40
32.60	138	2.8	10.80	33.30
32.60	167	2.3	10.62	32.90

Considering the cost of wheels 7.35 in. wide as compared to wheels 2.3 in. wide, and the relative power required to drive the two wheels, it is very evident that the use of a harder wheel 2.3 in. wide would offset the difference in wearing action without greatly reducing production and that the production of the 7.35-in. wheel is matched by the production of the 2.3-in. wheel using highest traverse and highest work speed.

[1] The figure of 5 cents a minute as time cost of operation is based upon labor at 75 cents an hour and an hourly burden of \$2.25 an hour (power, investment, rent, heat, light, etc.).

The most striking conclusion from the above is the fact that in order to use a narrow wheel and get great production the high work speed does not cause excessive wheel wear *due to the relief* on the wheel brought about by the *high traverse speed*. This traverse speed is also necessary to allow the rapid exposure of fresh work surface to the cutting face, making for a highly economical combination.

The foregoing should demonstrate clearly what this new development in the science of grinding may mean to the art as practiced throughout our production shops.

Actual grinding tests upon a machine having the high-traverse feature, and making use of the speeds shown in the table, have conclusively proven the deductions indicated by the mathematical calculations. On mild machine steel (0.15 per cent carbon) over diameters ranging from $^3/_4$ in. to 4 in., production rates as high as 2.00 cu. in. per min. have been easily attained, grinding to limits of 0.0010 in., removing 0.060 in. from the diameter over lengths of from 36 to 72 in.

When machine conditions, truth and balance of wheel, and proper use of steady rests and grinding compound are intelligently and skilfully handled, wheels of 36 and 46 grain size, and grades I to L (Norton system of grading) have been used in these roughing operations. Especially where the feeding is carefully regulated so as *never* to *crowd* the *radial depth* of cut to more than the possible depth of grain penetration (say, not to exceed 0.0015 in. on the diameter) per traverse, it has been found that the wheel face remained sufficiently true to leave a commercial finish of fair degree absolutely free from chatter marks, feed lines or any other imperfections of real or imaginary consequence.

Owing to the fact that in the above the highest work and traverse speeds were used in every case, the grade (hardness) of wheel was increased as the diameter of the work increased. This is in accordance with our formula for index of wheel wear. Instead of considering the work speed and work radius independently, they were in this case tied together by the fact that a constant work r.p.m. was used. The expression for this is as follows:

$$\text{Work speed } u = \frac{2\pi r N}{12} \quad \ldots\ldots\ldots\ldots\ldots\ldots [5]$$

where r = work radius (inches) and N = r.p.m. Substituting [5] in [4],

$$WW_1 = \frac{0.275\mu}{V^2}\left(\frac{N^2}{\sqrt{T^2 + 0.275r^2N^2}}\right)\sqrt{2fr^3} \quad \ldots\ldots\ldots [6]$$

Now if V, N, T and f are made constant, WW_1 must vary as the value r appears in the formula, the greatest effect being the $\sqrt{r^3}$ factor and we would expect therefore to use harder wheels as r increases.

Conclusions

The conclusions to be drawn from the foregoing are definite and indicate positively how to arrive at the solution of precision grinding problems, provided one has an intelligent knowledge of abrasive wheels and the usual materials ground.

Greatest grinding efficiency is obtained by the use of the *softest wheels* suited to the nature of the material ground. This efficiency is dependent upon the control of the dimension and speed relations between the wheel and the work so that the individual chip may have the minimum depth for a given volume determined by the maximum allowable radial depth of cut. This means long arc of contact, low work speeds and maximum feeds. With these conditions established, *increase of traverse speed increases production without increase of wheel-wearing action.* Machine conditions must be such as to maintain as accurately as it is reasonably possible the speed and dimensional relations of the wheel and the work.

There is an enormous field for the industrial engineer in obtaining better production at less cost in grinding operations. There is a definite science involved, there is no mystery about it. The proper appreciation of the laws of grinding by machine designers and operators is rapidly increasing and we may expect a constant improvement in the art as a consequence.

The Specific Mechanical Purposes for Which Cloths Are Used and an Enumeration of Their Applications in the Most Important Industries

By JAMES W. COX, JR.,[1] NEW YORK, N. Y.

Cloths for mechanical uses are made from practically all the well-known fibers, cotton predominating, with wool, asbestos, silk and linen following in about the order named. Occasionally other fibers are used in cloth for special purposes. Cloth is used for mechanical purposes where it only will function or as a substitute for leather, metal banding, metal cloth, rawhide, sheet metal, wire or wire screen. Cost is usually the principal consideration for substituting cloth for the above materials; also it has been found in many instances that a fabric did the work in a better manner than the original substances, flexibility being a large factor in its adoption.

These cloths can be classified as to specific uses and to different industrial groups. It is impossible in one paper to give every specific use of mechanical cloths. The following tabulation, however, roughly covers their most common uses:

Absorption	Containers	Inking	Pressing
Aprons	Cushion devices	Insulating	Screens
Backings	Curtaining	Jacketing	Sieves
Bagging	Distributors	Laminated materials	Slings
Belts	Drying	Leaders (machine)	Steaming
Binders	Facings	Linings	Straps
Buffers	Fabric bases	Marking	Tapes
Bumpers	Filters	Moistening	Tracing
Cabling	Flame protectors	Packing	Tubing
Carriers	Formers	Paddings	Washers
Cleaners	Gaskets	Partitioning	Webbing
Conveyors	Grips	Patches (repair)	Wicks
Covers	Hose	Polishing	Windings

Practically every industry uses cloth mechanically in some way, those listed below being the largest and perhaps the most prominent consumers:

Aircraft	Conveyor	Mining	Printing
Army	Electrical	Musical instruments	Pumping
Automobile	Engraving	Office machinery	Railroads
Baking	Farm machinery	Oil	Rubber
Beverage	Flour	Packing (mechanical)	Shipbuilding
Candy	Gas manufacture	Paint	Shoe machinery
Canning	Household machinery	Paper	Textile
Chemical	Laundry machinery	Powder	

Specific Uses

Absorptives. Coarse plain-woven jute and cotton cloth are used for this purpose. In either case the material is impregnated chemically so that when put in a machine, room or mine it will absorb gases of various kinds, moisture, etc. Cloth for absorption purposes is generally known as "brattice cloth." Jute was almost universally used until the price mounted; now low grades of cotton and cotton waste are used to a large extent as a substitute.

Belting. Woven belts are made for practically every purpose a leather belt is used for, including conveyors and machine aprons. Woven belting is being used plain, or impregnated with various substances such as tar, rubber and materials of this type. It has the advantages of being more nearly heat-, gas-, moisture- and water-proof and is usually cheaper. Belts of this type are made wholly of cotton, or if excessive strength is required the warp is of camel's hair. In general they are a two- to eight-ply plain fabric made like a webbing and resembling before treatment a heavy, thick, narrow duck.

Belts of canvas or light duck in two-ply and up are also made by stitching the length of the belt every half-inch or so apart. Then this is treated or impregnated in the same way as the solid-woven fabric.

Bindings and Check Straps. Heavy cotton webbing is used on various types of machines for lifting mechanisms. It is used in loop form on automobiles to prevent the too rapid recoil of the springs, also in special patented devices to achieve the same purpose. It is used for check straps on machines, train signals, and in street and railroad cars. Impregnated, light cotton tape is used for making various pipe connections and in electrical wire splices.

Conveying. Cotton duck, from light army to heavy numbered, is used extensively in conveying machinery of all kinds. Camel's-hair, plain cotton and stitched canvas belting is also used either treated or plain, according to the conditions under which the conveyor is run. The widths and weights vary from a cotton webbing for conveying small machine parts, to a heavy double- or triple-width belt for a box, barrel, coal or iron conveyor, etc. In two industries, candy making, and photographic-film making, cotton oilcloth is used on account of its smoothness and ease of cleansing.

Filtering. The filtering or straining of gases, air and liquids is considered under this head, the sifting of solids being taken up under "Sieves." In some cases when the filtration is slow and the pressure great the process is known as "pressing," but the action is identically the same, taking out substances that are not desired.

In the manufacture of some commercial gases a fine plain-woven linen, cotton or woolen cloth is used to take out solid particles of matter which are occasionally present. Fine asbestos cloth is also used when a detrimental chemical action would take place on cotton, flax, or wool. Medium asbestos and cotton cloths are used as smoke screens where cinders are an objection. In a few types of air-filtration installations a coarse cotton sheeting is used to take out the heaviest dust particles as the air enters.

As strainers on the ends of flumes in power-house work coarse open-mesh cotton or woolen cloths are used. They are usually called "flume bags" and are used secondarily to wire mesh which prevents the large pieces of substances getting in the pipes. Cotton strainer cloths are used sometimes in the pipes leading to water filters. They are used in canning establishments for the straining of fruit and vegetable juices and somewhat in factories making soups, sauces, relishes, etc. In cider mills a heavier, more open, and thicker cotton cloth is used for the extraction of the apple juice. It is generally a two- to five-ply yarn, loosely woven fabric, resembling a tire fabric in many ways with the exception of the tightness of the weave. This type of cloth is also used in the preliminary straining of other fruit juices.

The filtering of liquid chemicals is done by many kinds of woolen, cotton, linen and asbestos cloth. Some paint makers use a cotton filter cloth also in their manufacturing processes.

In the oil industry cotton filter cloths are used extensively. Crude oil, kerosene, gasoline, benzine, naphtha, linseed oil, cottonseed oil, in fact all kinds of oil, are generally filtered or "pressed" in the making. The cloths range from thin sheeting to heavy duck or multiple-ply hair cloth. When the oil is quite fluid, cotton sheetings and twills are used, and as the viscosity increases the heaviness and thickness of the filtering cloth increase. So next, heavier, thick twills are used, more on the order of a denim, then light duck, army duck and finally the very thick and many-ply cloths where the liquid is forced through by great pressure. These fabrics are of cotton, horse and other hairs. For the heaviest work where they have tremendous strain and pressure, a camel's-hair three- or four-ply cloth is used. These latter types are called "press cloths." In general they are stretched between flanges in a pipe and the oil or liquid forced or "pressed" through them by great pressure, necessitating great strength.

In the case of garbage or sewerage reduction the cloths used are of ply yarns, very open and plain weave. Asbestos cloth is used here to great advantage as it can be cleansed easily by subjecting to fire.

[1] Textile Engineer, 320 Broadway. Mem.Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, New York, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

Laminated Cloth. One of the principal uses of laminated cloth is for polishing. Practically always cotton cloth is used, osnaburgs, sheetings and in some cases light duck. Woolen cloth is used in glass polishing to some extent. Laminated cotton-cloth buffers are built up to any desired thickness, stitched, die-cut in circular form and occasionally stitched again spirally. A center of metal or wood is inserted and the polishing wheel is ready for service. This type of polishing wheel is used for polishing leathers, artificial leathers, woods, metals and various kinds of composition materials. It is sometimes used in hat cleaning.

Laminated cotton sheeting impregnated with composition materials of various kinds has been used also in certain types of universal joints. In the textile industry laminated numbered cotton duck stitched, riveted, or both, is used to some extent on looms in the form of lug straps, check straps and pickers. Fine sheeting and light duck laminated and impregnated with composition materials are used for the making of gears. The blank is built up and the gears are cut the same as if of iron, steel or rawhide. Laminated cotton sheeting alternated with a cheap, light woolen flannel is used at times for making pads on which great pressure is brought and where pressed felt would spread and cause an uneven surface.

Laminated cloths are used for packing as noted under that heading.

Packing. Cotton and asbestos cloths, plain and laminated, are used extensively for mechanical packing, in gaskets and in washers of various kinds. The cotton cloth is generally impregnated with composition materials of various kinds and cut in the desired shapes necessary. Asbestos cloth is used both plain and impregnated in the same manner as cotton cloth. It is used for the most part in places where there is great heat. It has this advantage over cotton-cloth packing, but under a tension the latter is generally better. Impregnated jute cloth is also used at times where a cheap packing is desired and no particular strain or heat is present.

A large amount of cloth packing is consumed by prime movers of various kinds: steam engines and turbines; and gas, kerosene, gasoline, and various kinds of oil engines. It is used generally about any power plant. Pipe joints use impregnated cloth packing of all kinds and the consumption of the material in this way is very large. Light army duck and sometimes a light flat duck are used as the outside covering of asbestos and magnesia pipe coverings.

Pads. Under this heading a closely woven cotton sheeting or some times a light twill is used as the covering on inking pads in the printing and engraving industry, particularly on flat-press work. As heretofore described, occasionally a laminated pad made of cotton sheeting and woolen flannel is used on work where there is much pressure against the pad.

Flat ironing machines as used in laundries and homes have a woolen-flannel backing covered with a thick sheeting or light duck as a press pad. This same type of machine somewhat modified is used in tailoring establishments where pressing is done in large quantities.

Polishing. Cloth is extensively used in polishing all kinds of surfaces. Cotton cloths of various types are laminated, sewed or riveted and then cut in disk form for polishing and buffing. They are used for polishing leather, wood, compositions and metals of various kinds, in the shoe industry and automatic shoe-polishing machines. The jewelry and electroplating trades use this type of polisher to some extent. In some instances cotton webbing is used when a heavy pressure has to be brought to bear.

In the making of lenses and various articles of glass, polishing is done by heavily felted woolen cloths, which cover the polishing wheels. These cloths vary from a thin billiard cloth to a thick heavy melton. Woolen cloths are sometimes used in the finishing of hats.

Pumping. Flexible cotton hose, plain or treated, is used very generally in pump connections for gases, air and liquids, especially in industries where a portable pump is necessary. The number of uses is legion and the following are fair examples of its very wide application:

a For gas work, in the handling of oxygen, nitrogen and most commercial gases

b For air use, in the portable vacuum-cleaning outfits on wagons and automobiles, on house, factory, and office cleaners, the connections on compressed-air drills of all kinds, connections on sand-blast cleaning outfits, and on outfits for pumping air to divers

c For combination air and liquid pumps, in the connections for various types of atomizers, spraying devices, etc.

d For liquids, in the connections on water pumps of all kinds; e.g., gasoline motors, fire engines, mine pumps, etc. On spray-painting connections and pumps of that type

e For liquids mixed with solids, in the connections for contractor's pumps, dredge pumps, bilge and boat pumps of different kinds, filtration and sewerage pumps, etc.

Sieves. Cloths of various kinds are used as sieves. The finest is known as silk bolting cloth and is a gauze-type fabric varying from about 20 meshes to the inch up to 200 for the very finest. This is made up to about forty inches in width and is used for sifting flour and any substance which has to be used in very fine powdered form as chalks, paint bases, chemicals, etc. Sieve cloths are made also of linen and cotton in various meshes and weights for not such fine work and where the silk cloth has not the required strength. The weave is practically always plain and the yarns fine.

Treated Cloth. Cotton cloth in the form of sheeting, duck, belting, webbing and tape is used extensively as backing for different types of impregnated fabrics, cloth made of other fibers being rarely used. The treated fabrics may be divided in the general classes of rubberized goods, oilcloths, artificial leathers, insulating materials, impregnated laminated cloths, and semi-transparent sheeting. They can best be described in this order.

Rubber-treated cloth is perhaps most used. Tires consume a large amount of sheeting and a special fabric. Belting and webbing are used for conveyors, belts, and straps. Sheeting and duck, plain and laminated, are used for packing gaskets and washers. Sheeting and duck are used for printers' blankets, bolster aprons on machines for removing hair from hides, paper machines, electric separators and various other purposes. Tubular fabrics are used for hose, tubing and sleeve work.

Sheeting and duck made into oilcloth are used in various ways. As a conveyor apron on office duplicating machines, as aprons on paper-mill machinery, as backing on the drums used on a tapestry carpet loom which prints its own filling, and as a conveyor on one of the machines used in fur-hat making. Oilcloth as belting or as webbing is used as a conveyor under certain circumstances where a smooth surface is desired. Its use in photographic-film manufacture and candy making are good examples of this. Oilcloth can in general be used to a great extent in places where a rubber-treated cloth is used.

Artificial leathers are a more recent development and have just started to prove their practicability in industry. So far their use for mechanical purposes is practically nil.

Treated cloths for insulation are described under the heading Electrical, and laminated treated cloths are discussed under the headings Polishing and Laminated Cloth.

Semi-transparent treated cloths are used for shades, light filters, and in tracing cloth for mechanical drawings. The cloth used varies from a $4^1/_2$-yd. cotton sheeting for shades down to a very fine linen for tracing cloth.

Wicks. Cotton webbing and in a few cases soft, thick flat duck are used on machinery for purposes of a wick to convey various kinds of liquids to a certain point. Soft webbing is used in heater appliances for the conveyance of gasoline, kerosene, and various oils to be burned. It is also used in moistening, oiling, gumming and inking machines of various types for conveying the liquid slowly to a certain point or surface.

Industrial Groups

Aircraft. This heading is readily divided into three classes: aeroplanes, balloons and dirigibles. On aeroplanes cloth is used in all ways common to the gasoline motor, as described under the heading Automobile. The wings use cloths of silk, linen or cotton

of rubber covered with cotton cloth to prevent incendiary bullets from igniting the gasoline. The straps used on the seats are often of cotton webbing in place of leather. The grip of the steering lever is often cloth-covered. Balloons use silk linen and cotton cloth for the bags. Dirigibles use the same type of cloths for the bags and body coverings.

Army. The cartridge carriers for automatic rifles and machine guns are metal or a combination of cotton webbing and canvas. The best types of the latter are woven as a part double cloth separated canvas and part webbing. In this manner is woven on one machine the belt in its entirety with pockets and flat spots as desired. Other carriers are made by stitching two webs or two layers of canvas. The slings and strappings for almost all guns are now cotton webbing in various widths and weights. The straps on gun carriages, wagons, tanks, tractors, etc., are practically all cotton web. Silk cloth is used for powder bags. It is generally a plain-weave, roughly made, silken fabric of coarse yarns spun of silk waste.

Automobile. The automobile is a very large user of textile products for mechanical purposes. On the motor, treated-cotton or asbestos-cloth packing, gaskets and washers are used. The fan belt is often either a plain cotton webbing, treated webbing, or an endless belt made by cutting cotton cloth on the bias, building up two to four layers of same and then rubberizing. In this way an endless belt is made which has good wearing qualities. Asbestos wrapping is often used around the exhaust manifold. Practically all water-circulating systems, whether pump or thermostatic, use a rubber-impregnated cotton hose.

Asbestos cloth has been used as a facing for clutches. Asbestos webbing is used for brake linings, plain, or more often with a wire warp and asbestos filling. Plain, thick cotton webbing is also used as brake linings on the cheaper cars. Foot-pedal grips are usually canvas-backed, rubber-treated cloth. Door straps are of heavy cotton webbing, plain, rubberized, or made into artificial leather.

On a certain type of cheap car a thick, narrow cotton webbing is used in the transmission. Cotton webbing in various widths and weights is used for plain check straps on the axles and for special devices for preventing too rapid recoil of the springs after going over a rough spot in the road.

In the electrical system impregnated silk or cotton cloth and cotton and asbestos tubing are found on the generator, motor, magneto, transformer coil, distributor and wires. A treated cotton sheeting is universally used for covers on the steering connections, magneto distributor, springs, etc. In the making of wheels, particularly a certain type of truck wheel, cotton canvas or duck is used. It is placed as a cushion and fitting device between the spokes and the felloe.

The automobile tire consumes a tremendous amount of cotton cloth annually. Plain tire fabric, cord fabric, breaker-strip cloth, and lining are so well known as to need no mention in this paper. Blow-out patches of a rubberized cotton fabric and tire-tread covers, used mostly in Europe, are usually a cotton-canvas backing reinforced in various ways. In the manufacture of tires a cotton sheeting is used in the mold.

Bakeries. The majority of cloth consumed is heavy duck, principally "00" weight. It is used as conveyor aprons in the ovens, mixers, conveyors and wrappers in the most modern up-to-date bakeries. Some webbing is used in the same way. Heavy sheets of asbestos cloth act as heat protectors in the ovens. When flour or other ingredients in the making of cake have to be finely sifted, a very fine cotton sheeting or silk bolting cloth is used.

Candy Factories. The same kind of cloths are used in this work as are used in bakeries, with the exception that some of the conveyor belting is of oilcloth, in order to have a smooth surface easily cleansed.

Chemical Work. Cloths of silk, cotton, linen, wool and asbestos are used in different ways in this industry. They are used principally for sieves and filters. Most of them are of fine, hard-twisted yarns, plain woven goods of various degrees of closeness, though twill weaves and double-cloth fabrics are occasionally

Electrical. In this industry cloth is used primarily for insulation work and generally impregnated with a composition material of some kind which is a non-conductor of electricity. For fine-wire insulation and very fine machine work silk tapes and cloth are used. As the sizes increase in each case the tendency is to use cotton tapes or sheeting. Abroad, linen tapes and sheeting are used somewhat, but their use in this country is not general on account of the cost and cotton can be substituted. On cable work cotton and asbestos tubing are also used. Asbestos webbing is used in the making of large generators.

In the telephone industry the uses of cloth are similar to those already mentioned; one particular webbing, however, is of interest as it is not believed such a web is used in any way comparable to it. A $1^1/_2$-in. web of wire warp of about forty ends is made with a heavy silk filling to insulate the warp. Diagonally at short intervals across the filling there are open spaces left, leaving the warp bare so that connections can be made. This web is used in switchboard work on board connections.

Engraving. Fine cotton sheeting is used in this industry to cover the inking pads on certain types of engraving machinery. The backing of the engraving press itself is usually a woolen cloth. It is a very fine, closely woven, and closely sheared woolen, very much on the order of a billiard cloth.

Farm Machinery. Army and numbered duck, cotton webbing and belting, packing cloths and hose, plain or treated, are used in farm machinery in varying amounts. They are used on tractors, tractor plows, ditch diggers, harvesters, threshing machines and pump connections of all kinds.

Household Machinery. Vacuum cleaners use treated cloth, usually cotton, as air and refuse bags and in certain types narrow cotton webbing is used as a drive belt. The hose connections are rubberized cotton hose. Some washing machines are partly cotton-cloth-lined to prevent splinters getting into the clothes. Narrow cotton webbing is used for driving belts. In certain kinds of carpet sweepers a rubberized narrow webbing is used as bands or rims to drive the brush rolls. Some mechanical mops use loosely bound laminated cotton cloth, generally a low-grade sheeting or osnaburg. On mechanical ironers cloths are used in the same way as in the laundry industry.

Laundry Machinery. Cotton or woolen cloth is used quite extensively on this machinery. The principal place, perhaps, is on the rolls of a cylinder ironing machine. These rolls are of metal. First is wound a cotton sheeting; next, many layers of what is termed laundry flannel until a good cushion backing is formed. This flannel is a heavy, straight or broken twill, all-woolen blanket. It is of a coarse wool and heavily napped to get the maximum cushion effect. On top of this flannel is wound a covering of light duck, usually about a No. 12.

On flat press ironers, resembling an old ironing board, two or three layers of the woolen flannel are used, covered by a couple of layers of cotton sheeting. On the starching machines a very open-mesh cotton cloth is used as a conveyor apron. It is made of about eight-three's yarn counting about eight to twelve warp threads and picks to the inch. On other machinery where conveyor aprons are needed, duck is used but heavier than on the ironing machine. In general the duck is a No. 4, 5, or 6. Woolen strainer aprons or cotton sheets are used to some extent to prevent the cloths from touching the inside of the extractors. These are any old cloths available. In the washing machines or kiers where family "wet wash" is cleansed, open-mesh bags are used to hold the cloths, in order to keep each lot separate as they turn over in the machine.

Musical Industry. Both cotton and woolen cloths are used in the manufacture of pianos, inasmuch as felt will not cover every purpose. These are used in the actions and in the keyboards. In piano players cotton webbing also is used for belts and treated cotton cloth in the bellows. In organs cotton strapping is used, treated cotton cloth for bellows and, in case of mechanically driven organs, cotton belting for drive belts. Motor-driven music boxes use webbing for belts.

On a few of the best-made phonographs a woolen cloth is placed

on top of the metal plate holding the record while being played. This replaces pressed felt. The cloth used for this is very much like a thick, coarse billiard cloth. Heavy cotton sheeting or light twills, drills or flannel are used in the manufacture of the record itself.

Office Machinery. The equipment of most business offices includes typewriters and adding and bookkeeping machines. These all require an inked ribbon for their operation and here a fine textile product is used. It is a cotton cloth made of very fine combed yarns, plain weave and generally from 80 to 100 counts each way. It is split lengthwise, gummed at the edges, inked and wound on small spools ready for use. On the stenotype machines there are also ribbons of this character.

On some adding machines, bookkeeping machines and dictaphones there are belts for driving them by electric motors and these are in most cases fine, narrow cotton webbing. Cotton sheeting and flannel are used in the manufacture of the record for the dictaphone. On duplicator machines of various types the conveyor aprons used is a cotton-back oilcloth.

Paper Industry. This industry is one of the largest users of textile products, and is entirely dependent on them, as contrasted to other industries where the textile product may be only an aid in producing results. The fabrics used are made of wool or cotton and are called woolen or cotton "felts," as the case may be. A pressed felt was originally used for the purpose and the name has remained although the product has changed to a woven piece of goods. Woolen "jackets" are also used. These are tubular woven cloths, for shrinking on steel rolls hereinafter described.

The first machine in the paper industry on which a fabric is used is the pulp machine. A thick, open-mesh, plain-weave, heavy, endless woolen fabric takes the stock from a tub and deposits it in layer form on a cylinder from which it is afterward cut in the form of sheets.

On paper-making machines, as the paper stock comes from a revolving wire screen, it is deposited on an endless woven "felt" and by this "felt" is carried through iron press rolls on which is shrunk the heavy woolen "jacket." In this manner the water is squeezed through the "felt" and the thin film of stock or partly formed paper is left on the top of the moving cloth. It is carried through numerous pairs of jacketed rolls and by thicker and finer "felts" and finally is formed paper.

The jackets are tubular two- to five-ply woolen cloths, very closely woven, and felted very hard. They are fulled down to a size less than the roll circumference, and sheared closely; then wet, stretched and placed on the roll. When dry they are so tight they are practically a part of the roll and form an excellent cushion.

The woolen felts mentioned above on which the paper is formed vary from a light, thin, open, well-napped blanket to a close, soft, thick cloth much on the order of a very heavy overcoating. They vary in degrees of openness, thickness, nap, etc., according to the conditions under which run. Double-cloth woolen "felts" having the back cloth a flat, smooth, hard-felted surface and the face cloth of hard yarns, are used as "marking felts," to make a special design on the paper after it has left the regular forming felt. "Carrier felts" of coarse, heavy woolen yarns, heavily fulled, are also used at times to convey the paper from one set of rolls to another.

With the paper formed but wet, it is delivered to an endless cotton "felt," which carries it around many steamed-heated cylinders until dry. The cotton drier "felt" is a very thick heavy duck. It is usually a three- to eight-ply cloth, each ply averaging as heavy as No. 4 duck. The weight, thickness and yarns used depends on the conditions under which it is run.

Heavy cotton webbing or doubled duck, impregnated with rubber, is used as a guard on each side of the wire screen which delivers the stock to the "felt." This cotton rubber-covered strip is called "deckle strap." Apron conveyors used between the wire screen and first woolen "felt" are made from cotton cloth or duck either rubberized or made into oilcloth.

Printing. In the printing of textiles, whether silks, linens, cottons, woolens or carpets, cloths are used in three ways. The cylinder which operates against the printing roll is first wound with a linen or linen and woolen lapping. The linen lapping gives a backing to the roll and is used on account of its strength. It is a plain-weave, tightly woven fabric. When the linen and woolen lapping is used, the warp is linen and the filling wool. This gives the requisite strength and more cushion. Stretched around this cylinder to another roll, is an endless belt, a sort of woolen jacket, which being next to the cylinder lapping gives the cloth being printed a cushion to work against. This woolen belt is a two- or three-ply, very close, heavily felted cloth, woven endless usually to get a smooth no-lap effect. Under certain conditions of printing a partially cotton or a rubberized cotton cloth is used in place of a woolen. In printing filling yarn on a tapestry carpet loom of a certain type a cotton-backed oilcloth is used on the drum. The third place where a cloth is used in this kind of printing is for a leader to carry the cloth to be printed into the machine. It is called the "backgrey" and is a heavy, closely woven cotton sheeting. No matter how many cylinders or printing rolls are used the principle is practically the same.

Narrow fabrics such as ribbons, tapes, fancy straps, suspender and other webbing are printed in practically the same manner. This same method is also used in printing wallpaper. In rotary printing presses for printing newspapers, magazines, and other big work the principle is the same, the difference being in the method of application. This is likewise so in rotary engraving work, the cloths in general being the same.

When flat printing or engraving is done, however, a cotton-sheeting-covered pad, a heavily felted light woolen, or a laminated cotton cloth and flannel backing are used. When inking is done by pad the covering is cotton sheeting.

Railroad Work. Cotton hose, usually treated, is employed for practically all airbrake connections on cars of all types. Also in steam and water connections for cars, roundhouses, stations and shops. Some parts of signaling systems use cotton webbing of different widths. On the individual electric car-lighting systems the generator is often driven by a rubberized cotton belt. Webbing in general is used as slings, straps, etc., in railroad-shop work. In steam packing for locomotives cloth is used in general as on a stationary engine. On electric locomotives insulating cloth is used as described under the head of electrical work.

Shipbuilding. The building of ships consumes much cloth in a mechanical way, not to mention the tons of duck used non-mechanically. It is used as cotton and asbestos packing in engines, turbines and pumps, pipes and pipe covering. Flexible cotton hose is used with certain types of ship pumps and it is also used for dredging sleeves for certain types of dredge pumps. Heavy cotton webbing is being gradually introduced to take the place of ropes where a flat surface is preferable to a round one; this is particularly advantageous for ship cranes in loading and unloading light cargo.

Shoe Industry. Wide cotton numbered duck is used on the shoe machines which form the box toes and heels of ordinary shoes. It is used as a forming agent for the parts of the shoe mentioned. Light 12 to 16-oz. duck is also used as backers or formers on other machines. Laminated cotton cloth in the form of buffer wheels is used for polishing.

Textiles. In the manufacture of textiles, cotton, woolen, jute camel's-hair, linen and asbestos cloths are used. These are so familiar to every engineer in the textile industry that no descriptions of them are necessary; therefore a tabulation only is given in order to have them in proper form. Cotton is used most extensively, approximately 80 per cent of the poundage being of that fiber:

a Belting. (Cotton or camel's hair, plain or treated):
- Main drives
- Machine drives
- Within machine drives
- Narrow conveyors.

b Card Clothing. (Linen, cotton and wool):
- Backing for various types of card clothing

c Clearer, Slasher and Roller Cloths. (Wool and cotton):
- Cotton, woolen and worsted work

d Cotton Duck:

1 Aprons for:

Automatic feeds	Driers	Openers
Blamire feeds	Dusters	Pickers
Camel's-back feeds	Fiber softeners	Scouring machines
Carbonizers	Fur depositors	Take-up rolls
Conveyors	Gill boxes	
Crosser formers	Loom beams	

(Continued on page 220)

Discussion on Motor-Truck Transportation, Government Operation of Inland Waterways, and the Proposed Plan for Handling New York City's Freight and Passenger Traffic

OF THE six papers presented at the sessions on Transportation, held in connection with the 1920 Annual Meeting of The American Society of Mechanical Engineers, three have already been published in the January issue of MECHANICAL ENGINEERING, namely, Railroad Transportation, by Daniel E. Willard; Feeders for Railroads, by Charles A. Morse; and Railway Terminals and Terminal Yards, by Col. William Barclay Parsons. Other papers presented were by Gen. Frank T. Hines on the Government and Inland Waterways, by Francis W. Davis on Motor-Truck Transportation, and by Gustav Lindenthal on the Transportation and Terminal Problems of New York as Affected by the Hudson River. Summaries of these latter are given in what follows, together with an abstract of the written discussion on Transportation offered at the meeting by J. R. Bibbins.

MOTOR-TRUCK TRANSPORTATION

BY FRANCIS W. DAVIS,[1] BUFFALO, N. Y.

IN THE short period of twenty years, motor highway transportation, in capital invested and diversified fields of application, has reached the point where it is warranted in seeking counsel with its elder brothers in transportation Except for certain specialized services the motor truck will never replace waterway and railway transportation, nor be related to them in other than a supplemental capacity.

The problem has three main aspects: (1) The field of truck transportation; (2) the present status of truck transportation; and (3) the improvement of truck transportation.

THE FIELD OF TRUCK TRANSPORTATION

In cheapness, capacity and low operating costs, waterways, where available, present the most economical form of transportation, especially for bulk material. There is and can be but little competition between waterways and the motor truck.

It is in the "short haul" and at terminal points that the railways are at greatest disadvantage, both as to service rendered and to their own earnings; and it is here that motor transportation comes as a help and releases cars for the long hauls where they are most efficient.

Where railroads and motor trucks do compete, as in the short haul, the problem is to determine which is best suited to discharge the service, where the advantages shift from one to the other, and then let each specialize in the field where it is the more efficient and economic.

The ratio of labor required to tonnage handled precludes the competition of motor trucks with the railway on the long haul.

A table given by the author shows the relative cost of shipping by rail and truck for various lengths of haul.

There is another field of service in which the motor truck is not in competition with other forms of transportation, the so-called "combination service." The truck engine, used primarily for transportation, is available for auxiliary purposes and increasing use is being made of it for loading and unloading operations, the driving of winches, cranes, pumps, etc., and for miscellaneous power requirements.

PRESENT STATUS OF TRUCK TRANSPORTATION

There are approximately 800,000 trucks in operation. If each of these averages five tons per day for 300 working days per year the total tons moved by truck would be about 1,200,000,000. This is of course only an approximate estimate. There is great need for accurate statistics on motor transportation similar to those available for the railways.

Truck operating costs vary so with conditions that general averages are almost useless as a guide for specific cases.

[1] Engineer, Pierce-Arrow Motor Car Company.

The question of possible increase in size of motor trucks is an economic one. There is no mechanical limitation preventing a considerable increase in carrying capacity, but if the size increases much beyond the present maximum of 5 to 6 tons capacity the vehicle becomes unmanageable, and the inability always to operate at capacity loads offsets the advantages of large-size units. The weight, too, would exceed the carrying capacity of many of present highways and bridges.

The development of the motor truck is intimately related to the rubber tire.

IMPROVEMENT OF TRUCK TRANSPORTATION

In 1918, J. E. Maloney, of the State Highway Department of Colorado, in an investigation of the 131 roads which constitute the state highway system of 3827 miles, gave the following conclusions:

> Taking the traffic for the 3827.6 miles, estimated in the tables published in December as 162,926,098 ton-miles, and applying the average cost, as given in the operating costs, of 10.8 cents per ton-mile, will make $17,595,917 per year as the operating cost for the traffic alone.
>
> A saving of but one cent per ton-mile on this traffic would equal $1,629,261 annually, which sum capitalized at 5 per cent would warrant the expenditure of $32,585,200 in the improvements necessary to effect this annual saving.
>
> From a gravel to a paved road there would be an average saving of 1.1 cents per ton-mile, so that an annual traffic of 95,000 or more ton-miles per mile of road would justify an expenditure of $21,000 per mile for the improvement.

If such savings are obtainable in a sparsely settled state, such as Colorado, proportionately greater savings should follow road improvement in the more densely settled sections where traffic is much heavier.

Proper surfacing and foundations are the greatest need. Grades are of very little importance if these are right. It will be necessary, however, to have bridges of ample capacity to take maximum loads.

Both motor transportation and the highways should be protected by reasonable legislation.

In conclusion, railway transportation should and will hold its place for long hauls and for carload shipments where there is direct railway connection to the factory or warehouse of the shipper. Motor transportation will relieve the railroads of the expensive short haul, serve them at terminals, and widen the zone tributary to the railroads thoughout their entire length. It will supplement the street railways and will spread into a wide field where the engine power can be utilized for auxiliary purposes. With the steady improvement of devices for shortening the loading and unloading time there will be a reduction in the use of horses for heavy freight haulage.

The ecônomic limit of the size of motor trucks will probably remain about as at present, although the use of trailers will increase the tons hauled per movement. The use of motor trucks will increase with the general improvement of the highways. The motor industry will welcome sound and uniform legislation, and aid in securing it.

THE GOVERNMENT AND INLAND WATERWAYS

BY FRANK T. HINES,[1] WASHINGTON, D. C.

A REVIEW of the experience of the Government in the operation of inland-transportation-service boats during and following the late war discloses that prior to the creation of the Council of National Defense but one comprehensive survey of the possibilities of inland water routes had been undertaken, namely, the Inland Waterways Commission, instituted by President Roosevelt in 1910.

The investigations of this body resulted in the accumulation

[1] Vice-President, Baltic Steamship Corporation of America.

of a wealth of data covering the status and traffic possibilities of our navigable and potential water routes, and its findings were submitted to the readers of public documents in some eight hundred pages.

From 1910 to 1916 but little was done by the Government for the improvement of waterway transportation aside from the routine river and harbor work of the Corps of Engineers of the Army. In the latter year came the forerunner of the present permanent Waterway Bureau, the Committee on Inland Waterways of the Council of National Defense.

Under the pressure of wartime conditions of 1917 this committee presented reports which were instrumental in later developing a definite governmental policy toward waterway transportation.

With the coming of the United States Railroad Administration and the actual coördination under Government control of all public transportation agencies, the waterway problem was forced still further toward a permanent solution. With the previously active competition between railroads and waterways temporarily suspended, there was presented an unprecedented opportunity for testing out on the basis of strict utility the relative merits of water-borne transportation.

An examination of the several phases affecting traffic on water routes revealed conditions eloquent of the demise of waterway transportation. On the Mississippi, upon which millions in federal appropriations had been spent, scarcely a craft was stirring. On the Warrior River, whose principal utility lies in its situation as an economical outlet for the coal, ore and lumber of central Alabama, a similar situation was met. On the New York State Barge Canal an equally discouraginge ondition existed, though due to the process of transference of traffic from the old route of the Erie Canal.

Early in the spring of 1918 the Director General of Railroads instructed that plans be prepared to make a maximum use of these waterways for the relief of wartime freight congestion. Whether physical operations on these routes should be maintained directly by the Government, as were other common carriers at that time, or whether better results could be secured by encouraging and assisting private enterprise, were questions left to the committee for solution.

After several weeks of intense study the committee recommended the former plan, including the acquisition by the Government of all suitable existing floating equipment and the construction of such additional boats as conditions demanded, it being thought that most immediately efficient results could be secured with the Government operating these fleets so that they would be actually integrated with nearby railways and highways.

Concurring in these views the Director General directed the commandeering of all privately owned craft, and set up the necessary organizations in order that operations might commence immediately on these three waterways.

This action resulted in the assembling of a very mixed collection of floating units, many of which were extremely inefficient and in poor operating condition. Nevertheless these boats made possible the initiation of freight movements by water on a scale much larger than had previously been possible.

It was not the purpose of the Railroad Administration, however, to depend on these chartered boats, and at the same time these lines were inaugurated the construction of fleets of larger and better barges and towboats was undertaken, with which equipment it was proposed to conduct more economical and efficient freight transportation.

Building-program estimates were made of the earnings, but as a matter of actual fact these were not realized and the maintenance of the lines by the Government was a hard, up-hill fight.

The routes are today serving as avenues for transporting thousands of tons of merchandise every month, at an average of 20 per cent below our rates for similar hauls. The most important things which the lines are doing are to awaken widespread public interest in the possibilities of waterway transportation, to educate the shipper in the advantages of routing shipments by water, to demonstrate the classes of merchandise best suited for water haulage and the types of boats best adapted, to indicate the necessity for waterway terminals, and to pave the way for a mutually profitable basis of interchange between the railroad and water carriers.

Congress has already appropriated $2,000,000 to be spent within the next year in building necessary terminals. These projects must stimulate similar construction by private capital. Once these individual lines have reached the stage where they are actually producing profits, the physical operation of the lines may well be given over to private ownership on much the same basis as the Shipping Board is disposing of its war fleets. Until that time, however, the money spent by the Government in pioneering the way toward profitable large-scale waterway transportation may be considered as an investment which will in the near future bring splendid returns.

THE TRANSPORTATION AND TERMINAL PROBLEM OF NEW YORK AS AFFECTED BY THE HUDSON RIVER

By GUSTAV LINDENTHAL,[1] NEW YORK, N. Y.

THE transportation of Greater New York has been the subject of study and plans for many years. That part of the problem which has been touched upon less than might be expected from its importance is the transportation needs and facilities for about 2,000,000 population in New Jersey, within a radius of 15 to 20 miles from the City Hall in New York City. That population separated by the Hudson or North River is a tributary to the city life of Manhattan in the same degree as the 2,500,000 population living on Long Island, separated from New York City by the East River.

To the problem of local passenger transportation across the North River, however, must be added the big problem of passenger and freight transportation from seven large railroad systems reaching out South and West over the American continent and bringing in food, fuel and materials for Greater New York on thirty railroad tracks, humming with traffic day and night.

The Hudson River is a barrier which must be crossed daily by 700,000 passengers, 3,000 freight cars and 8,000 to 10,000 vehicles. Of the passengers about one-half come through the tunnels, all the rest of the passengers, all vehicles and all railroad cars come over as they did 80 years ago, on floating equipment along a river front of 12 miles.

If the traffic crossing the Hudson River were accommodated in the same proportion as it is across the East River at least 20 additional subfluvial tubes would be required, costing around 400 million dollars. The cost of a bridge erected at or below 59th Street, Manhattan, where shores are favorable, is estimated at 100 million dollars.

One of the most effective means of distributing the passenger traffic at the Manhattan end of such a bridge would be a moving platform which would intersect every line, in subway, on elevated or on surface, running north and south, to which a passenger might change. Such a moving platform, at a moderate speed of nine miles per hour, would have a carrying capacity of 40,000 passengers per hour in each direction. The moving platform would be a most important and indispensable feature of the bridge across the North River.

The eight heavy railroad tracks connecting with the seven large railroad systems on the New Jersey side can be used alternately for rapid-transit cars or for through trains. If these eight tracks were connected with an elevated marginal railroad extending along the west side of Manhattan and looped at both ends, and if this West Side railroad were connected by a subway two-track tunnel with a similar East Side marginal railroad, the transportation capacity would be 200,000 passengers per hour. There would be on the bridge alone a potential transportation capacity of 500 million passengers per year, not including highway passengers.

The local passenger traffic out to a distance of 20 to 30 miles in New Jersey could be kept separate from through passenger traffic on all the railroad lines by accommodating the through traffic in a detached union passenger station, located close to the New York end of the bridge.

[1] Consulting Engineer.

This freight traffic as well as the passenger traffic is growing at the rate of over 10 per cent per year. At least 60 per cent of the food for a population of six million is brought on these railroads from the western and southern states. The capacity of the bridge and stations for freight would be sufficient to handle 2000 freight cars per day each way, which leaves a large margin for growth.

In laying out the plans for freight it is expected to have the coöperation of the city authorities, who are especially interested in the building of market halls at short distances from each other where the public can buy fresh food cheaply and with great convenience.

Total Cost of Plan

The estimated cost of the bridge and the various connecting systems and equipment is as follows:

a Classification yard in New Jersey meadows and approaches to North River Bridge	$ 15,000,000
b Multiple-track high-level bridge over the North River	100,000,000
c West Side Elevated R.R. in Manhattan, 8 tracks, with stations and market halls, $4^1/_2$ miles long	20,000,000
d Connection with New York Central going north at 57th St	8,000,000
e Union station in Manhattan	30,000,000
f Moving (conveyor) platforms under 57th St	10,000,000
g Power-plant equipment and locomotives	30,000,000
Total	$213,000,000

This is not a large sum compared with the cost of nearly 500 million dollars for subways in Manhattan and Brooklyn for merely local passenger transportation, but which has reached the astonishing figure of 1600 million passengers per year with a gross revenue of 80 million dollars.

Revenue and Financing

From a thorough investigation for many years, the conclusion has been arrived at that the interests of the public would be best served by a separate terminal organization acting as an agent and trustee of the Federal Government. It is unquestionable that private capital can build and operate this undertaking quicker, cheaper and more efficiently than it can be done with public funds, but the ultimate title to the structure after amortization should be held by the United States Government.

The time for preparing agreements and plans and for the construction of this gigantic work is estimated at seven years. The trustees of the undertaking should comprise the best managers of railroads, of shipping, of warehousing and of finance.

The gross revenue is estimated at over 45 million dollars, which would leave after expenses of operation a net income big enough to meet all fixed charges and a substantial margin for amortization and profit. The incidental benefits in the increase of real-estate values would be experienced on both sides of the river, but the bridge would undoubtedly make of northern New Jersey a new country.

TRANSPORTATION

By J. R. BIBBINS,[1] CHICAGO, ILL.

To discuss transportation as broadly as possible, the producing territory of the country should be considered as a drainage basin, with the tonnage gravitating to various destinations. There are two distinct problems, namely, (1) the interstate movement from the districts of origin to districts of consumption; and (2) the transcontinental movement to port.

Illinois is the approximate center of population and Chicago is the major inland gateway. About 25 per cent of the major production of the country and probably of the Mississippi Basin was exported in normal prewar times, mostly to countries north of

[1] Consulting Engineer, Chief Assistant, Bion J. Arnold, Mem.Am.Soc. M.E.

ward bound, in the months following there is a preponderant movement of homeward-bound empties.

All the traffic is obliged to filter through the various gateways or terminals and much of it through seaboard terminals where the local and export traffic of the seaboard cities must also be handled. Therefore the rail terminals of the country must be called on to handle a large majority of the nation's tonnage, and accordingly their design and operating plan must proceed toward enlargement and perfection in accordance with the growth of the business of the country.

A prewar analysis of this growth indicates:

a Population last doubled in 37 years, since 1883

b Train mileage last doubled in 23 years or increased as the square of the population

c Passenger traffic last doubled in about 13 years or increased as the cube of the population

d Freight tonnage last doubled in 11 years or increased as the fourth power of the population

While this approximate geometric progression must gradually recede or else reach impossible figures, it is nevertheless patent that we are dealing with a profound forward movement which involves the very life of the nation and which should not be permitted to suffer artificial retrenchment.

The tonnage movement of the country does not move in accordance with the minimum cost of transport, but is affected by the following causes:

a Shipping facilities, frequent and scheduled

b Banking facilities for underwriting cargo

c Balanced cargo movements, in and out

d Port-terminal capacity and special facilities

e Established precedent, commerce and transport.

In the terms of worldwide transportation the vector diagram of transport movement is east-west and north-south. At present the resultant is unquestionably north and east. Here indeed is a problem for serious future consideration.

It is a curious fact that not one major railroad trunk line runs direct from the great northwestern producing lands to New Orleans, the major southern watergate. This omission is significant and will probably not be corrected until transportation is conceived as a whole on broader lines and the nation begins to think in worldwide terms rather than in the purely empirical terms of established local precedent.

A comprehensive discussion of national transportation cannot neglect the important factors concerned with international waterways and port terminals. Perhaps no more definite and tangible result can be secured than by concentrating attention on the traffic gateways.

The economic survey has for some years been used in the manufacturing and utility fields. Is there any reason why the railroad should not adopt the same method to perfect the transport organization of the country along perhaps broader and more economic lines than in the past? Such an economic survey would reveal all the invaluable facts and figures in the various movements between origin and destination. In the writer's experience at least one survey has revealed these complete facts for an entire metropolitan port district. For example:

a Terminal organization, relative efficiency and desirable improvements

b Belt lines, yards and interchanges, proper location

c Relation to the city plan

d Coördination of rail, barge and marine operations

e Administration, finance and accounting, best form.

The time seems opportune to ask for some compensation for the economic isolation of the interior and perhaps at the present moment attention might be centered on the question of a comprehensive study of steam and water transport on a comparative basis. But this study will be worse than useless unless it is conducted with the object of ascertaining the complete facts, not only of technical but of economic and equitable nature.

Test Code for Evaporating Apparatus

Preliminary Draft of the Third of a Series of Nineteen Codes in Preparation by the A.S.M.E. Committee on Power Test Codes

IN 1918 the Power Test Committee of the A.S.M.E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, under the chairmanship of Fred R. Low, and under its direction are 19 individual committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the third of these codes to be completed, namely, the Test Code for Evaporating Apparatus.

This Committee will, of course, welcome suggestions for corrections or additions. These should be mailed before April 1 to the Chairman, care of The American Society of Mechanical Engineers.

Test Code for Evaporating Apparatus

Introduction

1 This Code of Tests of Evaporating Apparatus is intended primarily for apparatus heated by steam, such as vacuum pans, or single- and multiple-effect evaporators. The principal use for such evaporators is in the manufacture of alkali, salt, sugar, condensed milk, extracts from chemicals, and similar processes.

Objects

2 The objects of the test should be clearly defined before preparations are made. Some of the purposes for which tests of this character are made are to determine:

(a) The adaptability of the apparatus to the material to be concentrated
(b) The most feasible and practicable method or methods of operation
(c) The maximum and minimum range in capacity of the evaporator consistant with economical operation
(d) The efficiency of the apparatus as a whole, and of its several elements
(e) Relative capacity and efficiency of the apparatus compared with other apparatus doing similar work
(f) The location of losses which may be minimized or eliminated by improved apparatus or better methods.

Measurements

3 The measurements involved in the testing of evaporating apparatus heated by steam will depend to some extent upon the object for which the test is conducted as defined in Par. 2 above. In general, these measurements will include the following:

(a) The general data relative to type of apparatus, and principal dimensions as defined in Table A, Items 7 to 20
(b) The weight or volume of the liquor before and after each effect, and for the apparatus as a whole
(c) The weight or volume of the steam to each effect and to the apparatus as a whole; also to any auxiliary apparatus
(d) The pressure, temperature and quality of the steam to each effect; also to any auxiliary apparatus
(e) The temperature, specific heat, and specific gravity of the liquor before and after each effect, and before and after the unit as a whole
(f) The weight or volume of water evaporated from the liquor
(g) The weight or volume of condensing water used.

Instruments and Apparatus

4 The apparatus and instruments required for testing evaporating apparatus will include:

(a) Tanks and platform scales for weighing liquor and water, or calibrated tanks, or meters
(b) Pressure and vacuum gages
(c) Thermometers
(d) Calorimeters for determining the quality of steam
(e) Hydrometers for determining the specific gravity of the liquors, and degree of concentration
(f) Apparatus for analyzing the liquors
(g) Barometer
(h) Electrical instruments, including voltmeter, ammeter, and wattmeter, if electrical measurements are necessary.

NOTE: For a full description of the use, calibration and accuracy of these instruments and pieces of apparatus, refer to the Code on Instruments and Apparatus.

Preparations

5 The General Instructions, Pars. 4 to 8, should be read, and preparations made accordingly, in so far as these instructions apply to the apparatus to be tested. Take the dimensions of the apparatus and the auxiliaries; note their physical condition; examine for leakages; select and install the testing appliances.

For the heating surface of the evaporating apparatus, measure the surface in contact with the steam, the liquor being in contact with the opposite side.

Where the apparatus is subject to vacuum, examine for leakage of air.

To test for air leaks close up and blank off the apparatus. Pump the air out of the apparatus, blank off vacuum pump, and see if air leaks are noted by decrease in vacuum. Small leaks difficult to find may usually be located by painting the joints and the surfaces, if porous, with a good quality of white lead.

Operating Conditions

6 Determine the operating conditions necessary to conform to the object of the test, and see that these conditions are maintained throughout the test.

Starting and Stopping

7 The pressures, temperatures, densities of liquors, and volumes of same within the evaporator should be the same at the beginning and at the end of the test. The test should be started at the beginning of a commercial cycle where such cycles exist in the operation of the evaporator, and after running the required number of hours it should be stopped at the beginning of the next succeeding cycle.

Duration

8 The duration of the test should depend upon the degree of accuracy demanded by the object for which the test is made. In no case should the duration be less than the regular commercial operating cycle. If the cycles are less than four hours in duration the test should cover at least three complete cycles, and the results of each cycle should substantially corroborate the other two. When the cycles are of four or more hours' duration the test should cover at least two complete cycles and these should be substantially corroborative. Should the operation be carried on in shifts the test should continue at least one calendar day of 24 hours. This length of time should be the duration when the supply of liquor or steam is irregular or intermittent, or when for any reason the regularity of the operation cannot be maintained.

Records

9 The data should be taken and recorded in the manner described in the General Instructions, Pars. 20 to 30. Half-hourly readings of the various instruments will be sufficient, except where there is considerable fluctuation in such readings, in which case more frequent readings must be taken in order to give good averages.

Uniformity of operation may be assisted by the plotting of a chart while the test is in progress, as pointed out in Par. 29 of General Instructions.

10 The data and results should be tabulated in accordance with the form shown in Table A, forming part of this Code, adding items not provided for and omitting items not needed to conform to the object in view. Unless otherwise indicated, the items refer to the numerical averages of the readings which are recorded in the log.

The methods of calculating the results as tabulated, so far as not self-evident, or not sufficiently indicated in the text for the items, are explained in the following section.

Calculation of Results

Liquor Levels (Table A, Item 28). The datum from which

degrees of the liquor in any effect is the difference between the boiling temperature of the liquor in that effect and the boiling temperature of water under the same pressure as that of the vapor in the effect.

11 *Steam to Condenser* (Table A, Item 52). This cannot be measured directly. If a surface condenser is used this item can be determined by measuring or weighing the condensed steam discharged from the condenser. If a jet condenser is used, Item 52 may be calculated from the weight of condensing water and the rise in temperature of the condensing water. The product of these two will give the heat transferred to the condensing water, and this heat divided by the heat in a pound of steam going to the condenser, reckoned from the temperature at which the condensing water leaves the condenser, will give the weight of steam going to condenser. The same item may be determined by taking the difference in weight between feed and discharge liquors in the last effect.

If any retained product is found in the steam to the condenser, this must be taken account of in calculating the weight of steam going to condenser.

12 *Evaporation from Liquor* (Table A, Item 53). This is the sum of the steam to the condenser (Item 52) and the condensed steam drained from the effects, except that from the first effect. [Total of Item 61, except (*a*)].

13 *Liquor Entering* (Table A, Item 56). The weight of liquor entering the first effect is the weight of the feed liquor.

In case it is possible to measure the liquor passing from one effect to the next by pitot tube, venturi tube, or other device, the weight of the liquor entering each effect may be calculated from such measurement, and the temperature and specific-gravity test of the measured liquor. If the condensate can be measured, the liquor entering any effect can be calculated by subtracting the weight of the condensate from the feed liquor, or the liquor entering the previous effect. If it is impossible to measure the liquor passing from one effect to the next, the sub-items of No. 56, except (*a*), had better be omitted, as the calculation of these items is very unsatisfactory.

14 *Evaporation from Liquor in Individual Effects* (Table A, Item 58). The satisfactory determination of the several sub-items of this number, except in the case of a vacuum pan, or single effect, depends upon the successful measurement, or calculation, of the liquor passing from one effect to the next. If the liquor can be measured the evaporation in each effect is determined by taking the difference in weight of the liquor entering and leaving that effect (Items 56 and 57), or by measuring the condensate directly.

15 *Evaporation from Liquor from and at 212 Deg. Fahr.* (Table A, Item 53). This is Item 68 ÷ 970.4.

16 *Self-Evaporation* (Table A, Item 59). Self-evaporation in any effect is determined as follows: Multiply the weight of the liquor entering that effect by the temperature drop between the boiling point in that effect and the boiling point in the preceding effect, and by the specific heat of the liquor. Divide this quantity by the latent heat of evaporation in the effect considered. The result is the weight of self-evaporation.

17 *Heat Contained in Entering Liquor* (Table A, Item 63). This is the pounds of feed liquor multiplied by the temperature above 32 deg. fahr. of the feed liquor, and this product multiplied by the specific heat of the feed liquor.

18 *Heat from Steam Supplied to Entire Apparatus* (Table A, Item 64). This is the sum of the products of the pounds of steam, from Items 42, 43 and 44, multiplied respectively by the total heat, above 32 deg. fahr., in a pound of steam of the pressures and qualities used.

19 *Heat to Pumps* (Table A, Item 65). This is the product of the pounds of steam to pumps, Item 44, by (the heat units in a pound of live steam to pumps minus the heat units in one pound of exhaust steam from pumps corrected for quality).

20 *Heat Contained in Discharge Liquor* (Table A, Item 66). This is the product of the pounds of discharge liquor (Item 51) by the temperature, above 32 deg. fahr., of the discharge liquor, and the weight of steam to condenser (Item 52) and the heat units in a pound of this steam; otherwise this item must be calculated from the heat absorbed by the condensing water; or, pounds of condensing water (Item 62) multiplied by rise in temperature of condensing water [Item 37 (*b*) — 37 (*a*)]. To this must be added the heat in the condensate above 32 deg. fahr.

22 *Heat Contained in the Evaporation from Liquor* (Table A, Item 68). This is the heat in the steam going to the condenser, plus the heat in the condensed steam drained from the effects (except that drained from the first effect: Item 67 + (Item 73 — Heat in condensed steam from first effect).

23 *Heat Contained in Entrained Product* (Table A, Item 69). From the analysis of the steam to the condenser (Item 92) the amount of entrained product is determined. The weight of this entrained product, multiplied by its temperature above 32 deg. fahr., and this product, multiplied by the specific heat of the entrained product, will give the heat in such product escaping with steam to condenser.

24 *Heat Supplied to Heaters* (Table A, Item 70). This is the product of the pounds of live steam to heaters (Item 42) by the total heat above 32 deg. fahr. in a pound of such live steam. To this must be added the heat supplied from exhaust steam, if any. This is the product of the pounds of exhaust steam to heaters (Item 47) by the total heat above 32 deg. fahr. in a pound of such exhaust steam. In determining the heat in the steam the quality of the steam must be taken into account.

25 *Heat in Water from Heaters* (Table A, Item 71). This is the product of the pounds of water discharged from heaters (Item 60) by the temperature of such water above 32 deg. fahr.

In case of more than one heater the heat will need to be calculated for each heater separately and the sum of the several quantities taken.

26 *Heat Supplied to the Effects* (Table A, Item 72). This is the product of the pounds of live steam to the effects (Item 43) by the total heat above 32 deg. fahr. in a pound of such live steam. If exhaust steam is supplied to the effects its heat must be added to the above. Pounds of exhaust steam (Item 48) multiplied by the total heat, above 32 deg. fahr., in a pound of exhaust steam.

27 *Heat in Condensed Steam Drained from Effects* (Table A, Item 73). This is condensate taken from the steam space of an effect. In case of more than one effect this should be passed along to the next effect if possible, where its heat may, in part at least, be transferred to the liquor. This heat is the product of pounds of condensed steam [Item 57(*b*)] multiplied by the temperature above 32 deg. fahr. of such condensate. In case the apparatus has more than one effect the heat must be calculated for each effect separately, and the sum of the several quantities taken.

In case the condensed steam flows from the steam space of one effect to that of the next effect its temperature should be measured at point of leaving the last effect of the series. This temperature, in degrees above 32 deg. fahr., multiplied by the pounds of condensed steam leaving the last effect will give the heat in the total condensed steam drained from the effects.

28 *Heat Discharged from the Effects* (Table A, Item 74). This is the sum of Items 66, 67, 68 and 73.

29 *Apparent Heat-Transmission Coefficients*. The apparent heat-transmission coefficient in any effect is obtained by dividing the total heat transmitted per hour in that effect by the heating surface in that effect, and by the apparent temperature drop. The apparent temperature drop is the difference between the temperature corresponding to the pressure of the heating steam and the temperature corresponding to the pressure in the vapor space of the effect.

The total heat *transmitted* in any effect is not the heat corresponding to the evaporation in that effect. It is less than this quantity by the heat in self-evaporation. The total heat *transmitted* is therefore determined by subtracting from the total evaporation (Item 58) the self-evaporation (Item 59), and multiplying this difference by the total heat (above the temperature of the vapor) in one pound of steam at the pressure and temperature of the vapor in the effect.

30 *Corrected Heat-Transmission Coefficients* (Table A, Item 82). Apparent heat-transmission coefficients, as outlined in Par. 29, may be corrected for

(*a*) Excess boiling degrees
(*b*) Hydrostatic head
(*c*) Both excess boiling degrees and hydrostatic head.

The report should clearly specify which of these corrections have been made.

If a coefficient is to be corrected for excess boiling degrees, the heat transmitted as explained in Par. 29, is to be divided by the heating surface and by the temperature drop between the temperature corresponding to the pressure in the heating space and the actual boiling point of the surface liquor in the effect in question.

If a coefficient is to be corrected for hydrostatic head the total heat transmitted, as explained in Par. 29, is to be divided by the heating surface and by the temperature difference between temperature corresponding to the pressure in the heating space and the boiling point of the liquor at the mid-point of the hydrostatic head. This last temperature is to correspond to a pressure equal to the pressure of the vapor space plus a pressure due to a column of liquor equal to one-half the hydrostatic head.

FINAL REPORT

Evaporative Ratio and Efficiency of Individual Effects

31 *Overall Thermal Efficiency of the Entire Equipment* (Table A, Item 75). This is the ratio of the heat contained in the total evaporation from liquor, to the heat from steam supplied to entire apparatus. Item 68 divided by Item 64, and the quotient multiplied by 100 to give percentage.

32 *Thermal Efficiency of the Effects* (Table A, Item 76). This is the ratio of the heat contained in the evaporation from liquor to the heat supplied to the effects. Item 68 divided by Item 72, and the quotient multiplied by 100 to give percentage.

If the evaporation from liquor in each effect [Item 58(*b*)] is calculated, then these figures, with those of Item 61(*b*), may be used to check the above quantity of heat in steam evaporated from liquor, or to figure the efficiency of each effect, and of all effects.

33 *Thermal Efficiency of Heaters* (Table A, Item 77). This is the ratio of the heat put into the liquor in its passage through the heaters to the heat supplied to the heaters.

Item 50 multiplied by [Item 33(*a*) — Item 32(*a*)] and by the specific heat of the feed liquor.

The above product divided by Item 70, and this quotient multiplied by 100, will give percentage.

Economy

34 *Evaporation Per Pound of Total Steam Used* (Table A, Item 83). This is Item 51 ÷ Item 45.

35 *Evaporation from and at 212 Deg. Fahr. Per Pound of Total Steam Used* (Table A, Item 85). This is Item 54 ÷ Item 45.

TABLE A—DATA AND RESULTS OF EVAPORATING APPARATUS TEST

(*A.S.M.E. Code of 1920*)

General Information

(1) Date of test ...
(2) Kind of apparatus under test (vacuum pan, multiple-effect evaporator, etc.) ...
(3) Location ...
(4) Owner ...
(5) Builder of apparatus ...
(6) Test conducted by ...

Description, Dimensions, Etc.

(7) Type of apparatus ...
(8) Dimensions of shells ...
(9) Material of tubes and tube sheets ...
(10) Number of tubes in each effect ... { Length ... / Diameter ...
(11) Heating surface in each effect ... sq. ft.
(12) Number and type of liquor heaters ...
(13) Number of tubes in each heater ... { Length ... / Diameter ...
(14) Heating surface in each heater ... sq. ft.
(15) Liquor heating surface in each heater ... sq. ft.
(16) Type and make of condenser equipment ...
(17) Condensing surface ... sq. ft.
(18) Type and dimensions of vacuum and circulating pumps ...
(19) Kind of liquor concentrated ...
(20) Characteristics of liquor concentrated ...

Test Results

(21) Duration of test ... hr.

Average Pressures and Temperatures

(22) Steam pressure by gage ... lb. per sq. in.
(23) Barometric pressure ... in. of mercury
(24) Absolute steam pressure ... lb. per. sq. in.
(25) Pressure in exhaust-steam line from pumps ... lb. per sq. in.
(26) Pressure or vacuum:
  (*a*) 1st effect ... lb. pressure ... in. vacuum
  (*b*) 2nd effect ... lb. pressure ... in. vacuum
  (*c*) 3rd effect ... lb. pressure ... in. vacuum
  (*d*) 4th effect ... lb. pressure ... in. vacuum
  (*e*) 5th effect ... lb. pressure ... in. vacuum
  (*f*) 6th effect ... lb. pressure ... in. vacuum
(27) Vacuum in the condenser ... in. of mercury
  (*a*) Corresponding absolute pressure ... lb. per sq. in.
(28) Liquor levels:
  (*a*) In 1st effect ... inches
  (*b*) In 2nd effect ... inches
  (*c*) In 3rd effect ... inches
  (*d*) In 4th effect ... inches
  (*e*) In 5th effect ... inches
  (*f*) In 6th effect ... inches
(29) Temperatures of saturated steam corresponding to the vapor pressure in:
  (*a*) 1st effect ... deg. fahr.
  (*b*) 2nd effect ... deg. fahr.
  (*c*) 3rd effect ... deg. fahr.
  (*d*) 4th effect ... deg. fahr.
  (*e*) 5th effect ... deg. fahr.
  (*f*) 6th effect ... deg. fahr.
(30) Steam temperatures:
  (*a*) Superheated steam ... deg. fahr.
  (*b*) Normal temperature of saturated steam ... deg. fahr.
  (*c*) Temperature of exhaust steam ... deg. fahr.
(31) Temperature of liquor:
  (*a*) Entering 1st heater ... deg. fahr.
  (*b*) Entering 2nd heater ... deg. fahr.
  (*c*) Entering 3rd heater ... deg. fahr.
  (*d*) Entering 4th heater ... deg. fahr.
  (*e*) Entering 5th heater ... deg. fahr.
  (*f*) Entering 6th heater ... deg. fahr.
(32) Temperature of liquor:
  (*a*) Entering 1st effect ... deg. fahr.
  (*b*) Entering 2nd effect ... deg. fahr.
  (*c*) Entering 3rd effect ... deg. fahr.
  (*d*) Entering 4th effect ... deg. fahr.
  (*e*) Entering 5th effect ... deg. fahr.
  (*f*) Entering 6th effect ... deg. fahr.
(33) Temperature of liquor:
  (*a*) Leaving 1st effect ... deg. fahr.
  (*b*) Leaving 2nd effect ... deg. fahr.
  (*c*) Leaving 3rd effect ... deg. fahr.
  (*d*) Leaving 4th effect ... deg. fahr.
  (*e*) Leaving 5th effect ... deg. fahr.
  (*f*) Leaving 6th effect ... deg. fahr.
(34) Excess boiling degrees of liquor:
  (*a*) In first effect ... deg. fahr.
  (*b*) In 2nd effect ... deg. fahr.
  (*c*) In 3rd effect ... deg. fahr.
  (*d*) In 4th effect ... deg. fahr.
  (*e*) In 5th effect ... deg. fahr.
  (*f*) In 6th effect ... deg. fahr.
(35) Temperatures of condensed steam discharged:
  (*a*) From 1st heater ... deg. fahr.
  (*b*) From 2nd heater ... deg. fahr.
  (*c*) From 3rd heater ... deg. fahr.
  (*d*) From 4th heater ... deg. fahr.
  (*e*) From 5th heater ... deg. fahr.
  (*f*) From 6th heater ... deg. fahr.
(36) Temperatures of condensed steam:
  (*a*) Drained from 1st effect ... deg. fahr.
  (*b*) Drained from 2nd effect ... deg. fahr.
  (*c*) Drained from 3rd effect ... deg. fahr.
  (*d*) Drained from 4th effect ... deg. fahr.
  (*e*) Drained from 5th effect ... deg. fahr.
  (*f*) Drained from 6th effect ... deg. fahr.
(37) Temperature of condensing water:
  (*a*) Entering condenser ... deg. fahr.
  (*b*) Leaving condenser ... deg. fahr.
(38) Temperature of air in evaporating room ... deg. fahr.
(39) State of weather:
  (*a*) Temperature of external air ... deg. fahr.
  (*b*) Relative humidity of external air ... per cent

(a) Moisture in steam.............................per cent
(b) Superheat.............................deg. fahr.
(c) Factor of correction for quality of steam..............
(41) Exhaust steam:
(a) Moisture in steam.............................per cent
(b) Factor of correction for quality of steam..............

Total Quantities	Total Pounds	Pounds per Hour
(42) Live steam to heaters..............		
(43) Live steam to effects..............		
(44) Live steam to pumps..............		
(45) Total live steam supplied to entire apparatus (sum of Items 42, 43 and 44)..............		
(46) Equivalent weight of total live steam from and at 212 deg. fahr..............		
(47) Exhaust steam to heaters..............		
(48) Exhaust steam to effects..............		
(49) Total exhaust steam..............		
(50) Feed liquor..............		
(51) Discharge liquor or concentrated product..............		
(52) Steam to condenser..............		
(53) Evaporation from liquor..............		
(54) Equivalent evaporation from liquor from and at 212 deg. fahr..............		
(55) Equivalent evaporation from liquor, from and at 212 deg. fahr., per sq. ft. of the total heating surface in all the effects..............		
(56) Liquor entering:		
(a) 1st effect..............		
(b) 2nd effect..............		
(c) 3rd effect..............		
(d) 4th effect..............		
(e) 5th effect..............		
(f) 6th effect..............		
(57) Liquor leaving:		
(a) 1st effect..............		
(b) 2nd effect..............		
(c) 3rd effect..............		
(d) 4th effect..............		
(e) 5th effect..............		
(f) 6th effect..............		
(58) Evaporation from liquor in:		
(a) 1st effect..............		
(b) 2nd effect..............		
(c) 3rd effect..............		
(d) 4th effect..............		
(e) 5th effect..............		
(f) 6th effect..............		
(59) Self-evaporation in:		
(b) 2nd effect..............		
(c) 3rd effect..............		
(d) 4th effect..............		
(e) 5th effect..............		
(f) 6th effect..............		
(60) Water discharged from:		
(a) 1st heater..............		
(b) 2nd heater..............		
(c) 3rd heater..............		
(d) 4th heater..............		
(e) 5th heater..............		
(f) 6th heater..............		
(61) Condensed steam drained from:		
(a) 1st effect..............		
(b) 2nd effect..............		
(c) 3rd effect..............		
(d) 4th effect..............		
(e) 5th effect..............		
(f) 6th effect..............		
(62) Condensing water..............		

(63) Heat above 32 deg. fahr. contained in entering liquor.....B.t.u.
(64) Heat from steam supplied to entire apparatus, including pumps. (Calculated from total live steam)..........B.t.u.
(65) Heat to pumps.............................B.t.u.
(66) Heat above 32 deg. fahr. contained in discharge liquor....B.t.u.
(67) Heat contained in steam to condenser..................B.t.u.
(68) Heat contained in the evaporation from liquor..........B.t.u.
(69) Heat contained in entrained product escaping with steam to condensers.............................B.t.u.
(70) Heat supplied to the heaters.............................B.t.u.
(71) Heat above 32 deg. fahr. in water discharged from heaters...B.t.u.
(72) Heat supplied to effects by live and exhaust steam.......B.t.u.
(73) Heat above 32 deg. fahr. contained in the condensed steam drained from the effects.............................B.t.u.
(74) Heat discharged from the effects.............................B.t.u.

Evaporation Ratio and Efficiency of Individual Effects

(75) Overall thermal efficiency of entire equipment..........per cent
(76) Thermal efficiency of each effect..........per cent
(77) Thermal efficiency of the heaters..........per cent

(79) Raw liquor to apparatus per 24 hours..........gal.
(80) Concentrated product per 24 hours..........gal.
(81) Apparent heat-transmission coefficients:
(a) For 1st effect
(b) For 2nd effect
(c) For 3rd effect
(d) For 4th effect
(e) For 5th effect
(f) For 6th effect
(82) Corrected heat-transmission coefficients:
(a) For 1st effect
(b) For 2nd effect
(c) For 3rd effect
(d) For 4th effect
(e) For 5th effect
(f) For 6th effect

Economy

(83) Evaporation per pound of total steam used..........lb.
(84) Concentration product per pound of total steam used..........lb.
(85) Evaporation per pound of steam from and at 212 deg. fahr lb.

Heat Balance	B.t.u. per hour	per cent
(86) Heat to pumps, heaters, and effects:		
(a) Heat from steam to entire equipment (Item 64)..............		
(b) Heat above 32 deg. fahr., contained in entering liquor (Item 63)..............		
Total = (a) + (b)..............		
(87) Heat discharged from heaters and effects:		
(a) Heat in water from heaters (Item 71)..............		
(b) Heat in condensed steam drained from effects (Item 73)..............		
(c) Heat in steam condenser (Item 67)..............		
(d) Heat in entrained product (Item 69)..............		
(e) Heat in discharge liquor (Item 66)..............		
Total = (a) + (b) + (c) + (d) + (e)..............		
(88) Radiation and unaccounted-for losses: [Item (86) Total — Item (87) Total]..............		

Liquor Analysis

(89) Analysis of feed liquor
(90) Analysis of discharge liquor
(91) Analysis of liquor out of each effect
(92) Analysis of steam to the condenser to determine the amount of entrained product

Physical Properties of Liquor

(93) Specific gravity of feed liquor
(94) Specific gravity of discharge liquor
(95) Specific gravity of liquor out of each effect
(96) Specific heat of feed liquor
(97) Specific heat of discharge liquor
(98) Specific heat of liquor out of each effect.

(*Signed*)

E. N. Trump, *Chairman*
B. N. Bump,
E. A. Newhall,
H. L. Parr,
L. C. Rogers.

James Watt International Memorial

The Society's check for 250 guineas, the total of the individual subscriptions received from members in response to the appeal issued by the James Watt International Memorial Committee, has been forwarded to Birmingham, England.

A few late subscriptions are still being received and these will be forwarded in a lump sum later. Any members of the Society who have not yet done so, may still send in their subscriptions to the Secretary and their names will be recorded on the list of individual subscribers and sent to Birmingham as soon as compiled.

Chicago Engineers, Attention!!

The following appears at the head of the editorial page of the Chicago *Tribune*. Evidently the editor of the *Tribune* sees clearly that the development of Chicago is an engineering job and that the solution of the engineering problems he enumerates will result in a bigger, cleaner, more moral city.

The Tribune's Platform for Chicago

1—Lessen the Smoke Horror.
2—Create Modern Traction System.
3—Modernize the Water Department.
4—Build Wide Roads Into the Country.
5—Develop All Railroad Terminals.
6—Push the Chicago Plan.

INDUSTRY'S SUPPLY OF ENERGY

(Continued from page 166)

great efficiency, but even in Europe and North America only about one-fifth of the potential power has yet been developed. To that extent only have we succeeded in "borrowing the might of the elements" "for the use and convenience of man," but we may expect our rivers to take on an even larger share of the base load in any power program that seeks to conserve the energy supplies in coal, oil, and men. Of course, even with wisest utilization, coal must again take up the burden as full development of water power is approached, for coal is the world's great source of heat and power, and the largest development of water powers is practicable only with coal power as the dependable "stand-by," ever ready to meet promptly any special demand.

Oil and natural gas are the popular fuels, regarded as highly efficient because they are preeminently labor-saving—easily produced, easily transported, and easily used. As source of power these fluid fuels present a marked contrast with water. Hydroelectric energy is even more easily distributed and used, but water-power development involves large capital outlay and in any national emergency no quick response in water power is possible; the water-power projects planned to meet the power needs discovered in the course of our wartime expansion of industry are even now hardly under way. But when the large necessary investment of labor and material is once made in water power the output of energy continues for generations. Oil and gas, on the contrary, are quickly developed and quickly exhausted. Already we realize that natural gas, the ideal fuel, is a resource so temporary that its use forms merely an incident in industrial progress; it has been a wasted as well as a wasting resource. The sorry lesson we have learned in natural gas may have its value if we apply the truth to our use of oil. Unless we check the increase in the consumption of oil it too will be but a flash in the pan.

If we leave the world point of view for a moment and look at the power problem in our own country we are able to see in more detail the relative position of water, coal, and oil as sources of energy. Millions of horsepower, thousands of billions of tons, and billions of barrels are the measures of our nation's wealth in these three resources, yet no comparison is possible except as we reduce these units to a common denominator—something more expressive of true value, which is their use by man. Indeed, such statistics of quantity are too large to be grasped unless we translate them into some kind of national units.

To compare these three resources, then, we may start with the country's present total power requirements: if we take 50 million horsepower as an average figure for the potential water power of the United States, without storage, we find that if fully developed and if used at the average load factor of today our rivers and streams would just about meet the country's present needs and would supply that amount of power for all time; moreover, with storage and an improved load factor they could provide a considerably increased output of energy to meet the growing demand.

Now if, leaving our water-power resources to one side—indeed we have already left them aside too long, we try putting the whole power burden on our coal mines we are able to make a direct comparison between our coal resources and our potential water powers. There is in the United States accessible and available for future use an aggregate of about 2500 billion tons of coal, not including lignite. Only about one-fifth of this is in the Eastern States, another fifth is in the coal fields of the Central States, and nearly three-fifths is in the Rocky Mountain and Western States. In converting these great reserves of coal into power I did not allow directly for the greater differences in the thermal value of the coals, but instead of figuring B.t.u. and thermal efficiency of prime movers, I reached somewhat the same result by using the best central-station practice of today on the Atlantic seaboard, here in the Central States, and in the Rocky Mountain region. Incidentally, I found myself using a new unit, the horsepower-century, for which the equivalent in eastern coal is 250 tons, in interior coal 300 tons, and in western coal, 350 tons. By applying these factors to our estimates of reserves we get 2240 million horsepower-centuries, 1750 million horsepower-centuries, and 4171 million horsepower-centuries, respectively, or a total of 8161 million horsepower-centuries. I should add that a million horsepower-centuries is seven times the present power output of the United States. So you will see that by adopting the best steam practice of today the present power requirements of this country could be met with coal for 57,000 years, although we know that long before the end of that period the greater depth of the coal mines and their increased distance from market would alone create power demands for mining and transportation that would considerably cut down the amount of power available for other uses.

We measure the petroleum wealth of the United States by billions of barrels—about 5 billion already produced in the last 60 years, and about 7 billion left for the future. Again adopting the best steam practice of today in public-utility stations of Texas and California—a little less than 32 barrels to the horsepower-year—and trying to carry the whole power load of the country with oil alone, we find that the oil reserves of the United States, although measured by billions of barrels, would last only 9 years and 3 months. Without allowing for the fact that steam raising for power is only one of the many uses of coal, these two figures, 57,000 and $9^1/_4$ years, are sufficiently impressive to make us fairly receptive to the general truth of Mr. Eckel's statement in his recent book, Coal, Iron and War: "We have just as much real chance of replacing coal by oil as we have of finding enough gold to use it in place of steel."

Costs of Energy

These are comparative estimates of the energy supplies which may be tapped for the use of our own citizens, and before discussing their distribution, we should give a thought to the relative cost in human energy in making these three kinds of energy available. I need not tell an audience of engineers the differences in labor outlay in constructing a hydroelectric plant, opening up a coal mine, and drilling an oil well. Each is an engineering project that requires careful planning and the expenditure of money, skill, and labor, but in widely different amounts. Moreover, the water-power plant ought to last for generations and the coal mine for several decades, but the life of an oil well is measured by a few years. In operation, however, the water-power plant is a labor saver, and the best illustration of this fact is that balance sheet put out by the Alabama Power Company, which compares a large steam plant with a hydroelectric plant operated under the same management and feeding into the same transmission lines. In terms of 1000 kw. capacity it takes $13^1/_2$ men to run the steam plant and the coal mine tributary to it. And how many does it take for the corresponding units in the hydroelectric plant? One-sixth of one man. The exact ratio is 84 to 1. Another comparison with coal is afforded by the statement that in Mexico one man can produce and transport to market the oil equivalent of the coal that it would take 10 men in the United States to mine. These approximate comparisons of the labor cost of our different energy slaves may well be kept in mind as we plan or the larger use of mechanical power.

As mechanical engineers you are best fitted to grasp the national aspects of this energy-supply problem: you can see in true relations both the layout of the supply and the distribution of the demand. Better production is the country's need just now and you men are production engineers in the broadest sense. But, as you well understand, it is not enough for you and me to see the problems of the day and to understand them—that is simply a matter of our mental capacity—but what about performance? It strikes me that this matter of full utilization goes further than material resources or energy supplies: do we not need to raise our intellectual load factor? Is not there too great a gap between our peak practice and our average load? In a word, the engineer needs to be more of a citizen, or, as Herbert Hoover put it the other day, "Organize the engineering mind for expression in public service."

As the result of experience gained on the Santa Fe system, it is stated that the life of a boiler fired with coal is about 10 per cent greater than that of one fired with oil, while the life of the tube is about 40 per cent higher in the coal burners.

Recent Trend in Locomotive Design in Europe

VARIOUS influences are at work in Europe in the matter of locomotive design. There is a general feeling that the efficiency of locomotive operation must be increased, and that what was "good enough" in prewar days when fuel was cheap and labor plentiful, may not be good enough at all today, with things as they are.

Of great importance also is the leaven brought in through a greater familiarity with American design. European railroad men have seen the big American engines hauling immense loads in France, and while they are still prepared to find fault with some of their features at least, as far as they apply to European conditions, they have been quick enough to notice many things that are good.

The two English locomotives described in the following abstracts clearly show the influence of American practice, in addition to which they are of interest also as showing some of the original tendencies of British locomotive engineering.

The German internal-combustion locomotives described in the third abstract do not represent anything strikingly novel, but were considered worthy of attention mainly because the entire art of gasoline-locomotive construction is still in such a state of development that every bit of information is of value.

GREAT NORTHERN THREE-CYLINDER FAST-FREIGHT LOCOMOTIVE

Great Northern Three-Cylinder Fast Freight Locomotive. Features of this locomotive are the novel valve gear with comparatively early cut-off, designed to give high economy through a wide range of power, the use of three steam cylinders, a single plate for the barrel of the boiler, etc. The boiler itself is far larger than has been the British practice hitherto. Ball and roller bearings are used for certain joints in the valve gear, heat-treated chrome steel for connecting and coupling rods, and the locomotive altogether is probably more unlike the standard British practice than any which has yet been placed in service.

So far only one engine, No. 1000, has been placed into service, but nine others are under construction. This engine is a general-purpose one and handles both heavy passenger and heavy freight trains. The barrel of the boiler is made of a single plate $^5/_8$ in. thick measuring nearly 19 ft. long by nearly 11 ft. 6 in. broad. It has a butt joint with quadruple riveting through two butt straps, the inner strap being much wider than the outer. As a consequence two rows of rivets pass through both the straps and the plate, while the two other rows pass only through the inner strap and the plate. In tests it was found that the ratio of yield point of joint to yield point of material was no less than 93.7 per cent.

In the superheater, which is of the Robinson type, an anti-vacuum or snifting valve is placed just before the chimney and opens downward on the admission side of the header. Steam pressure raises and closes it, but when steam is shut off and the engine is drifting the valve drops and air is sucked through the superheater by the cylinders and discharged up the blast pipe which keeps the elements cool and the cylinders warm.

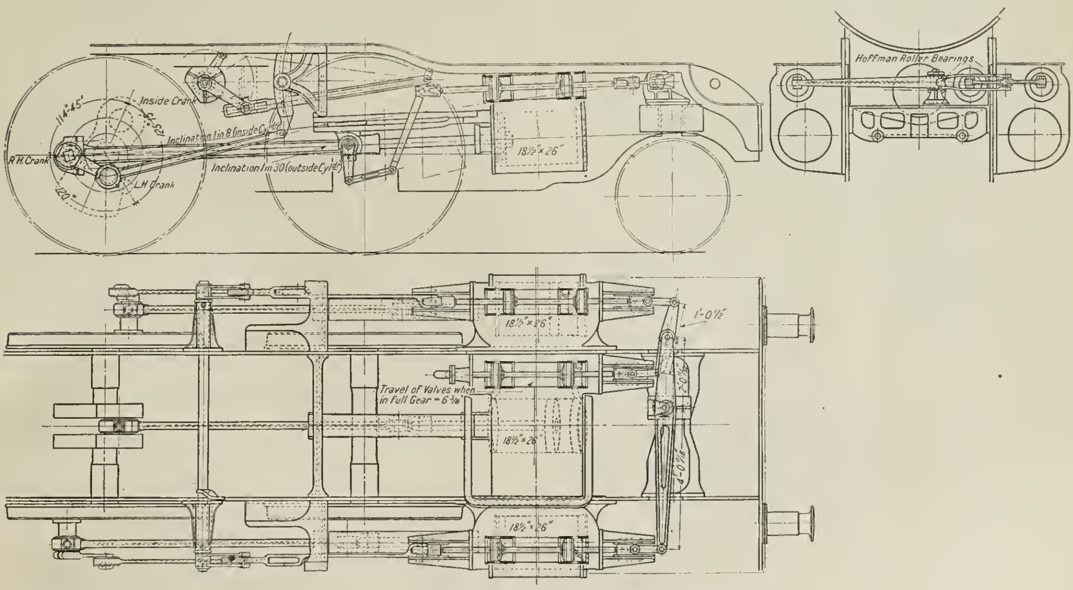


Fig. 1 Diagram of Gresley Valve Gear for Great Northern Railroad Engine No. 1000

The cylinder arrangement is shown in Fig. 4. The cylinders are almost horizontal (1 in 30), the inside cylinder alone being inclined at 1 in 8 to clear the leading axle. By placing the three valve chests in one straight line it was possible to use a very simple form of Gresley's valve gear.

The valve motion is shown by diagram, Fig. 1. The two outside cylinders are fitted with Walschaerts' gear. The tail rod of the right-hand valve is linked to a long lever which is fulcrumed on the front transom. This is a lever of unequal arms — 2 to 1. On its left-hand end is carried a floating lever of equal arms, one end of which is linked to the left-hand valve and the other to the inside

valve. The most striking feature about it is the great horizontal lever, over 6 ft. long between centers. It is made of steel and has been carved away to make it as light as possible. At the fulcrum it is fitted with a Hoffman ball and roller bearing, and a bearing of the same kind carries the floating lever. This lever, the only possible feature in the motion that could give rise to any anxiety, has proved perfectly satisfactory. An interesting little question in a gear of this kind is the effect of expansion of the valve rods by heating. Since the position of the two outside rods is fixed by the valve gear, they would transfer the effect of their elongation to the inside valve.

It is claimed that the expansion is so small that only $^1/_8$ in. has to be allowed for on the central valve and $^1/_{32}$ in. on the outside valves, all measured cold. The effect is less than might be expected, because the frames expand as well as the valve rods and carry the fulcrum of the big lever with them. The valve settings are given in Table 1. From this it would appear that a very early cut-off had been adopted for full-gear working, which is intended to permit to secure the full benefit from the use of the three-cylinder arrangement.

In this connection, attention may be called to the Pennsylvania Decapod locomotive described in The Journal of the American Society of Mechanical Engineers, August, 1917, p. 738. There a 50 per cent cut-off was employed, the purpose being to eliminate the range of cut-offs within which the water rate of the cylinder is excessive, and to make possible an increase in the ratio of cylinder power to boiler capacity. The Great Northern engine has its valves set to give a maximum cut-off of 65 per cent.

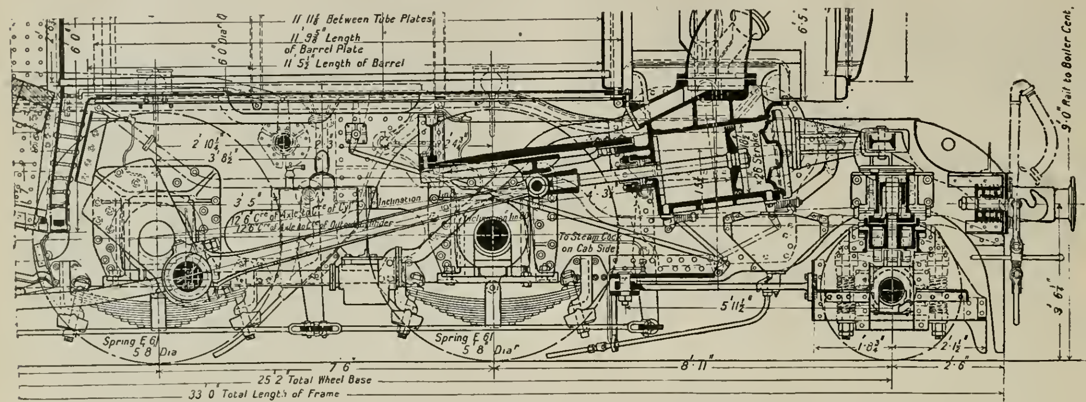


Fig. 2 Great Northern Three-Cylinder Locomotive

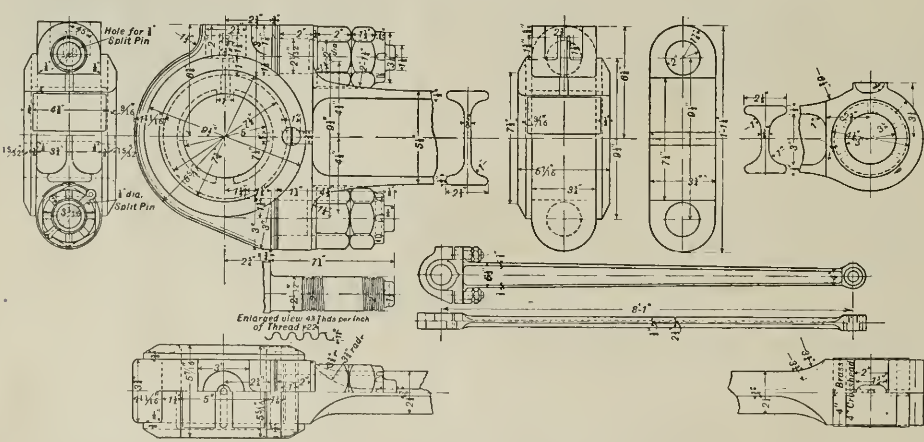


Fig. 3 Details of Outside Connecting Rod

TABLE 1 VALVE SETTING FOR GREAT NORTHERN THREE-CYLINDER FAST-FREIGHT LOCOMOTIVE

2–6–0 type engine; 8-in. piston valve, 1½ in. lap,—⅛ in exhaust lap; three cylinders, 18½ in. diameter by 26 in. stroke.

Mean cut-off	Outside cylinder: Travel of valve, inches	Lead F. inch	Lead B. inch	Valve opening F. inch	Valve opening B. inch	Cut-off F. per cent	Cut-off B. per cent	Inside cylinder: Travel of valve, inches	Lead F. inch	Lead B. inch	Valve opening F. inch	Valve opening B. inch	Cut-off F. per cent	Cut-off B. per cent
Forward Gear														
Mid.	3¼	⅛ F	⅛ F	⅛ F	⅛ F	4.8	4.2	3 9/32	5/32	⅛	5/32	⅛	5.3	4.8
25 per cent.	3 19/32	⅛ F	⅛ F	9/32	5/16	25.2	24.3	3 19/32	⅛ F	⅛ F	9/32 F	5/16	25.5	26.0
40 per cent.	3 31/32	⅛ F	⅛ F	15/32 B	½	39.9	38.2	4 1/16	5/32 B	5/32	½ B	9/16 B	39.0	37.3
60 per cent.	4⅞	⅛ F	⅛ F	⅞ F	1	62.3	57.5	4⅞	⅛ F	3/16 B	⅞ F	1 B	59.1	57.7
Full gear. . . .	6⅜	⅛ F	⅛ F	1⅝ B	1¾	77.4	72.6	6 3/16	⅛ F	3/16 F	1 9/16 B	1⅝ F	77.4	74 6
Backward Gear														
40 per cent. . . .	3 15/16	⅛ F	⅛ F	7/16	½ B	40.4	40.1	4 5/32	⅛ F	3/32 B	9/16	19/32	40.4	39.0
Full gear.	5 15/16	⅛ F	⅛ F	1⅜	1 9/16 B	75.2	72.4	6 3/16	⅛ B	1/64	1⅝ B	1 9/16 F	74.6	70.7

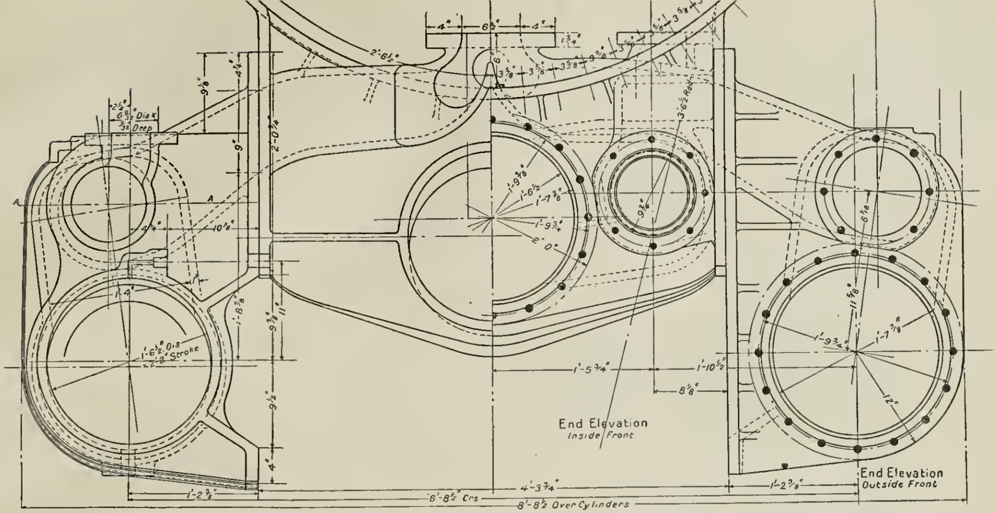


Fig. 4 Great Northern Locomotive Cylinder Arrangement

As it has three cylinders, no very large cylinder diameters need to be used in order to produce sufficient tractive force to absorb a proper percentage of the adhesive weight.

Fig. 3 shows the details of an outside connecting rod made of heat-treated chrome-nickel steel. The weights for the rods are as follows: Outside connecting rod, 295 lb.; inside connecting rod, 347 lb.; coupling rods, 471 lb. The following observation may be of interest: When chrome-nickel rods came back to the shop after heat treatment, it was noticed that they were strongly magnetic in the middle, but not at all at the ends. Furthermore, when the magnetism was examined, it was found that it was positive in the center and negative at the ends. A further investigation has shown, however, that this peculiarity was due to the fact that the rods had been handled by a lifting magnet of the familiar annular form.

In further reference to the boiler, it may be mentioned that the cross-stays above the firebox are carried by brackets riveted to the wrapping plate, and that thirty-two superheater tubes are used.

Particulars given by E. C. Poultney regarding the experience with this engine would indicate that the engine has given great satisfaction in most respects. This part of the article, however, is not suitable for abstracting. (*The Engineer*, vol. 130, no. 3392, Dec. 31, 1920, pp. 634–635, and one 2-page plate. Compare also May 7, 1920, pp. 466–472, illustrated, *dA*)

MIDLAND DECAPOD LOCOMOTIVE

Midland Decapod Locomotive. Fig. 5 shows a 10-wheel coupled banking engine placed by the Midland Railway, England, for service on the Lickey Incline.

Particular attention is called to the inclination of the cylinders, which apparently is coming into favor in England. Tests made in that country have shown that moderate inclination of the cylinders is disturbing only at very low speed.

In the Midland Decapod the evaporative surface in tubes is 1560 sq. ft. and in the firebox 158.25 sq. ft. The superheater area is 445 sq. ft. and the grate area 31.5 sq. ft. The tractive effort at 85 per cent boiler pressure is 43,312 lb.

In connection with British locomotive development generally might be mentioned the heavy tank engines recently placed in service by the Metropolitan Railway. The wheel arrangement, which is 4-4-4, gives a fixed wheelbase of 7 ft. 9 in., and enables the engine to take yard curves of only 4.5 chains radius. The total weight on the coupled wheels is 39 tons, and on each truck 19 tons, making 77 tons in all in working condition. The cylinders are 19 in. by 26 in., the wheels 5 ft. 9 in. in diameter, and the working steam pressure 160 lb. The engines are required to accelerate rapidly and haul trains of 250 tons, which their tractive effort of 17,400 lb. enables them to do. (*The Engineer*, vol. 131, no. 3393, Jan. 7, 1921, pp. 10-11, 2 figs., *dA*)

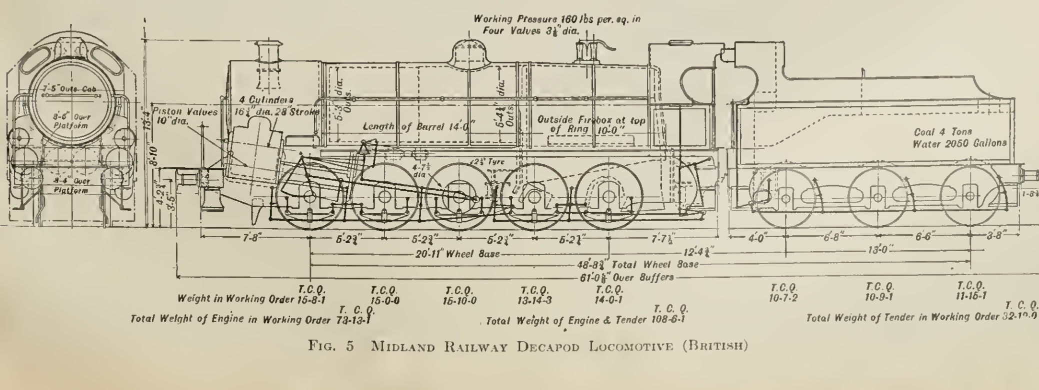


Fig. 5 Midland Railway Decapod Locomotive (British)

GERMAN INTERNAL-COMBUSTION LOCOMOTIVES

Internal-Combustion Locomotives and Their Industrial Applications. The need for satisfactory means of transportation of light loads at moderate speeds has already been felt for a long time in the mining industry where the available new types, such as fireless, compressed-air, and electric locomotives, have not been found entirely satisfactory. In such work the internal-combustion locomotive has proved superior to the types mentioned in many respects, and in Germany the Deutz Gas Engine Company has led in their development.

Fig. 6 shows side and end elevations of a Detuz internal-combustion mine locomotive equipped with chain drive. The engine is of the single- or multiple-cylinder 4-stroke-cycle type. Cooling is effected by evaporation, some of the water being led to the muffler for the condensation of the exhaust gases, the purpose of this being to render them odorless. This is particularly important in mine locomotives in order to prevent contamination of the air. In particular, in connection with the use of internal-combustion locomotives in mines, it is claimed that the contamination of air resulting therefrom is less objectionable than that consequent on the employment of animals for haulage purposes.

The transmission of power from the engine to the driving axle is carried out either by the chain and gear drive or by gear drive exclusively. If chain drive is employed (Fig. 7), then the power is transmitted from the engine A through the gear wheel R_1 secured firmly on the crankshaft, through the loose intermediate gear R_2 and thence to the gears R_3 and R_4. These latter are loose on the shafts B_1 and B_2 and run in opposite directions and at different speeds. On the other side the shafts B_1 and B_2 are interconnected by gear wheels R_5 and R_6 which are of equal diameters and held fast on their respective shafts. The arrangement is such that if either of the shafts is set into motion by the interconnected friction couplings C' or C'', both shafts must run in opposite directions and at speeds corresponding to the number of teeth in the gear wheels R_3 or R_4. Further on the shafts B_1 and B_2 are set the loose sprocket wheels D_1 and D_2 which may be connected rigidly with their respective shafts by means of appropriate claw clutches F_1 and F_2.

The driving axle is driven from the sprockets D_1 and D_2 by the chains G_1 and G_2. To change the running speed all that is necessary, therefore, is to change the engagement of the friction couplings, while to change the direction of running, the clutches F_1 and F_2 may be used.

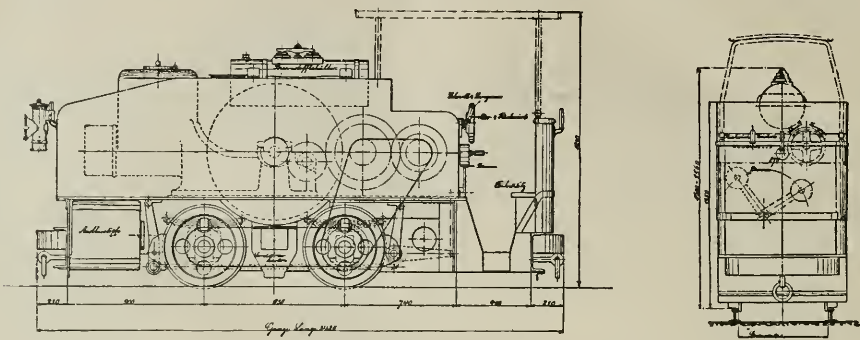


Fig. 6 Deutz Internal-Combustion Mine Locomotive

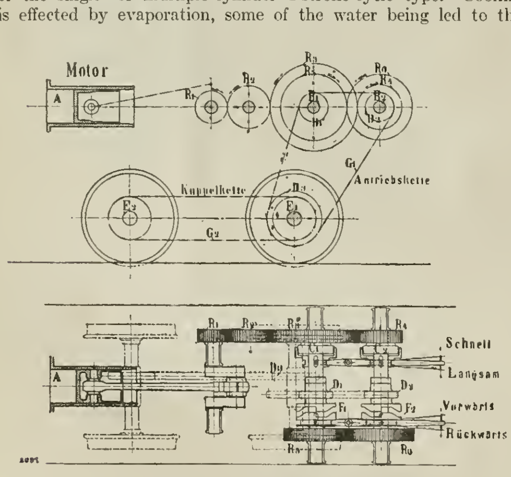


Fig. 7 Chain Drive of the Deutz Internal-Combustion Mine Locomotive (2-Speed Transmission)

(*Antriebskette* = driving chain; *kuppelkette* = transmission chain; *schnell* = high speed; *langsam* = low speed; *vorwarts* = forward; *ruckwarts* = reverse.)

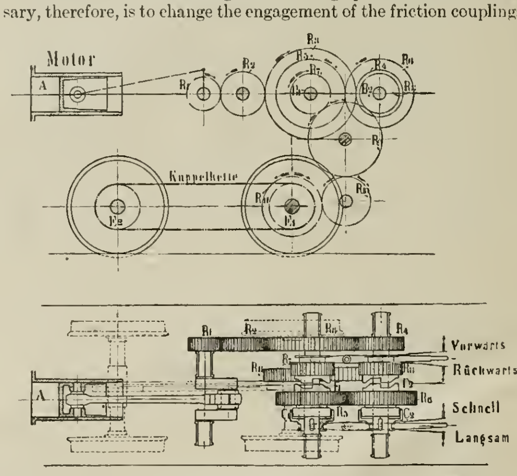


Fig. 8 Gear Drive of the Deutz Internal-Combustion Mine Locomotive (2-Speed Transmission)

(*Kuppelkette* = transmission chain; *schnell* = high speed; *langsam* = low speed, *vorwarts* = forward; *ruckwarts* = reverse.)

In the arrangement shown in Fig. 8 the same general construction is used as in the previous case but the drive is transmitted through the gears R_7 to R_{11} instead of through sprockets and chains.

Mine locomotives in Germany are built in sizes of from 4 to 5 hp. to as high as 60 to 70 hp. (First of a series of articles in *Oel-u. Gasmaschine*, vol. 17, no. 12, December 1920, pp. 177–180, 7 figs., *d*)

A Comparison of the Theories of Elongation and of Shear Stress, Prof. H. Bonte. When a machine part is stressed simultaneously in tension and torsion or bending and torsion there arise in it stresses as to the magnitude of which there is as yet no agreement.

In continental Europe these stresses are evaluated on the basis of the maximum elongations caused by them, which is in accordance with views dating back to St. Venant (theory of elongation). Since, however, the engineer has no direct way of determining the specific elongations, the actual elongation is simply multiplied by the modulus of elasticity E. In this way a value is obtained which may indicate the magnitude of the stresses present when the load on the body is applied along a single axis. The formula by which this stress is computed reads as follows:

$$k_z \geqq \sigma_i = 0.35\sigma + 0.65\sqrt{\sigma^2 + 4\tau^2} \qquad [1]$$

It is made to agree more closely with practical values by the application of the Bach method, in accordance with which the so-called "coefficient of effort" $\alpha_0 = k_z/1.3k_d$ is added to the shear stress τ, in which event the formula is written as follows:

$$k_z \geqq \sigma_i = 0.35\sigma + 0.65\sqrt{\sigma^2 + 4(\sigma\tau_0)^2} \qquad [2]$$

In this equation k_z(or k_d) is the permissible stress in tension (or torsion) for the given material under the given conditions, σ_i the ideal stress in tension as described above (elongation × modulus of elasticity), σ the maximum normal stress produced by the tension or bending, and τ the maximum shear stress produced by the torsion.

In England and America principal stresses computed in accordance with the Rankine equation $\sigma_{max} = {}^1/_2\sigma + {}^1/_2\sqrt{\sigma^2 + 4\tau^2}$ are used, but this formula is losing ground in those countries and has been entirely abandoned in continental Europe.

On the other hand, the theory of shear stress developed on the basis of experiments carried out during the last 20 years starts from the viewpoint that it is the shear stresses in a body that cause various disturbances. The maximum possible shear stress is computed by the equation

$$\tau_{max} = {}^1/_2\sqrt{\sigma^2 + 4\tau^2} \qquad [3]$$

and τ_{max} with single axial loads is only half as great as the stress in tension. Numerous investigators, however, have vigorously questioned the correctness of this theory also, and in its stead several others have been proposed, of which the most important is the one suggested by Mohr in 1900.

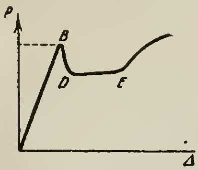


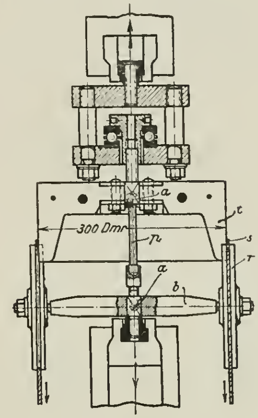
Fig. 1 Stress-Elongation Curve

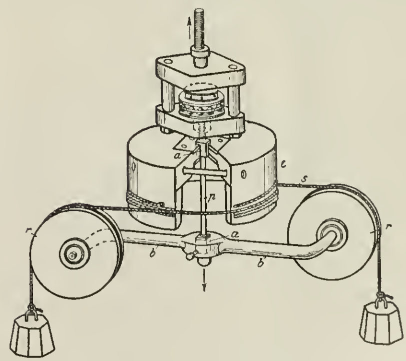
There are insuperable difficulties in the way of experimentally testing the correctness of any of the formulas proposed, as it is impossible at present to determine the stresses existing in the interior of a body. The only thing we can do is to measure the elongations and then compute the stresses that produce them on the assumption of proportionality in accordance with Hooke's law. This procedure, however, cannot be applied when we are dealing with combined stresses, because then single elongations cannot be measured any more, and, furthermore, Hooke's law does not apply for phenomena occurring beyond the elastic limit.

The following method may be applied in order to test the correctness of the various equations proposed for the determination of stresses.

The tension-elongation curve (Fig. 1) for soft iron, which is of importance in machine construction, runs as follows: After passing the limit of proportionality at the point B (upper yield point) where it reaches a maximum, it falls off down to the point D and then continues in a practically horizontal line. At E, however, the stress begins to rise again.

While, in general, the material does not indicate the stresses occurring therein, an exception to this rule occurs after the upper yield point B is passed, in that the scale beam of the testing machine suddenly drops, owing to the decreased resistance in the bar. If we start out with the assumption that a similar material independently of the method in which the stress is produced will suddenly give way at a predetermined stress, we can consider the dropping of the scale beam as an indication that through the coöperation of such tensional and torsional stresses as may be present the yield limit has been reached. If then we should compute the individual values of the tensional and torsional stresses according to the various formulas under consideration, that equation will prove to be entitled to greater consideration which under the various conditions of testing will give the same stress for the yield point at which the dropping of the beam takes





Figs. 2 and 3 Apparatus for Determining the Limit of Elongation in Test Bars

place. With this in view, the tests have been carried out on a testing machine with the auxiliary device illustrated in Figs. 2 and 3.

The test piece p is held at both ends in rectangular holders a. To the upper holder is attached a split wooden drum t, while the lower holder carries an S-shaped arm b with two rollers r (on ball bearings). The cord s transmits the torsional moment from the weights to the test piece p.

In the first instance Equations [1] and [3] of the theory of elongation and theory of shear, respectively, were tested and the data of these tests are presented in Figs. 4 to 7 where the moments of torsion are plotted as abscissae. These moments of torsion were obtained through a drum 30 cm. (1.18 in.) in diameter. The maximum torsional stress produced in the test piece and computed in accordance with the formula $\tau = 16M_d/\pi d^3$ is represented by an inclined straight line passing through the origin of coördinates. The tension stresses σ at which the scale beam drops down are plotted as ordinates. As was to be expected,

these stresses decreased with the increase in the moment of torsion.

The proper values of σ and τ were then computed and plotted first in accordance with Equation [1] (σ_i curves in Figs. 4 to 7) and then in accordance with Equation 3. The values τ_{max} were also plotted, since at $M_d = 0$, $\sigma = \sigma_i = 2\tau_{max}$.

Fig. 4 shows at a glance the superiority of Equation [1] as the values of σ_i remain approximately equal for all moments of torsion in clear distinction from the sharply rising curve of $2\tau_{max}$.

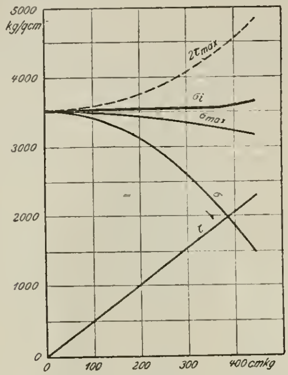


Fig. 4 Upper Yield Point in Solid Test Bars

In addition to tests for the upper yield point, tests were also carried out to the fracture point. Here the values of σ_i increase with increasing moments of torsion, though not in the same proportion as the values of $2\tau_{max}$. These tests, however, do not prove much, as the bar contracts laterally and the proportionality

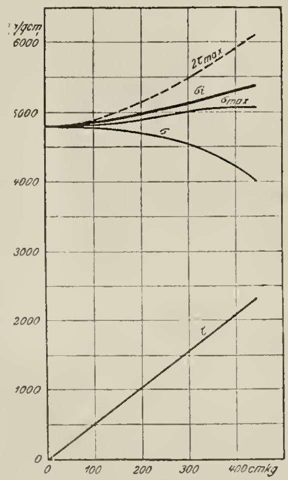


Fig. 5 Fracture Point in Solid Test Bars

between twist and torsional stress ceases to obtain. Because of this lateral contraction the diameter decreases, which affects the area carrying the stress in a square ratio, but the moment of resistance in a cubic ratio.

After the completion of the first series of tests with bars of commercial wrought iron 20 mm. in diameter and 100 mm. long, the question arose as to whether it is correct to compute the torsional stress even at the upper yield point under the assumption of the applicability of the law of proportionality, that is, whether it is correct to apply to the moment of resistance the formula $16M_d/\pi d^3$.

If it be assumed that the limit of proportionality is exceeded even before the occurrence of the dropping of the beam, it is necessary to admit that in the full cross-section of the test piece the torsional stresses do not occur in accordance with a straight-line law, increasing from the center of the piece outward, and therefore the moment of resistance cannot be computed. If, however, it be assumed that proportionality obtains down to the very instant of the dropping of the beam, the moment of resistance can be computed. In order to secure clearer information on this point, tests were carried out with hollow rods 12 mm. (0.47 in.) outside diameter and 8.17 mm. (0.32 in.) bore, the material for the test piece being taken from the same bar as the first test pieces. The tests carried out with the solid test pieces were repeated with the hollow test pieces (Figs. 6 and 7).

In this series of tests it was found that the dropping of the beam does not occur with the same clearness as in the case of solid bars, a fact which agrees with the behavior of machined material found by Bach.

In tensile tests on hollow test pieces all hesitation regarding the permissibility of making use of the moment of resistance is eliminated for the reason that in that case the entire material is located at approximately the same distance from the axis of torsion. This may explain why the σ_i values in the case of hollow test pieces barely vary with increasing moment of torsion, even in tests carried to the rupture point.

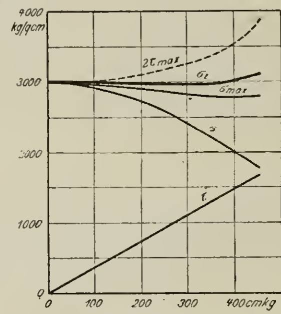


Fig. 6 Upper Yield Point in Hollow Test Bars

In this connection the author mentions the experiments of Guest, published in England in 1900, with the significant comment

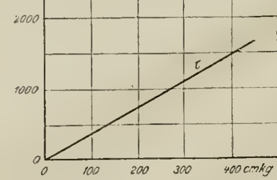


Fig. 7 Fracture Limit in Hollow Test Bars

that as Guest's values are expressed in English units, comparatively few German engineers would be inclined to devote time and attention to their study. Guest does not believe in the so-called theory of elongation. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, no. 51, Dec. 18, 1920, pp. 1071–1073, 7 figs., *pe*)

AERONAUTICS

Aeronautics in 1920 in Great Britain. A general review of events of the past year, of which the part referring to commercial aeronautics is of particular interest.

From an examination of results obtained on the mail service from London to Paris, it would appear that out of 391 flights 298 (76 per cent) were completed without a delay of more than three hours. In 16 cases the flights were completed during the day on which they were started, but without a delay of more than three hours. In 77 cases the flights were either completed on the following day, not completed at all, or not started.

Railway passengers would probably have just cause to complain if one train in every four on a certain line between two cities failed to make the trip with a delay less than three hours.

It has also been found that aerial transportation both of passengers and freight is still very costly as compared with other methods. The main reason, however, why the public distrusts aerial transportation is on account of the impression of danger.

Turning to the records of the past year in England it is found that during the seventeen months from May 1919 to September 1920, according to Air Ministry statistics, 100,285 passengers were carried in England in machines licensed for civilian flying. In this period seven pilots and eight passengers were killed in air accidents, and 13 pilots and 15 passengers were injured. The casualty rates per thousand passengers carried were thus 0.07 pilot and 0.08 passenger killed, and 0.13 pilot and 0.15 passenger injured. If the same rate of accidents prevailed on British railroads 140,000 passengers would be killed each year and over 260,000 injured, while in something like three months all the engine drivers in England would have lost their lives. Admitting that such a comparison may involve gross errors, the margin against the safety of flying is still quite great.

As regards the status of production, the Sopwith Company went into liquidation, the Aircraft Manufacturing Company was absorbed by another concern, while the British Nieuport, the General Aircraft Company, the Grahame-White and the British Aerial Transport Company have practically closed the doors. The Vickers, Ltd., has been doing some work on training machines and on an order from the Chinese Government. Several companies, however, are fairly active in developing new types. (*The Engineer*, vol. 131, no. 3393, Jan. 7, 1921, pp. 5–7, 3 figs., *g*)

AIR MACHINERY (See also Machine Shop; Wind Motors)

Scholl Automatic Hydraulically Operated Air Pump. The purpose of the air pump described in this article is to create automatically a vacuum in centrifugal pumps, suction lines and vacuum apparatus generally, and also to create a pressure in air chambers on pumps, air lifts, etc. Fig. 1 shows the principle on which the Scholl pump is designed. Assume that the container *a*, the riser pipe *g* and the ground pipe *r* are filled with liquid and that further the float and water valves are in positions shown in the drawing, so that gas at atmospheric pressure can be drawn in by suction. Since the outlet of pipe *r* is below the level of *a*, the liquid in *b* will flow out through *r* and force the gas through *k* by suction into the container, while the level of the liquid in the float goes down and the float itself rises. Sooner or later the upward movement of the float overcomes the pressure in the water inlet valve *i*, the valve rises and takes the open position while the exhaust valve *f* closes. The liquid flowing in through *i* passes through the channel *w* into the ring-shaped space between *a* and *b*, where because of the rise of the float the lever of the liquid has gone down thus it passes into the interior of the float. Simultaneously with this, however, the gas content in *a* is compressed and when it reaches the necessary gage pressure is delivered through *l* into the pressure line connected thereto. Shortly before the float is entirely filled with liquid the weight of the float overcomes the pressure difference between *a* runs out through *f* and *g* and the gas taken in by suction is again in position to flow into *a* through *k*, which starts the new cycle of operation similar to the one described above.

With the arrangement shown in Fig. 1 the gas is delivered to the pump through a suction line attached at *k* and passed along through *l*. The pressure liquid from the air pump is discharged at *r* of which the lower end should be bent upward to prevent the entrance of air. If the pressure of the gas taken in by suction is equal to or lower than atmospheric pressure, the lower end of *r* must be located lower than the pump, its position being determined by the specific weight of the liquid and the vacuum obtained.

With a pump of ordinary design in operating single-stage a vacuum in the ratio of ten to one or 0.1 atmosphere absolute can be obtained; in compression the gage pressure of 10 atmos. can be obtained. Where pressures higher than 10 atmos. are desired, a special high-pressure model must be employed.

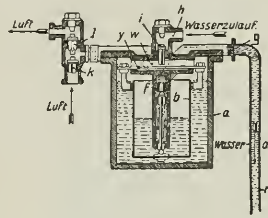


Fig. 1 Scholl Automatic Hydraulically Operated Air Pump
(*Luft* = air; *wasserzulauf* = water admission; *wasserablauf* = water outlet.)

Several other designs of the same pump applicable to various purposes are described and illustrated. (*Der Praktische Maschinen-Konstrukteur*, vol. 53, no. 43, Oct. 28, 1920, pp. 380–382, 6 figs., *d*)

BUREAU OF STANDARDS

Gypsum—Properties, Definitions and Uses. Owing to the rapid growth of the gypsum industry, the nomenclature has not been standardized. A brief description of the various gypsum products will tend to fix their names.

Gypsum is a soft, white rock, usually occurring in beds. Other varieties of the same material are known as gypsite and alabaster. It is of common occurrence throughout the United States. Chemically it is a calcium sulphate combined with water. Anhydrite is a variety which contains no water.

Raw gypsum is used for the manufacture of portland cement and as a fertilizer. Calcined gypsum is made by heating raw gypsum in a kettle until the first evolution of water has ceased. It contains one-fourth as much water as the raw material. This product is frequently known as plaster of paris and is used either as such or as the basic ingredient for the manufacture of wall plaster, potter's plaster, dental plaster, etc. Large quantities of it are used in the manufacture of portland cement, plate glass, and cold-water paints.

When calcined gypsum is mixed with water it sets to form a hard mass. The time required for this reaction can be varied at will by the addition of suitable retarders or accelerators.

Neat gypsum plaster is calcined gypsum to which has been added some material (such as hydrated lime) to improve its working quality, and the proper amount of retarder. Gypsum sanded plasters are mixed with sand ready for use. Any of these plasters may or may not be "fibered" with either hair or wool fiber. And a special wood-fibered gypsum plaster is made to be used without sand.

Gypsum plasters have excellent fire-resistive ability.

The raw gypsum can be heated until all of the water is given off. The product so formed sets more quickly than calcined gypsum. It is not marketed, but is used at the factory to make such

products as gypsum tile, gypsum plaster board, gypsum wall board, etc. Further heating of the raw gypsum forms a material which sets very slowly. An accelerated variety of this is marketed as Keene's cement.

Gypsum tiles are factory-made building blocks. They come in a great variety of sizes, either plain or reinforced. They are used for building walls and roofs.

Gypsum plaster board consists usually of a sheet of set gypsum plaster between two sheets of unsized paper. It comes in many sizes, usually about 3 ft. sq. by $^3/_8$ in. thick. It is used instead of lath as a backing for plaster.

ENGINEERING MATERIALS (See Bureau of Standards)

FUELS AND FIRING

Modern Gasoline and Its Vaporization—Heated Manifolds and the "Hot Spot"

The Volatility of Internal-Combustion Engine Gasoline, Frank A. Howard. Discussion of the character of gasoline, its vaporization, and available means for improving combustion. The author sees the best solution of the present problem in a wider adoption and improvement of heated manifolds, in particular of the hot spot. Particular attention is called to data presented on the vapor pressure and inherent volatility of the gasoline of today.

Gasoline is a complex mixture of hydrocarbons, varying from pentane, the lightest, to undecane, the heaviest present. From the chemical equations of volumetric proportions of a combustible mixture it is found that a perfect combustible mixture of pentane vapor and air must consist of 40 parts by volume of air and 1 part by volume of pentane. Also a perfect combustible mixture of undecane vapor and air must consist of 1 part of the fuel to 85 parts of air, by volume. Since gasoline contains more of the lighter than of the heavier hydrocarbons, the volumetric proportion of gasoline vapor in a perfect mixture will be somewhere in the neighborhood of 1 part in 60, or 1.67 per cent.

Such a small proportion of gasoline vapor in the mixture can be brought about by evaporating the gasoline under favorable conditions and without boiling it. Dalton's laws of the vaporization of liquids state that evaporation from an exposed liquid continues until there is established a definite pressure of the vapors of the liquid, that this pressure increases with the temperature, and that when other vapors are present the total pressure of the mixture multiplied by the volumetric percentage of any constituent gives what is called the partial pressure of that constituent; so long as the partial pressure of the vapor in question is below the vapor pressure of the liquid, condensation cannot occur.

Measurements of the vapor pressure of 58 deg. Baumé gasoline in air were made with an instrument designed by C. I. Robinson, chief chemist of the Standard Oil Co. of New Jersey. First the vapor tension of the original gasoline was determined at several temperatures. Then the sample was reduced by distillation in the ordinary way, taking off successive 10 per cent fractions. After each reduction operation the vapor tension of the residual portion of the gasoline was determined at temperatures of 50, 75, 100 and 125 deg. The vapor tension in millimeters of mercury was 44.75 at 50 deg. fahr. with 90 per cent residuum, 9.66 with 60 per cent, and 4.84 with 40 per cent. At 125 deg. fahr. with 50 per cent residuum the tension was 29.50; with 30 per cent, 12.55; with 20 per cent, 8.05; and with 10 per cent, 5.07. Of the last residuum, according to the combustion equation, a perfect combustible mixture would contain 1.2 per cent. The average pressure in an engine manifold is around 0.5 atmosphere. Calling it 400 mm. of mercury, $0.012 \times 400 = 4.8$ mm. is by Dalton's law the partial pressure of the fuel vapor, assuming that the fuel is made up entirely of the least volatile fraction of the present gasoline. But, as the figures quoted indicate, at any temperature above 125 deg. fahr. the least volatile portion of the gasoline had a vapor pressure well above 4.8 mm. It follows, therefore, that even if the gasoline consisted entirely of what is at present its heaviest constituent, it would still possess sufficient inherent volatility to make it a possible fuel for an automotive engine. It is a fuel and can become and must remain a gas at an intake temperature not substantially higher than present practice. Stating it generally, complete vaporization of fuels heavier than those now sold is possible without increase of mixture temperatures; but condensation of these fuels is impossible. Manifold condensation is impossible above the temperature indicated, because it is physically impossible for any vapor to condense when its partial pressure is lower than the determined vapor pressure of the liquid itself at that temperature, and this is apparently the average condition in an engine manifold.

Utilization of the full inherent volatility of a fuel is dependent upon three factors: time, surface and heat. If heat is applied rapidly enough and at a high enough temperature, surface and time become unimportant.

Air heating and manifold heating are helpful, but apparently the means which best meets the physical requirements of volatilization is the so-called "hot spot." The definite problem is to supply heat to the fuel; not to supply heat to the air or to the mixture, but to the fuel itself. This heat should be supplied to the fuel in the presence of the air to have its maximum effect. Preheating the fuel would cause the distillation of the lighter hydrocarbons and their consequent wasteful loss. The latent heat of vaporization of the fuel must be applied to it as (or after) the mixture is made. One obvious way is to preheat the air; another, to directly heat the charge. However, the heat conductivity of air is so low that, unless this is carried to an extreme which results in substantial loss of power, there is not sufficient time for the necessary exchange of heat between the evaporating fuel drop or film and the enveloping air current.

The solution of the problem, therefore, seems to lie in the further development of the hot spot. Tests have been reported in the technical press which showed that within 35 sec. after the exhaust gases were admitted to the jacket of the hot spot the mixture passing was perfectly dry as shown by a glass manifold. The writer found in experiments with a hot spot of that design that complete vaporization of the fuel was secured with a manifold temperature beyond the hot spot of 125 deg. fahr. The surface of the hot spot itself showed a temperature of 350 deg. fahr., as accurately as could be measured. It is apparent that advanced hot-spot design has already reached a point at which automotive engineers can come very close to utilizing the full inherent volatility of the fuel by the simple and logical expedient of directly heating the unvaporized fuel in contact with the air, rather than by trying to preheat the fuel or to heat the fuel by contact with heated air. (Paper read at the Annual Meeting of the Society of Automotive Engineers, New York City, January 12 and 13, 1921, 4 pp., 1 fig., *tep*)

Importance of Hardness of Blast-Furnace Coke, Owen R. Rice. Coke to be used in blast furnaces has to be of a certain hardness because soft coke does not permit proper furnace operation. The methods thus far employed to determine the physical nature of coke have not, however, given full satisfaction.

Thus the shatter test does not fully indicate the character of coke and the author recommends instead an apparatus which has a combination of a tumbler and ball mill.

On the other hand, however, it should not be thought that the hardness of coke is the deciding element in furnace operation, though it has been found that coke of the hardness below number 81 causes trouble, while the hardness above 85 does not appear to bring any particular advantage.

There does not appear to be any clearly established rule determining the quality of coke resulting from different coals. Ash in coke has a detrimental effect on hardness. Another factor which affects the coal materially is the hydrogen-oxygen ratio. The stocking of coal affects this ratio in a very material manner. A 9-mo. stock of Davis coal showed a ratio of 102 per cent, while Davis coal direct from the mine showed a ratio of 125.8 per cent. Some 9-mo. stock of Fulton coal showed a ratio of 55.1 per cent, while Fulton coal direct from the mine showed a ratio of 57.5 per cent. (Paper presented at the Annual Meeting of the American Inst. of Mining and Metallurgical Engrs., New York, Feb. 1921, abstracted through the *Iron Age*, vol. 107, No. 6, Feb. 10, 1921, pp. 380–381, 1 fig. *ep*)

of Highly Volatile Fuel Without Intervening Cleaning, A. B. Reck. Results of two tests with bituminous coal—one made before and another after 14 days of continuous firing with the same fuel without intervening cleaning. The test results are given in the form of a table and curve, the former showing that the overall efficiency obtained in the test with clean boilers was 77.9 per cent and was lowered to 74.9 per cent, or only 3 per cent after 14 days of continuous running.

This relation between efficiency, capacity and chimney draft is shown graphically in the diagram in Fig. 2, together with similar results obtained in a great many other tests made with the same kind of fuel, viz., bituminous coal, and in the same clean boiler. The curve shows a maximum efficiency around the capacity, at which the test A was conducted. As neither the capacity nor the efficiency is seriously reduced after 14 days of continuous firing at approximately the same draft (see test B), the conclusion may be drawn that with sufficient data at hand of tests made with the same fuel and the same boiler after 14 days of continuous firing it should be possible to draw a new efficiency curve, in which the efficiency found in test B likewise will prove to be a maximum.

In order to verify the correctness of efficiency values with clean boiler and bituminous coal, tests were made in the same type of boiler with anthracite of stove size. The efficiency obtained with

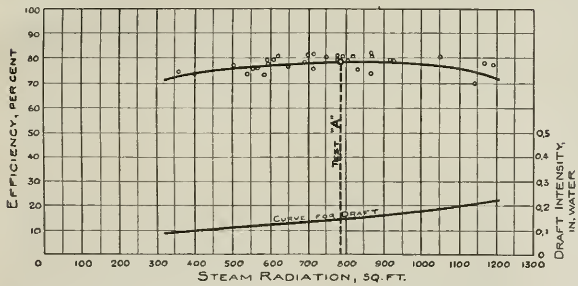


Fig. 2 Efficiency Curve for Steam Boiler with Bituminous Coal (Clean Boiler)

that fuel was 83.1 per cent, or 5.2 per cent higher than with bituminous coal.

The author ascribes these high efficiencies to the method employed in introducing the supplementary secondary air. Each section of the boiler is provided with an air channel located on the edge toward the combustion chamber as shown in Fig. 3. The air leaves the canals through the opposite rows of close-sitting openings in the form of jets, striking the combustible gases liberated from the surface of the fuel bed just as they are to enter the smoke flues, which are located between the boiler sections. It is claimed that this intermixing shower of fresh air evenly distributed over the whole surface of the fuel bed is sufficiently far from the surface itself to avoid acting as primary air. It is also claimed that the use of these air channels prevents the overheating of the exposed water ways, acting for them as a protection against the radiant heat. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 27, no. 1, January 1921, pp. 1–53, figs., *de*)

HEATING (See Fuels and Firing)

HYDRAULIC MACHINERY (See Air Machinery)

INTERNAL-COMBUSTION ENGINEERING (See also Fuels and Firing; and the Abstract on page 192)

Air-Temperature Regulation Effects on Fuel Economy, Reuben E. Fielder. Test conducted by Fifth Avenue Coach Co., of New York City, to study the effect on fuel economy of regulating the temperature of the air entering into the engine cylinders. Comparative tests were made with and without this thermostatic-control device, using the same engine, carburetor and similar equipment, under the same atmospheric temperature conditions. The average saving in fuel consumption was 7.85 per cent and a 5 per cent increase in horsepower was obtained when using the thermostatic control.

The temperature in the manifold when using the thermostatic control was constant, whereas without this device it varied from 130 deg. fahr., as a minimum, to 160 deg. fahr., which showed a loss of power and increased consumption of fuel at all speeds, indicating a loss in volumetric efficiency due to excessive heat. This test was made at a time when the atmospheric temperature was 68 deg. fahr. What happens when the atmospheric temperature is around 90 deg. fahr. as in the summer, or 0 deg. fahr. as in winter, can well be imagined.

The best manifold temperature for the gasoline used was found to be 102 deg. fahr. This temperature was determined upon after tests in which the engine speed was held constant while varying the temperature in the manifold, the power developed

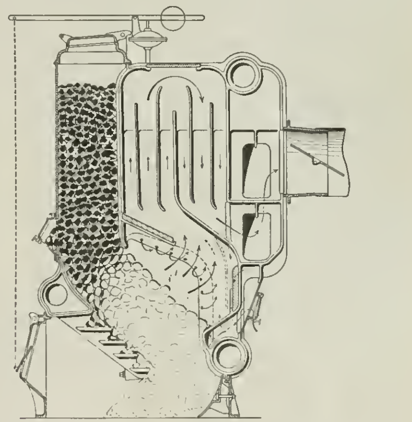


Fig. 3 Vertical Section through Reck Boiler

and the fuel consumption being recorded. The speeds selected were 700 and 1200 r.p.m., thus representing the high and low limits of speed. With the thermostat set to maintain a manifold temperature of 102 deg. fahr the saving in fuel was 8 per cent or more.

Other tests were performed to observe the effect of variation of manifold temperature on economy and torque, with different jets, and also the effect of thermostatic control on the volumetric efficiency of the engine. (Paper read at the Annual Meeting of the Society of Automotive Engineers, New York City, January 11–13, 1921, 4 pp., 7 figs., *c*)

Problems Awaiting Solution in Diesel-Engine Design

Problems and Probable Field of the Oil Engine, Paul Rieppel. The author starts with the discussion of the economical and political problems connected with the control of the world's supplies of oil and of the application of the oil engine—by which he means the various types of internal-combustion engines, the Diesel and its modifications being first considered. In the course of the article the author makes many interesting observations and raises several questions well worth attention.

Combustion Processes. As regards the nature of combustion processes in the Diesel engine, our knowledge has reached the point where we can clearly distinguish the processes of injection, vaporization, gas formation and combustion. The author believes, however, that a very wide field in this domain remains as yet unexplored and that more work should be done in the laboratory by the physicist, such work being preferable in many cases to extensive experimentation on actual engines.

The most rapid and complete combustion is a function of the fineness of atomization, intermixture with air, and, to an extent which has not yet been fully appreciated, of turbulence. No thorough tests have been made to determine what is the best method to obtain the most complete atomization and what fineness of atomization is needed under each set of conditions.

As to the influence of catalysis in the cylinder, whether that due to presence of water or of some other catalytically acting material, the tests of Stein contain valuable material, but the influence of very small, in fact extremely small, amounts of water on fuel combustion remains as yet to be investigated. As a matter of fact we know that under certain conditions very poor oils burn better in the presence of water, and the use of other catalytic agents, such as silicon and various metals, may bring startling developments in engine design and offer a means of increasing our ability to control combustion.

How to obtain the best possible conditions of turbulence and how to evaluate the influence of turbulence are questions which may be answered by tests on self-ignition of oils and the velocity of flame propagation therein. In a bomb, oil vapor at rest does not ignite at all at temperatures corresponding to the temperature of compression in a Diesel engine, but when a slight turbulence is produced, as, for example, by injecting a small amount of air, self-ignition takes place. Comparatively little has been done in this direction. This and other questions must be considered by everyone interested in the subject of combustion processes, and they are not mere academic problems but important stones in the foundation upon which the structure of economic design of an engine has to be raised. Had we had this information a highly economic Diesel engine could have been designed long ago and have done away with the compressor. From this the author proceeds to the discussion of various attempts to build a Diesel engine without a compressor, such as have been proposed by Vickers, Price and Steinbecker.

Economy of Operation. In the determination of the economy of operation, questions as to the use of a 4-stroke or 2-stroke cycle, high or medium pressures, are ones which lie at the foundation of the problem. After discussing briefly the relative position of the 4- and 2-stroke cycles and the question of scavenging, the author proceeds to the question of compression and asks whether we shall continue to operate Diesel engines with a compression of 35 atmos. and the heavy weight of the engine and mechanical difficulties which it involves.

The higher thermal efficiency secured with this compression does not have decisive value in the author's eyes, as motors employing lower compression pressures would have a lower first cost, be more reliable and show a better mechanical efficiency. As regards the advantage secured through self-ignition of the mixture, it is pointed out that the point of self-ignition is lowered very materially when the cooling produced by the expanding stream of the injection air is eliminated. With solid injection every condition of engine operation can be met without external means of ignition at a pressure of 25 atmos. But even assuming that self-ignition would have to be dispensed with, why not? The high value placed on the ability of the engine to operate on a basis of self-ignition is a survival of a time when electrical ignition was still complicated and unreliable. Today it is quite easy to provide reliable means of producing a good electric spark having a good control of timing, or, where necessary, to produce a wire spirally wound and maintained constantly at a glowing heat by a flow of electric current. There is no reason why one should not employ outside methods of ignition in engines in which the most economical operation may be secured at compressions at which self-ignition can no longer be relied upon.

In connection with the problem of securing the most economical operation of oil engines, the author takes up the question of utilization of waste heat. It is true that as high as 40 per cent of the heat in the fuel may be usefully employed in the oil engine, but this is no reason why one should waste the other 60 per cent without any effort at recovery. The comparison with the 12 per cent heat efficiency of the steam engine is often misleading because in a steam engine a good deal of the heat in the exhaust steam may be still utilized for purposes of heating and drying. In properly conducted factory processes employing steam, the power generated by the steam engine should be considered as a mere by-product, while in the case of oil-engine drive it is the main if not the only product of fuel combustion.

The problem of utilizing the waste heat of oil engines is one of the most important from an economical point of view. The usual way is to pass the exhaust gases on to steam boilers, a method well known in large gas-engine operation. This cannot be done as conveniently with oil engines, because the temperature of the exhaust gases is considerably lower. Furthermore, any attempt at a thorough utilization of exhaust heat from oil engines would involve a considerable increase in the first cost of the installation and also possibly corrosion troubles due to the presence of sulphurous acid in the exhaust gases. In particular, in the case of auxiliary boilers on shipboard, it has been found advisable to equip them with direct oil heating in addition to heating by exhaust gases. An important physical problem is the determination of the coefficient of heat transfer from exhaust gases to the boiler wall. This is a question proposed by Nusselt, but, in general, the coefficients now employed are more or less of a rough nature and do not take into consideration many important factors.

In this connection may be mentioned attempts to mix the exhaust gases with steam and to add to them compressed air and utilize the mixture either in turbines or in reciprocating engines. It does not appear than any such efforts may lead to useful conclusions.

In another part of the same article, which will be abstracted at an early date, the author discusses the application of oil engines, in particular those operating on heavy oils as opposed to gasoline and kerosene engines, to various specific purposes, such as the driving of locomotives, road vehicles, tractors and aircraft. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 64, nos. 49 and 50, Dec. 4 and 11, 1920, pp. 1021–1027 and 1051–1055, 10 figs., *gA*)

MACHINE SHOP

Sand Blasting, C. W. Starker. A practical article describing the types of apparatus, abrasives, nozzles, air pressures, dust exhausting and general methods of operating.

There are several systems of sand blasting differing in the manner of applying the stream of abrasive to the surface to be treated. Air compressed to varying pressures is commonly employed in all sand-blasting equipment, but the pressure is applied in different ways.

In the direct-pressure system the air and the abrasive are combined in and discharged from a closed tank through a nozzle. In the suction system the abrasive is carried to the nozzle by the suction created by a jet of compressed air, which, in passing through the nozzle, carries the abrasive with it. This system is also known as the siphon system. For this system an apparatus known as the sand-blast gun is employed. In the third system, known as the gravity system, the abrasive is carried by mechanical means to a place above the nozzle and is fed down by gravity.

In general it may be said, other things being equal, that the higher the air pressure used the stronger the force of the jet discharged against the surface to be treated, and therefore the greater the amount of work done. It may be roughly stated that according to actual practice 50 lb. air pressure will perform twice as much work as 20 lb., or 65 lb. will accomplish twice as much as 30 lb., and 72 lb. twice as much as 40 lb. The air pressures used for different materials are as follows (fair average practice): Steel castings or forgings, 80 to 100 lb.; malleable iron, 70 to 85 lb.; cast iron, 60 to 70 lb.; and brass and aluminum, 35 to 50 lb.

The volume of air flowing to a nozzle opening at a given pressure is governed by the size of the nozzle. (Table 1). As the nozzle is apt to wear, however, it is important to design it so as to reduce this wear as much as possible. Moisture in compressed air prevents an even flow of abrasive and causes the sand to form lumps. It is also detrimental to pneumatic tools which are operated from the compressed-air system.

As regards the abrasive materials, sand is the most commonly used on account of its relatively low price. Ordinary lake or river sand is inferior to sea sand and silica sand. Abrasives, such as steel grit and shot are used to a certain extent, but are not suitable

All abrasives should be screened each time before using to remove particles large enough to plug the nozzle and also to eliminate fine particles which only produce dust and have no abrasive quality.

TABLE 1 FLOW OF FREE AIR FOR DIFFERENT SIZES OF NOZZLES

Diameter of nozzle, in.	Pressure (Cu. Ft. per Min.) and Corresponding Horsepower Required							
	20 Lb.	Hp.	30 Lb.	Hp.	40 Lb.	Hp.	50 Lb.	Hp.
1/8	7.70	0.63	10.00	1.03	12.30	1.50	14.50	1.99
3/16	17.10	1.40	22.50	2.32	27.50	3.26	32.80	4.49
1/4	30.80	2.53	40.00	4.12	49.10	5.99	58.20	7.97
5/16	48.17	3.95	62.89	6.48	76.60	9.36	90.70	12.43
3/8	69.00	5.66	90.00	9.27	110.00	13.42	130.00	17.81
	60 Lb.	Hp.	70 Lb.	Hp.	80 Lb.	Hp.	100 Lb.	Hp.
1/8	16.80	2.57	19.00	3.19	21.20	3.86	25.73	5.33
3/16	37.50	5.74	43.00	7.22	47.50	8.65	57.88	11.98
1/4	67.00	10.25	76.00	12.77	85.00	15.47	103.00	21.32
5/16	105.00	16.07	119.00	20.00	133.00	24.10	161.00	33.82
3/8	151.00	23.10	171.00	28.73	191.00	34.76	232.00	47.90

It is important to have the sand-blast rooms well ventilated. In the majority of cases it is also necessary to provide methods for gathering and settling the dust rather than discharging it into the atmosphere. (*Machinery*, vol. 27, no. 5, Jan. 1921, pp. 458–462, 11 figs., *p*)

Work Speeds in Cylindrical Grinding, Robert J. Spence. The author claims that the importance of the function of the speed-changing device in grinding machines does not seem to be understood in general by the operators, of whom a very large number believe that the faster the work revolves the greater the amount of work produced. The author believes this is erroneous and that to operate a grinding machine continually on the fastest work speed is just as wrong and just as wasteful as it would be for a lathe operator to run his machine continuously at a filing speed when turning work.

To prove this, the author analyzes a case where a man is grinding a bar of steel and using the fastest work speed and fastest table traverse with which the machine is equipped. He shows that when an excessively high speed is used only part of the wheel face is presented to the work, and when such a thing happens the remaining part simply laps over on the surface ground during the preceding revolution of the work and there is a non-uniform wearing action. The portion of the wheel face which is not cutting but simply dragging on the work becomes glazed and adds useless friction to the operation, thus increasing the power consumption of the machine.

The importance of using the greatest possible radial depth of cut is next discussed. Even a small increase in the radial depth of cut permits for the same amount of work to reduce the number of table traverses, which, for the same rate of traverse, means a material reduction in the time consumed in grinding a piece.

The question of the effect on the amount of stock removed in its relation to wheel wear when the speed of grinding is reduced, is also discussed in some detail on the basis of the graphic analysis of the action of a grinding wheel proposed by Prof. George I. Alden. A discussion of the numerical case indicates that in that instance a change of work speed from an excessive rate of 190 r.p.m. to a more rational speed of 75 r.p.m. increases the amount of stock removed per unit of wheel wear 150 per cent. (*Machinery*, vol. 27, no. 5, Jan. 1921, pp. 438–440, *p*)

MEASURING INSTRUMENTS

Use of the MacMichael Viscosimeter in Testing Petroleum Products, W. H. Herschel and E. W. Dean. The MacMichael viscosimeter is of the torsion type. Its essential parts are a rotatable motor-driven oil cup and a torsional pendulum suspended above the center of the cup by a piano wire. The cup has an inside diameter of about 70 mm. (2–13/16 in.), is equipped with an external heating coil of resistance wire (which can be used only when the cup is at rest), and is set in an oil jacket which also revolves. The cup is driven with a set of speed-reducing gears by means of a small electric motor. The latter is equipped with a speed-control device of the phonograph type and it is possible

The pendulum consists of a tube inclosing the suspension wire and carrying a disk at its lower end, an oil-filled dashpot slightly below the middle of the tube, and a graduated dial near the point of support. The disk is about 60 mm. (3–5/16 in.) in diameter and 5 mm. (3/16 in.) thick. The dashpot, attached to a support cast on the frame of the instrument, serves to minimize oscillation of the pendulum and also is a convenient device to indicate when the whole instrument is properly leveled.

The dial is fastened to the tube by a tapered fit and is graduated from 0 to 300 for reading the angular deflection of the pendulum. The zero setting is made roughly by turning the dial on the tube, and more accurately by movement of the pointer attached to the support of the pendulum.

The instrument may have wires of different sizes.

Some of the limitations of the instrument are indicated by this description. It is obvious that one of the most vital parts is the suspension wire and that this can easily be injured either through careless handling or by using a wire with so viscous an oil that the deflection is sufficient to strain the wire. One of the vital dimensions controlling the readings obtained is the clearance between the bottom of the disk and the oil cup. The method of attaching the wire in the disk is such that it is practically impossible to control this clearance, which is a disadvantage in that it renders a new calibration necessary every time a wire is removed and replaced. Changing of wires is frequently necessary, as one of the principal disadvantages of the instrument is the range of viscosity that can be covered by the use of properly selected wires of different diameters.

The advantages of the MacMichael viscosimeter as compared with the usual efflux types are (1) that the time consumed in making a determination with it is relatively small, and (2) that it gives moderately accurate results with oils that are not perfectly homogeneous. This latter is important in measuring the apparent viscosities of such substances as emulsified products or used automobile crankcase oils containing both water and finely divided sediment. Efflux type viscosimeters (such as Saybolt) are extremely unreliable for testing products of this sort, while with the MacMichael instrument reasonably accurate measurements can be made. It is also of value in distinguishing true liquids from plastic solids.

The limitation, in addition to what is stated above, lies in the fact that its construction is such that calibration of the instrument in terms of its dimensions is impracticable.

It is important to bear in mind that the readings of the MacMichael viscosimeter are related to absolute viscosity instead of kinematic viscosity, and it is therefore necessary to know the specific gravity of the oil tested before MacMichael readings can be translated into terms of Saybolt seconds. This, however, introduces no difficulty as it is the practice in the petroleum industry to measure the gravity of all samples anyway.

The paper gives careful directions for the calibration of the apparatus and for the methods of its use. Among other things, an interesting method is suggested for measuring absolute viscosities with the Saybolt viscosimeter. (Reports of Investigations of the U. S. Bureau of Mines, Serial No. 2201, Jan. 1921, abstracted from mimeographed copy, *tp*).

MECHANICS

Torsional Strength of Multiple-Splined Shafts, C. W. Spicer. Comparative torsional tests of splined shafts and full-round shafts.

Fifteen shafts were tested. Five were splined with small diameter of 1.315 in. and outside diameter of 1.5874 in. The other ten were full-round shafts, five 1.2806 in. in diameter and five 1.5 in. in diameter. This last diameter was computed as the theoretical equivalent of the splined shafts. The 1.2806-in. shafts were intended to have the same diameter as the small diameter of the splined shafts, but they were reduced to the size that would clean up by grinding the most badly warped shaft in the

heat-treating operation. All of the full-round shafts had at the ends practically the same diameter as the large diameter of the splined shafts.

Curves were plotted showing twist against torsional stresses. An Olsen torsion-testing machine was employed and readings were taken by means of the Olsen troptometer attachment. The average readings obtained with the five shafts of each series were used.

It was found that a twist of 0.2 in. measured on a 12-in. radius between 9-in. centers was produced in the full-round shafts with the small diameter by a load of 6000 lb. per sq. in., while 8350 lb. per sq. in. was required to produce the same twist in the splined shafts and 11,500 lb. per sq. in. in the theoretically equivalent full-round shafts. For a twist of 0.3 in. the figures were 9000, 12,250 and 17,000 lb. per sq. in., respectively, for each of the three classes of shafts. Similarly for 0.4 in. twist, 12,000, 16,500 and 22,500 lb. per sq. in.; and for 0.5 in. twist, 15,000, 20,000 and 27,800 lb. per sq. in. At this point the Johnson elastic limit was located for the splined shafts, that is, the unit increment of deflection per unit load increase was 50 per cent greater than at the beginning. The Johnson limit occurred in the small round shafts at a load of 22,000 lb. per sq. in. with a twist of 0 78 in., and at 32,000 lb. per sq. in. with 0.58 in. twist in the theoretically equivalent round shafts. (Paper read at the Annual Meeting of the Society of Automotive Engineers, New York City, January 12 and 13, 1921, 2 pp., 4 figs., *e*)

Three-Point Suspension for Automobile Engines, One Point Being Rigidly Fixed

A New Principle of Engine Suspension, S. E. Slocum. Discussion of application of three-point system of support to automotive engines as a means for eliminating the vibration due to synchronism.

In designing a system of engine suspension which will eliminate vibrations, it is well to remember that there are two main types of vibration, one due to unbalance and the other to synchronism.

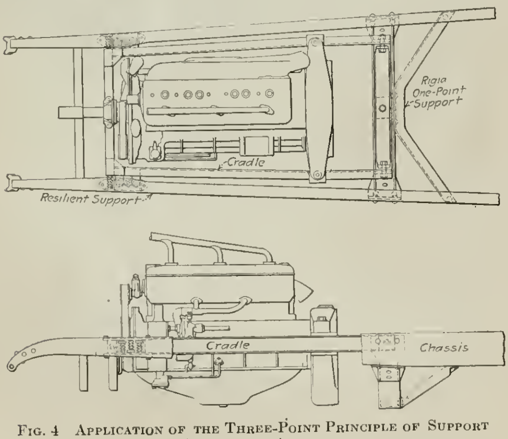


Fig. 4 Application of the Three-Point Principle of Support to Automotive Apparatus

The first can be eliminated by well-known methods of balancing, leaving only the vibration due to torque recoil and inertia forces. The second can be eliminated by preventing synchronism, and this can be accomplished by isolating a machine from its support so far as the transmission of vibrations is concerned. To explain what this implies, it is pointed out first that any body may have at most six degrees of freedom; that is, it may be free to move along any three mutually perpendicular axes, giving three degrees of freedom, and it may also be free to rotate about these three axes, giving the remaining three degrees of freedom. If one point of the body is fixed, this destroys the first three degrees of freedom since the body can no longer move as a whole in any direction; but it is still free to rotate about any axis through the fixed point, so that it still possesses three degrees of freedom as regards rotation.

To apply this to the automotive engine, suppose that one point of the engine is fixed, so that it can pivot about this point. Suppose that, in addition to this one fixed point, two other points of the machine are mounted on resilient supports. It is then evident not only that the machine will have three-point support, but also that within certain limits it will have freedom of motion about the fixed point, due to the resiliency of the other two supports. This type of three-point support, one point being rigidly fixed and the other two supports being elastic or resilient, leaves the body three degrees of freedom, and yet makes it possible to control absolutely the period of the vibration. In other words, by properly designing or adjusting these resilient supports it is possible to change the period of vibration so as to prevent any possibility of its synchronizing with the natural period of the engine bed or foundation.

Fig. 4 illustrates a three-point-support system as applied to automotive engines. The method consists in mounting the engine in a cradle, and supporting this cradle on the chassis at three points. The rear support is here the rigid point of the three, and in this case is placed directly underneath the transmission. The two forward supports are the resilient ones and are formed by interposing coiled springs between the cradle and the chassis. A special form of double telescoping spring is used, which permits vibrations of very small amplitude, but is very rigid as regards road shocks. In fact, the action of the resilient supports is exactly the opposite of the ordinary shock absorber. The supports absorb vibration but do not respond to road shocks.

It should be noted that this method of suspension supplements, but does not replace, careful balancing of all rotating parts; furthermore, that its use will improve the performance of any type of engine, although most needed by the four- and eight-cylinder types. (*The Journal of the Society of Automotive Engineers*, vol. 8, no. 1, Jan., 1921, pp. 54–56, 1 fig., *tp*)

MOTOR-CAR ENGINEERING (See also Mechanics)

POWER GENERATION (See also Wind Motors)

Power Generation from Natural Hot Waters

Power Generation from Natural Hot Waters, P. Caufourier. In a number of places in France, northern Africa, Syria, Martinique, New Caledonia, etc., there are natural sources of hot water, and attention has been drawn to them as a possible source of power generation through the rise of cost of fuel in the last few years.

The idea itself is not new, and several attempts have been made to employ such water for useful purposes. In 1917 Gabrié presented to the Academy of Sciences in Paris a proposal to vaporize water by means of heat in the interior of the globe, believing that the depth to which the water would have to be delivered would not be prohibitive.

In the present instance, however, the discussion is confined to the use for purposes of power generation of hot water as it comes out of the ground without adding any heat through external combustion. This is intended to be done by means of "self-evaporation" of natural hot water. The theory of this is as follows: Let there be a weight P of water at the temperature t_0 enclosed in an adiabatic chamber under an absolute pressure below the saturation pressure of steam at t_0. The liquid will then evaporate partially up to the point of saturation of the free space, and in doing so will borrow the latent heat of evaporation from the non-evaporated part of the liquid. Let t_1 be the final temperature and p the weight of the vaporized liquid. We then have the equation

$$P(t_0 - t_1) = p(606.5 - 0.695t_1)$$

A drop in temperature of 6 deg. cent. will vaporize about 1 per cent of water (by weight). If now the vaporizer be placed in communication through a turbine with a condenser of temperature t_2, saturation will no longer occur and steam generation will be continuous. The output of steam will be a constant one on condition

densing, the steam will give up a quantity of heat equal to

$$p(606.5 + 0.305\, t_1 - t_2)$$

and the work which can be theoretically usefully employed is represented by the product obtained by multiplying this quantity by the mechanical equivalent of heat (425) and by the Carnot efficiency coefficient $(t_1 - t_2)/(273 + t_1)$, all values being in c.g.s. units.

The application of this method of computation to various values of t_1 and of $t_0 - t_1$ when t_2 = 27 deg. cent. gives the results shown in Table 2, where for each of the three temperature differences the first line represents the water vaporized by the cooling of a cubic meter of water from t_0 to t_1, and the second line represents the corresponding output of power (theoretical) in metric horse-

TABLE 2 WATER VAPORIZED AND POWER GENERATED IN A LOW-TEMPERATURE SELF-VAPORIZING BOILER

	Values of t_1					
	45 deg.	54 deg.	63 deg.	72 deg.	81 deg.	90 deg.
$t_0 - t_1$ = 6 deg.	10.4	10.54	10.66	10.78	10.9	11.03
	0.55	0.816	1.076	1.309	1.581	1.829
$t_0 - t_1$ = 9 deg.	15.6	15.81	15.99	16.17	16.36	16.55
	0.825	1.224	1.614	1.964	2.372	2.744
$t_0 - t_1$ = 12 deg.	20.8	21.08	21.34	21.56	21.81	2.744
	1.10	1.632	2.152	2.618	3.162	2.744

power-hours. For practical purposes the values in the table for the theoretical horsepower per cubic meter of water developed by self-evaporation must be multiplied by a factor representing the efficiency of the turbine and piping, which is somewhere between 0.65 and 0.75.

Applying these figures to some of the sources of hot water avail-

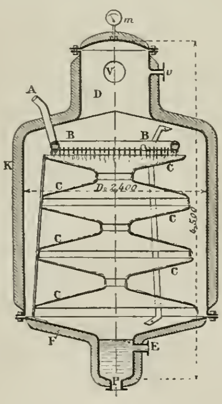


FIG. 5 CAUFOURIER SELF-VAPORIZER FOR GENERATION OF STEAM FROM WATER AT TEMPERATURES OF 50 TO 75 DEG. CENT.

able in France and Africa, the author finds that they are capable of giving outputs of from 100 hp. to as high as 12,200 hp., which, if true, would mean that natural sources of hot water represent a source of power generation which deserves serious attention under certain conditions.

So much for the theory. As far as practical realization of the problem is concerned, the first thing needed is the construction of a self-vaporizer such that heat losses shall be reduced to a minimum, and also of a turbine working at pressures below atmospheric. For this purpose, however, the present exhaust turbine may be conveniently used. As regards the boiler or self-vaporizer, a good deal has been done in the way of producing such apparatus on a small scale in various medical establishments stationed at the natural sources of hot water with a view to increasing the volume of steam for purposes of inhalation. Such is, for example, the "vaporigene" of Doctor Lajaunie, as used at Ax-les-Thermes, built somewhat like an alcohol still. In this the mixture of gas and vapor generated in the upper part is taken up by a suction pump and sent through tubes surrounded by hot water coming

For large outputs the author suggests a generator built roughly as shown in Fig. 5. The outer casing may be made either of steel or of copper according to the character of the salts and gases present in the water. In fact, as the pressure is low and the temperature not in excess of 212 deg. fahr., in some cases the casing might be made of concrete provided the water is of such a character that it does not affect the latter materially. This casing is vertical, cylindrical, and surmounted by a dome D, wherein are located the steam outlet V and the vacuum-pump outlet v. The entire structure should be protected by a good heat insulator K. The water admitted through A flows over a perforated sheet B on to a series of dished annular plates C, alternately inclined first toward the center and then toward the periphery, and provided with flanges partly to make the structure more rigid and partly to guide the flow of water. The entire assembly of plates C is rigidly attached to the bottom F, which is made demountable for purposes of periodic cleaning of the surfaces and its bottom. The solid deposits are cleaned by removing the plates C, while the mud is accumulated in the lower part of the apparatus and may be blown

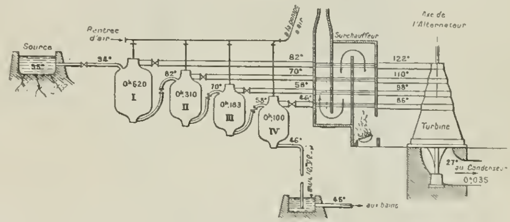


FIG. 6 PROPOSED SCHEME OF INSTALLATION FOR POWER GENERATION FROM NATURAL SOURCES OF HOT WATER

out at P. The cold water is removed through E and may either let out entirely or passed on to the next boiler having a lower pressure of evaporation.

To start the boiler the desired vacuum is created by means of a pump attached to the vacuum outlet v and then hot water is admitted, slowly at first to heat the boiler, and then at the normal rate. Steam if formed on the sheets of water flowing over the plates C and is given off either at the center or along the periphery. In order to make the flow of steam easier the plates C are smaller at the top and larger at the bottom of the generator.

From the generator (Fig. 6) the steam flows to a superheater (surchauffeur) the purpose of which is to dry the steam and raise its temperature from 35 to 40 deg. cent. (95 to 104 deg. fahr.). From the superheater the steam may go either to a series of turbines, or preferably to one low-pressure turbine. The condensers and pumps used would be of the standard types.

It does not appear from data presented in the article that any such machine has ever been built, but the subject is of considerable interest. (*Le Génie Civil*, vol. 78, no. 2, Jan. 8, 1921, pp. 37–39, 2 figs., *d*)

SHIPBUILDING

NEW DESIGN OF 10,000-TON TANKER. Description of a tanker built by Sir W. G. Armstrong, Whitworth & Co., at Newcastle-on-Tyne, England.

The most interesting feature of this vessel is the structural framing which is carried out on the Foster-King transverse system, in which the total weight does not exceed that of the longitudinally framed vessel such as is embodied in the Isherwood system.

In the King system a number of deep longitudinal girders are fitted to the bottom and sides of the vessel and also to the center bulkhead. At the transverse bulkheads these girders are carried athwartships, while one or more deep floors are arranged in each oil compartment according to its length. The deep girders on the transverse and fore and aft bulkheads are so arranged that alternate tanks are left clear for calking. (*Marine Engineering*, vol. 26, no. 1, Jan. 1921, pp. 12–15 and 2 plates, *d*)

STEAM ENGINEERING

Vertical Boiler with Water Purifier

Water Purifier in Vertical Boiler. In locomotive cranes the item of washing and maintenance work on the boiler is of great importance, especially on contract work where such water has to be used as is available.

A locomotive-crane boiler has been placed on the market equipped with an annular scale chamber located between the tubes and the shell plate as shown in Fig. 7.

The feedwater is passed through this scale chamber at about 1/200 of the speed through the intake pipe and attains a temperature at which the scale-forming impurities are liberated from solution without the use of any chemicals. The impurities are then carried in suspension, and as the movement of the water is

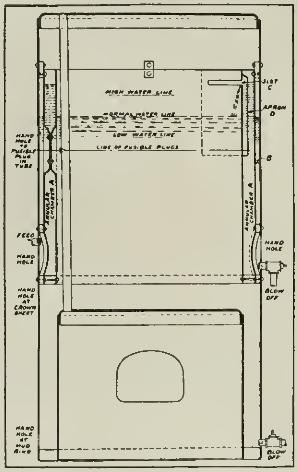


Fig. 7 Parker Locomotive-Crane Vertical Boiler with Water Purifier

very slow these suspended precipitates settle down readily to the bottom of the chamber. This settling is accelerated by the decrease in density of the water as it is heated and by the decrease in its fluid friction.

The purifier consists of the annular scale chamber *A* extending completely around the tubes with a 1-in. water space *B* between this chamber and the boiler shell. The outlet into the main portion of the boiler is the slot *C* guarded by the apron *D*. The feedwater is admitted directly to the scale chamber *A* at a point farthest from the outlet slot. It travels slowly around this chamber to the outlet and reaches, approximately, the boiler temperature before overflowing. The apron shown at *D* keeps any floating impurities, such as grease, oil, etc., from being discharged into the main boiler.

As regards the efficiency of this purifying device, it is stated that in one test of a 42-in. diameter boiler of this type at Paterson, N. J., a feedwater naturally carrying 5 grains per gal. was loaded with 70 grains of calcium and 70 grains of earth, a total of 145 grains per gal. The feed was taken from a barrel agitated with carbonic acid gas to form calcium carbonate. After about 1200 gal. of this kind of water has been passed through the boiler it was allowed to cool, when the heating surface and lower mud ring were found to be perfectly clean and the mud about 6 in. deep in the scale chamber. The blow-offs were both plugged so that all impurities remained in the boiler.

No data as to the relative sizes of the parts or as to cost of construction of the boiler are given by the author in the original article. It is stated that this boiler was designed in 1919 by Thomas T. Parker, formerly chief boiler inspector of the Fidelity and Casuality Company. (*The Iron Trade Review*, vol. 68, no. 4, Jan. 27, 1921, p. 293, 1 fig., *d*)

TESTING (See Abstract on page 193)

WELDING

Properties of Metal in Arc-Fusion Welds

Properties of Arc-Fused Metal, Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan. An extensive paper, of which only the summary can be presented here. A fusion weld is fundamentally different from all other types in that the metal of the weld is essentially a casting. The arc-fusion weld has characteristics quite different from other fusion welds. A preliminary study of a considerable number of specimens welded under different conditions confirmed this general opinion concerning arc welds. A knowledge of the properties of the arc-fused metal is fundamental in any study of electric-arc welding.

Blocks of arc-fused metal of size large enough to permit a tension specimen (0.505 in. diameter, 2 in. gage length) to be taken from each were made under different conditions of fusion. Two types of electrodes, a "pure" iron and a mild steel, were used in the bare condition and also after receiving a slight coating. With these were included a set of similar specimens prepared outside of the Bureau of Standards by expert welding operators.

During the fusion the composition of the metal of both types of electrodes is changed considerably by the burning-out of the carbon and other elements, and the two become very much alike in composition. A very considerable increase in the nitrogen content occurs at the same time.

The mechanical properties of the arc-fused metal as measured by the tension test are essentially those of an inferior casting. The most striking feature is the low ductility of the metal.

All of the specimens showed evidence of unsoundness in their structure, tiny inclosed cavities, oxide inclusions, lack of intimate union, etc. These features of unsoundness are, seemingly, a necessary consequence of the method of fusion as now practiced. They determine almost entirely the mechanical properties of the arc-fused metal. The observed elongation of the specimen under tension is due to the combined action of the numerous unsound spots rather than to the ductility of the metal. That the metal is inherently ductile, however, is shown by the changes in the microstructure produced by cold bending. By taking extreme precautions during the fusion, a great deal of the unsoundness may be avoided and the mechanical properties of the metal may be considerably improved. However, the specimens as described are more representative of actual present practice in welding.

A very characteristic feature of the microstructure of the arc-fused metal is the presence of numerous plates within the ferrite crystals, arranged usually along crystallographic planes. These persist in the metal after prolonged heating; for example, 10 hr. at 1000 deg. cent. in vacuo does not remove them. The various lines of evidence available indicate that they are related to the nitrogen content of the metal, which is increased during the fusion.

Upon heating the metal above the temperature of the Ac_3 transformation, the nitride enters into solid solution in the ferrite and is retained so by quenching. Upon heating this quenched metal the plates reappear and begin to show at a temperature of approximately 700 deg. cent. The effect of nitrogen upon the Ar_3 transformation is very similar to that of an equal amount of carbon. However, there is no evidence of a transformation corresponding to the A_1 or the pearlite change due to the nitrogen in the steel.

Microscopic examination indicates that there is but little, if any, relation between these nitride plates and the path or rupture produced by tension. The effect of grosser imperfections of the metal is so much greater than any possible effect of the nitride plates in determining the mechanical properties that the conclusion appears to be warranted that this feature of the structure is a matter of relatively minor importance in ordinary arc welds.

Judged from the results obtained, neither type of electrode appears to have a marked advantage over the other. The use of a slight protective coating on the electrodes does not appear to affect materially in any way the mechanical properties of the arc-fused metal.

An extensive bibliography of physical characteristics of the metal of the weld and on nitrogen in iron and steel is appended. (*U. S. Bureau of Standards Bulletin No. 179*, 1920, 63 pp., 28 figs., *gA*)

THE MAXIMUM THEORETICALLY POSSIBLE UTILIZATION OF WIND IN WIND MOTORS, Dr. A. Betz. The rising costs of fuel have once more directed the attention of engineers, especially in Germany and the Scandinavian countries, to the use of wind as a source of power generation, and when engineers and not millwrights have tried to design wind-motor wheels, it has been discovered that there is an almost complete lack of knowledge as to the basic elements of the theory underlying the operation of this type of motor. The present article deals with the subject of efficiency of wind motors.

The question of efficiency in the case of wind motors is more complicated than with other prime movers, because it is difficult to determine what should be considered as the amount of power supplied to the motor by the wind. The author of the present article thinks that the power supplied to the motor by the wind should be so determined as to make it proportional to the size of the motor, in particular to the area of the wind wheel.

For example, the windmill can be considered as an inversion of an air propeller, which can be done by imagining that the wheel is moving forward in still air in an axial direction with the velocity of wind v, which substantially is equivalent to having the air move with that velocity against the wheel. If the operation of the windmill be conceived in this manner, it becomes obvious that the energy supplied to the wheel is the energy necessary in order to produce the axial translation of the wheel. If the wind exerts on the wheel a pressure in the axial direction P, then the input of energy per second is equal to P_v, and if the useful work delivered by the wheel at the shaft is L, the efficiency is

$$\eta = \frac{L}{P \times v} \quad [1]$$

This definition of efficiency satisfies the theoretical requirements as it makes it possible to see clearly what the energy supplied to the wheel is and what it amounts to. For practical purposes, however, Equation [1] is unsuitable, as the axial pressure P is a magnitude of only secondary importance for commercial purposes as bearing on the properties of a wind motor. Furthermore the work Pv is not produced at any cost to the owner of the mill.

Of greater importance in practice is the question of how much energy can be produced by a wheel of a given diameter with a given wind velocity. In order to compute the performance of a windmill in this respect, its useful output can be compared only with the kinetic energy which flows per second through a plane equal in magnitude to that of the windmill and assumed to be placed normally to the direction of the wind. If the diameter of the wheel be D, this area is $F = \pi D^2/4$; and if the wind velocity be v, then the energy flowing through that plane per second is

$$E = \frac{\rho}{2} F v^3 \quad [2]$$

where ρ denotes density of the air.

The ratio of the useful output of the windmill at the shaft to the output expressed by Equation [2], or

$$\eta_f = \frac{2L}{Fv^3} \quad [3]$$

may be called the area efficiency.

From this the author proceeds to the determination of the conditions under which for a given wheel area F the largest amount of the energy E in the wind may be converted into useful output, and what is, under these conditions, the area efficiency of the wheel. To do this the problem is conceived in an ideal manner, namely, the windmill wheel is replaced by a surface which opposes a certain resistance to the wind and thereby reduces its velocity and kinetic energy, transforming this kinetic energy into useful work with no losses. Actual windmill wheels differ from this idealized conception mainly by the fact that in their case losses occur in the process of conversion of energy which still further reduce the area efficiency. By employing the idealized conception of the wheel the numerical values of efficiencies are made larger than they can be actually, and represent really the upper limits of efficiency which are never exceeded in actual practice.

why the entire kinetic energy flowing per second through a plane of area F is not converted into useful work by the wheel which also has an area F. The reason is that because of the falling off of the kinetic energy of the air in the windmill wheel, the velocity at which the air flows through the wheel falls off also. The more the energy contained in, say, 1 cu. meter of air is utilized in the windmill, the less the velocity of the air and the less the air that flows through the wheel. There is therefore a certain optimum value of the decrease of velocity of the air at which the product of the volume of air flowing through the wheel per second by the amount of energy abstracted by the wheel per unit of air, is a maximum.

In order to carry out the computations numerically it is necessary to consider with what velocity w the air flows through the surface of the wheel. The velocity of the wind ahead of the wheel is v. Because of the loss of energy at the wheel, its velocity at the rear is v_1. If we denote the mass of air flowing through a section of the wheel surface ΔF as m, then this mass exerts on the wheel a force in the axial direction equal to

$$\Delta P = m(v - v_1) \quad [4]$$

If now the velocity at which the air flows through the wheel is w, the wind does per second the work

$$\Delta L = \Delta P \times w = m(v - v_1)w \quad [5]$$

This work results in a decrease of the kinetic energy in the wind from $^1/_2\, mv^2$ to $^1/_2\, mv_1^2$. If now the work done by the wind is equated with the kinetic energy it contains, then

$$m(v - v_1)w = {}^1/_2 m(v^2 - v_1^2) \quad [6]$$

whence

$$w = {}^1/_2(v + v_1) \quad [7]$$

The velocity with which the air flows through the wheel is therefore the arithmetic mean between the velocities ahead and behind the wheel. Knowing this velocity, we can also easily determine the amount of air which flows through the section ΔF of the wheel per second. Its mass is

$$m = \rho \times \Delta F \times w = \rho \times \Delta F \times \frac{v + v_1}{2} \quad [8]$$

where ρ is the density of the air. If we now substitute this value for m in either Equation [5] or [6], we obtain the value of the work done within the area ΔF, namely,

$$\Delta L = \rho \times \Delta F \times \frac{v^2 - v_1^2}{2} \times \frac{v + v_1}{2} \quad [9]$$

It becomes important at this point to know what must be the value of v_1 or the velocity of the air leaving the wheel, in order that with a given wind velocity v the maximum of work be done at the wheel. The author shows that this happens when v_1 is equal to $v/3$; and furthermore that the wheel of a windmill produces the maximum of its work when

$$L_{max} = \frac{8}{27} \rho F v^3 \quad [14]$$

This is, of course, only the theoretical maximum of output. If the value for L be now inserted in Equation [3], we obtain

$$\eta F_{max} = \frac{2L_{max}}{\rho F v^3} = \frac{16}{27} \quad [15]$$

as an upper theoretical limit of efficiency of the wheel. The actual efficiency however, will be lower, because of the presence of losses in the wheel. (*Zeitschrift für das gesamte Turbinenwesen*, vol. 17, no. 26, Sept. 20, 1920, pp. 307–309, *t*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquires for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give he origin of research information which has been completed, to ive a résumé of research results with formulas or curves, where uch may be readily given, and to report results of non-extensive esearches which in the opinion of the investigators do not warrant paper.

utomotive Vehicles and Equipment A1–21. STARTING AND LIGHTING BATTERIES. The Bureau of Standards has made a brief study of starting and lighting batteries at the request of the Motor Transport Corps of the Army. The curves show the instantaneous demands upon batteries when cranking engines. The initial values of current and voltage have been obtained by the use of the oscillograph and the way in which the rapid decrease of current occurs as well as the pulsations resulting from the compression in the different cylinders is clearly shown. An interpretation of the curves shows that much additional information could be obtained with respect to the operation of the starter system and of the engine itself. The results are qualitative rather than quantitative, but indicate a possibility of using this method for the study of lubrication, ignition, compression and distributor action. In addition, an exact method is secured for measuring the speed from one revolution to another. Measurements were made at different speeds, different throttle openings and different temperatures. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

utomotive Vehicles and Equipment A2–21. CARBONIZATION OF LUBRICATING OILS. Circular 99 of the Bureau of Standards on Carbonization of Lubricating Oils may be obtained from the Superintendent of Documents, Government Printing Office, at 10 cents per copy. The paper contains 44 pages, discusses the nature and effect of the deposits formed in internal-combustion engines, and shows that the term "carbon" is a misnomer because the deposit consists mainly of asphaltic matter. Brief accounts are given of the nature of petroleum oils and theories concerning the formation of deposits. The oxidation and cracking of petroleum are discussed in detail. Carbonization tests which depend upon oxidation and upon cracking are discussed with full description of the apparatus, and procedures for the "Waters" and "Conradson carbon residue" tests are given. The distillation methods are touched upon and the general discussion gives brief summaries of certain controversial papers, and finally it is pointed out that much is to be learned on the subject of lubrication of internal-combustion engines. This paper was prepared by C. E. Waters, Chemist, Bureau of Standards. Address Director S. W. Stratton, Bureau of Standards, Washington, D. C.

'ement and Other Building Materials A4–21. DEFINITIONS AND SPECIFICATIONS OF LIME. Circular 106 of the Bureau of Standards contains a discussion of lime, its manufacture and use. It can be obtained at 5 cents per copy from the Superintendent of Documents, Government Printing Office, Washington, D. C.

'uels, Gas, Tar and Coke A1–21. GAS BURNERS. The Bureau of Standards has been investigating burner design and operation for the Industrial Fuel Committee of the American Gas Association. The result of the first part of the work is covered in a paper entitled The Design of Atmospheric Gas Burners, which will be published shortly. The work refers to industrial burners, but a study has been made of domestic burners for natural gas. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke A2–21. STANDARDS FOR GAS SERVICE. Circular 32 of the Bureau of Standards deals with standards for gas service. A fourth edition of this will be released shortly and will include all changes in the standards for gas service to the end of 1920, including a short discussion of the causes which have compelled changes in the standards and the significance of such changes. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke A3–21. STRUCTURE IN BITUMINOUS COAL. Report Serial 2196 on the Structure of Bituminous Coals, by Rheinhardt Thiessen, Research Chemist of the Bureau of Mines, gives a résumé of the work reported in Bulletin 117 on the Structure of Paleozoic Bituminous Coals recently issued by the Bureau of Mines. The Bulletin contains 296 pages with 160 illustrations and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 80 cents. The report indicates the method of microscopic examination which shows that the coal is made up of parts which were at one time pieces of wood and other parts which contain humic matter, resin, carbonized material and some mineral matter. U. S. Bureau of Mines, Washington, D. C. Address F. B. Foster, Director.

Fuels, Gas, Tar and Coke A4–21. CARBONIZATION OF LUBRICATING OILS. See *Automotive Vehicles and Equipment A2–21.*

Leather and Glue A1–21. LEATHER FROM RABBIT SKINS. Leather made from Australian rabbit skins has been tested at the Bureau of Standards. The tensile strength is low, varying from 800 to 1200 lb. per sq. in., as compared with 4000 lb. for calfskin leather. The leather exhibited little resistance to tearing. Some raw pelts were tanned in the laboratory by the one-bath chrome process, the resultant leather being the same as the original samples. Samples have many surface defects. Could be used for linings, novelties or other similar work. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Leather and Glue A1–21. GLUE DATA. Table 1 gives data regarding certain glues. Forests Products Laboratory, Madison, Wis. Address Director.

TABLE 1 COMPARISON OF FIVE DIFFERENT TYPES OF GLUE

(Prepared by Forest Products Laboratory)

Particular Compared	Animal Glue	Casein Glue	Vegetable Glue	Blood Glue	Liquid Glue
Source	Hides, bones, horns, etc.	Casein from milk	Cassava starch	Dried blood	Animal glue or fish parts
Cost per lb. 1920	25–42 cents	16–20 cents	10–12 cents	20 cents	\$1–\$5 per gal.
Spread in sq. ft. per lb.	25–35	35–55	35–50	30–100	No data
How mixed	Soaked in water and melted	Mixed cold with rapid stirring	Mixed with alkali and cold or hot water	Mixed cold	No preparation
How applied	Warm with brush or mechanical spreader	Cold with brush or mechanical spreader	Cold with mechanical spreader, not by hand	Cold with brush or mechanical spreader	Cold or warm usually applied by hand
Temperature of press	Cold, or with hot cauls	Cold	Cold	Hot	Cold
Strength (in shear (test)	High grades stronger than strongest woods	Equal to medium-grade animal glue	Equal to medium-grade animal glue	High strength in plywood. Not used for joint work	Best grades equal to medium-grade animal glue
Water resistance	Low	High	Low	High	Low
Chief uses in woodworking	For strong joint work	For water-resistant plywood or joint work	For veneer work because of cheapness	For water-resistant veneers	For repair work and small articles

Metallurgy and Metallography A7–21. HARDNESS OF STEELS BY ABRASION. The relative hardness of various types of steels produced by subjecting all of them to the same abrading influence has been determined with the following results: In all cases except the high-carbon austenitic steel no pronounced effects of the abrasion were observed. The hardness of carbon steel is increased and that containing 0.85 per cent carbon shows the greatest increase. Alloy steels generally show a smaller increase in hardness of the abraded surface and in some cases show a decrease of hardness. High-carbon austenitic steels show a marked decrease of Brinell and scleroscope hardness. This process of abrasion viewed in the light of Beilby's theory may be considered as resulting in the production of amorphous matter at the expense of crystalline matter which affects the hardness of the abraded surface of the metal but probably not the general character of its structure. The decrease of hardness in the high-carbon austenitic steel may be caused by the martensite being present in a greater amount in the lower layer of the examined specimen than in the inner portion according to Benedick's pressure theory, and it seems possible that if the surface layer is ground away the next or more austenitic layer should be found somewhat softer. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A8–21. TEMPER BRITTLENESS OF STEELS. An extensive view of the literature on this subject has been made with the result that the nature and occurrence of temper brittleness may be summarized as follows: Certain steels which have been hardened by quenching from temperatures above the A_3 point and tempered at temperatures ranging from about 450 to 600 deg. cent. show less impact values if they are cooled slowly from tempering temperature as compared with those cooled quickly. The cause of this phenomenon, which is also referred to as "Krupp Krankheit" has not been clearly established. The property of temper brittleness has been found present in carbon steel (0.25 to 0.4 per cent), nickel, chrome-nickel, chromium and certain other alloy steels. Chrome-nickel steels of the same chemical composition and heat treatment have been found to

than the quickly cooled ones. The process of manufacture appears to have more of an influence than small changes in chemical composition; thus, steels made by the acid open-hearth process are more prone to temper brittleness than electric or crucible steels. The opinion has been advanced that the degree of work and the temperature employed during the process of fabrication from the ingot bear some relation to the degree of susceptibility to temper brittleness. Other factors appearing to have an influence on the subject are the temperature of hardening preceding tempering treatment; degree of hardening, as cooling in water, oil or air; the rate of cooling from tempering temperature; phosphorus content; and the furnace atmosphere in which the material is treated. Other questions bearing upon the problem and upon some of which no general agreement has been reached and concerning which but little knowledge appears to be available are: relations between microstructure and susceptibility to temperature brittleness; path of rupture; heating and cooling curves; relation between impact values and tensile-test values as well as the Brinell hardness values; and the influence of the shape of the notched specimen upon impact-test values. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mining, General A2–21. Coal-Mine Fatalities in 1920. During 1920 there was a marked decrease in the number of fatal accidents. In the first eleven months of the year 1983 men lost their lives. This was 163 less than the corresponding period of the previous year. This decrease amounts to 7.6 per cent and during this period the output was 16 per cent greater than in 1919. The production from January to November was 585,000,000 tons. The number of lives lost per million was 3.39 in 1920 as compared with 4.28 in 1919. This is covered in Report 2197 by W. W. Adams. Bureau of Mines, Washington, D. C. Address F. Bain Foster, Director.

Mining, General A3–21. Miners' Flame Safety Lamps in Gaseous Coal-Dust-Laden Atmospheres. Report 2199 by L. C. Ilsley and A. B. Hooker gives the results of tests carries out in a special gallery constructed by the Bureau of Mines. Coal dust which passed through a 200-mesh screen was fed into a compressed-air line. The air line was also charged with natural gas. The tests were made by subjecting the lamps to conditions known to be on the border of failure without coal dust and then coal dust was added. No tests were made with velocities exceeding 2500 ft. per min.

As soon as the coal dust was added a change could be noted. Thirteen failures occurred out of fifty tests with unbonneted lamps and two of the thirteen failures were caused by the addition of coal dust. No failure occurred from 38 tests with bonneted lamps. The conclusions of the tests are that unbonneted lamps are less safe in atmospheres containing coal dust, provided the lamp is suddenly brought into such atmosphere when its gauze is at a bright-red temperature. Bonneted lamps are affected less by the addition of coal dust. In extremely dusty atmospheres there might be a greater tendency for the glasses to crack. Bureau of Mines, Washington, D. C. Address S. B. Foster, Director.

Paints, Varnishes and Resins A1–21. The following specifications have been prepared by the Bureau of Standards:

Circular 102:—Recommended Specification for Composite Thinner for Thinning Semi-Paste Paints when the Use of Straight Linseed Oil is Not Justified.

Circular 103:—Recommended Specification for Spar Varnish.

Circular 104:—Recommended Specifications for Asphalt Varnish.

Circular 105:—Recommended Specifications for Liquid Paint Drier.

These may be obtained from the Superintendent of Documents, Washington, D. C.

Refrigeration A1–21. Non-Condensible Gases. Technologic Paper 180 on the Cause and Prevention of Formation of Non-Condensible Gases in Ammonia Absorption Refrigerating Machines, by E. C. McKelvey and Aaron Isaacs, was issued in October, 1920. It may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents a copy. The paper covers ten pages and discusses the effects of non-condensible gases in ammonia machines and then describes experiments with distilled water and aqua ammonia. It also discusses the method of determining carbon dioxide in small amounts and the methods for preventing gas formation. A summary of the paper follows:

1 The non-condensible gases found in ammonia absorption refrigeration machines are due to either or both of two causes, namely, (*a*) leaks of air into the system and (*b*) the corrosive action of the ammonia liquor on the metal of the plant.

2 When the foul gas is mainly nitrogen, the gas is derived from air that has leaked into the system, and leaks should therefore be sought. The oxygen in the air is very quickly used up and so will be present in only a very small percentage of its original amount. If the foul gas is hydrogen, the cause is corrosion of the ammoniacal liquor. A gas containing both nitrogen and hydrogen shows both causes to be present.

3 If a solution of sodium or potassium dichromate is added to the generator charge so that the charge in the generator will contain the salt to the extent of 0.2 per cent by weight, all foul-gas formation from the corrosive action of the ammonia charge will be stopped. It is recommended that the dichromate be added in all cases, as it has been found that its presence decreases the very small amount of gas caused by even the highest-grade ammonias.

4 A method is given for the quantitative estimation of carbon dioxide in ammonia.

Ventilation A1–21. Automatic Control of Humidity in Shops. Technical Notes 121, Forest Products Laboratory, discusses the automatic control of humidity in shops. The apparatus developed at the Forest Products Laboratory has kept the woodworking rooms of the laboratory at a uniform temperature and humidity during the whole year. The instrument requires little personal attention. The principle upon which it acts is that of bringing the air to the dewpoint temperature for the desired atmospheric condition, saturating it with moisture at that point and then heating it without the addition of moisture to the required room temperaure. Thus if too wet or too dry originally it is brought to the proper condition. The apparatus consists of a small cabinet or chamber through which the air is drawn as often as it needs to be conditioned. The conditioning chamber contains water sprays, the temperature of which is kept constant by a mixing valve. The air then leaves the chambers and is heated to room temperature by coils. Drawings and further details may be obtained on application. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A1–21. Dry-Kiln Construction. Any building materials may be used. The choice depends on relative importance of first cost, maintenance and fire hazard. A well-built wood kiln is very satisfactory. The chief objection aside from fire risk is the tendency to swell and shrink, causing working of the frame and loosening of the nails. All lumber should be thoroughly seasoned. Fir, Douglas fir, yellow pine, redwood, cypress and similar woods with low shrinkage rates should be used for sheathing and sills. Good straight-grain material for frames. Sheathing should be in ship-lap form, laid horizontally and nailed twice to each stud at the middle and bottom of the board. Outside walls should be sheathed on both sides or sheathed inside and plastered outside. They should be insulated with a good moisture-proof, heat-resistant insulator. Quilt insulation between waterproof paper has not proven satisfactory. Walls should be painted with asphaltic paint. Where lumber is plentiful, crib or laminated structure may be used, employing 2-in. by 6-in. planks laid flat. Roof of similar material on edge.

Brick of hollow style is more satisfactory than wood where permanency is desired. Walls should be laid in tempered cement mortar. Unequal expansion caused by the difference in temperature of the outer and inner faces may cause cracks, which should be painted with elastic cement rather than mortar. The tile should be chosen so that openings run horizontally rather than vertically. Walls of monolithic concrete or concrete block are highly absorbent of moisture. Forest Products Laboratory, Madison, Wis. Address Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Machine Tools B1–21. See *Metallurgy and Metallography B5–21.*

Metallurgy and Metallography B5–21. Magnetic Testing of Twist Drills. The Bureau of Standards is taking part in a coöperative investigation by a Committee of the A.S.T.M. on testing drills by magnetic analysis. Steel has been especially prepared for the investigation and it has been tested for homogeneity by a magnetic method at the Bureau. Drills are to be manufactured under carefully controlled conditions, after which they will be again tested magnetically. The drills are then to be tested mechanically and an attempt made to correlate mechanical performance of the drills with the magnetic tests. The object of the investigation is to develop an apparatus to test drills in a commercial way without destroying them. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Machine Design C1–21. Shafts in Bronze Bearings. The behavior of steel shafts with various carbon contents when running in bronze bearings is desired. This should refer to friction, wear and similar data. Address S. A. Hand, Associate Editor, *American Machinist*, New York City.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Scovill Manufacturing Company D1–21. Equipment. Apparatus for electrical measurements of the following range:
Resistance from 1×10^{-6} ohm to 1×10^{7} ohms.
Inductance from 1×10^{-5} henry.
Capacity from 1×10^{-4} microfarad.
Voltage from 1 millivolt of any frequency.
Current from 0.1 milliampere of any frequency.
Breakdown voltages up to 30,000 volts.

The laboratory is equipped with platinum thermocouples, standard pure metals for melting-point measurements, General Electric oscillograph, complete radio apparatus for generation, study and use of high frequencies; accoustic apparatus, including visual electric noise indicator developed in the laboratory for quantitative, relative indication of loudness of sound, a dictograph loud speaker, a callophone loud speaker, a Winkler-Reichman loud speaker, a magnavox telemegaphone, microphones, receivers, transformers and generators.

Galvanometers, voltmeters, ammeters, wattmeters, inductances, capacities, Wheatstone bridges, capacity bridges, inductance bridges and potentiometers are also found in the laboratory.

The laboratory is equipped with selenium cells, constant-frequency and speed apparatus, an Evershed bridge megger and three electric furnaces.

The laboratory force consists of four technical men, four meter men, one jeweler, one high-grade mechanic, one helper and two apprentices.

The laboratory is located in a two-story brick building, the first floor containing a fully equipped machine shop, special research rooms, several motor-generators and storage space. The second floor contains the meter department, the standardizing, high-current and high-frequency tables and space for miscellaneous testing and special set-ups with the time-signal apparatus and desk space. The laboratory is provided with 110–220 volt d.c. and a.c. current and 440–volt, three-phase, 60 cycle a.c. current. In addition there is 110-volt emergency storage-battery lighting system and a storage battery for currents up to 500 amperes at three volts. Laboratory apparatus will give constant frequency between 60 and 80 cycles at 110 volts and high freqneneies of 1000 cycles and above for small currents. Two-phase current may be obtained at any frequency up to 133 cycles.

The laboratory is used for development of inventions and the perfection of manufacturing methods with the development of theory underlying the action of new electrical apparatus. It makes tests for the Sales Department, for the Purchasing Department and for the Manufacturing Department. It performs technical service regarding time-signal reception for the regulation of the electric-clock system and the maintenance of X-ray apparatus. The service is extended in the Meter Department to the installation, maintenance and repair of electrical switchboard instruments and service meters, pyrometers and thermometers, and the monthly checking of switchboard meters with portable meters which are calibrated periodically against laboratory standards. Address Scovill Manufacturing Company, Waterbury, Conn. Attention R. S. Sperry.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Metal Manufacturing, Miscellaneous F1–21. Forging and Finishing Claw Hammer Heads. A bibliography of 1/2 page. Search 3243. Address A.S.M.E., 29 West 39th St., New York.

Petroleum, Asphalt and Wood Products F2–21. Bibliography of Petroleum and Allied Substances 1917. The Bureau of Mines has issued Bulletin 120 giving the Bibliography of Petroleum and Allied Substances for the Year 1917. This may be obtained from the Government Printing Office, Superintendent of Documents, Price 25 cents.

Properties of Engineering Materials F2–21. Fluorspar. A bibliography of three pages. Search 3240. Address A.S.M.E., 29 West 39th St., New York.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

DeLamater Ericsson Tablet Fund

To the Editor:

The following subscriptions to the DeLamater Ericsson Tablet Fund have been received from members of the A.S.M.E.:

S. and V. D. Bevin	$10
A. Falkenau	5
A. Hollander	1
D. S. Jacobus	5
D. J. Lewis, Jr.	5
J. W. Lieb	10
G. M. Newcomer	10
A. Schein	3
H. R. Towne	50
	$99

Further subscriptions will be duly reported.

H. F. J. Porter, *Chairman,*
DeLamater Ericsson Tablet Committee.

New York, N. Y.

The St. Lawrence River Project

To the Editor:

Having read in the correspondence columns of Mechanical Engineering and elsewhere much pro and con discussion of this subject, it may be permissible for one who is familiar with the St. Lawrence River to state some facts for the benefit of those who would like to give some consideration to the subject without devoting much time to the question.

Measured as to any one of its qualities, the St. Lawrence is one of the greatest rivers of the world. But, measured as to all its qualities collectively, it is the greatest. From the standpoint of history and discovery it occupies a prominent position. The Gulf of St. Lawrence was probably entered by Norsemen as early as 1000 A.D., the accounts of Lief Ericsson and his followers clearly indicating that they were in the gulf at that date, though the discovery of the river is credited to Jacques Cartier in 1534. Since the time of Champlain, about 1600, it has been a traveled pathway to the heart of North America. To the early explorers and later developers of the continent it was by far the most important pathway. The explorers passed up the St. Lawrence through the Great Lakes, or along their shores, to the plains of the West and down the Mississippi River.

The St. Lawrence River is remarkable for its magnitude, for the stability of its bed, and for its beautiful shores and islands, affording innumerable summer homes for those who love nature. It drains some 300,000 square miles of area, of which 100,000 is water surface of the Great Lakes. Lake Superior is 1000 ft. deep, its bottom reaching 400 ft. below sea level. Such great natural reservoirs give the river a unique status as to the uniformity of its flow and as to the absence of destructive floods. The remarkable clarity and purity of its waters result in large measure from the influence of the lakes.

When it comes to national, in fact international, economics, the St. Lawrence River is superlatively paramount. Though

evading many shallow rapid sections; though there are a number of important water powers now developed, yet the possibilities as to navigation and water power have scarcely been touched. The surface of Lake Ontario is about 245 ft. above sea level and the average available flow is about 220,000 cu. ft. per sec. Thus there are now being wasted in hydraulic friction some 6,000,000 hp., by far the greater portion of which can be recovered by a comprehensive scheme for ultimate expansion which must, by all means, provide for the greatest possibilities of navigation by ocean-going vessels. There must be no mistake as to capacity. It should be determined by a congress of the competent representatives of all the interests and nations concerned.

The importance of the St. Lawrence River and its possibilities to the world in general, and to the evolution of American civilization in particular, is so vast and so intrinsically meritorious that any great and truly comprehensive project will be self-promoting to the point of realization. B. F. Groat.

Pittsburgh, Pa.

Contends That Monotony Is Not Objected to By Operators on Repetition Processes

To the Editor:

Mr. Gibbons in the January number speaks of monotony of operation and takes it for granted that operators on repetition processes have difficulty on account of monotony.

So far as I know, there is no evidence whatever to support this view. I have made some personal investigations and find that operators on repetition processes make no complaint whatever regarding monotony. In fact, in many cases, I have seen definite indications that the fact that the operator has to make no mental effort, is considered as a distinct advantage. This seems to indicate that the present system of monotonous repetition work distinctly conserves human life of the average repetition worker.

S. A. Moss.

West Lynn, Mass.

Music Hath Charms But Not Power

To the Editor:

I notice in your valuable journal in an article on "Measuring the Two-Hundred Millionth Part of an Inch," on page 59 of your January issue, near the bottom of the 2nd column, there is a repetition of an old fallacy, which ought to have been dead and buried long ago without any possible resuscitation. It occurs in the words: "Many years ago it was stated that it would be possible to wreck the Brooklyn Bridge by means of a violin so played that the vibrations set up would always be in unison with the oscillations of the bridge. Whether this can be done or not is not very important." The plain truth is that it cannot be done, and whoever first inflicted such a statement on the public did not know what he was talking about. I heard this statement repeated many years ago in what purported to be scientific lectures, which to this extent were simply impositions on the credulity of the audience. Any vibrating structure like a bridge is subject to large internal losses by the imperfect elasticity of the structure, and even the turbulence of the air surrounding a large structure in vibration would consume considerable energy, and yet the tiny amount of energy radiated by a violin string—most of which would not even enter the resonant structure but spread into the surrounding void—is supposed to be enough to wreck such a structure as the Brooklyn Bridge. The thing is so absurd that one wonders why this fallacy should ever be repeated in print or in any other way. It is a fantastic statement from beginning to end. Just think of the loud note that the bridge itself would have to utter in unison with the violin before the bridge fell!

Elihu Thomson.

West Lynn, Mass.

To the Editor:

In looking into the literature on the subject of milling-machine feed systems I have been much impressed by the lack of systematic investigation and even, frequently, of reasonably straight analysis in connection with the data already at hand. A case in point, not so much connected with the action of a milling cutter as with the functioning of a milling machine, is the question of the two types of feed systems. This was brought more distinctly to the fore by the definite stand taken in a recent article in favor of a machine driven from the spindle.[1] The best current practice has rejected this feed system. The new system of constant-speed feed shaft lends itself to very rigorous demonstration as being in all ways superior to the system formerly in vogue.

There are two different systems of feed mechanisms used in milling machines. The older one has the feed mechanism driven from the spindle of the machine. The modern method uses a separately driven feed shaft running at constant speed.

The following six statements are submitted in logical sequence, some being axiomatic:

1 In discussing the action of milling, *feed per tooth* is the fundamental quantity
2 A large-diameter cutter will have more teeth than a small cutter
3 One tooth in a large face mill will take a heavier cut than a tooth in a small end mill
4 Peripheral speed is approximately constant for a given quality of cutter and of material. It follows that the large-diameter mill will be used in conjunction with slow speeds and small-diameter mills in conjunction with high speeds
5 A large-diameter cutter will call for a larger feed per revolution than a small-diameter cutter does. (See statements 2 and 3.)
6 Slow spindle speeds will call for heavy feeds per revolution and fast spindle speeds will call for light feeds per revolution. (See statements 4 and 5.)

For simplicity consider a machine with four speeds: n, rn, r^2n, and r^3n revolutions per minute. Assume similarly four gear changes in feed box in geometrical progression. When spindle speed is n, let smallest table travel be a inches per revolution of spindle. Let the ratio of successive changes of gears in feed train be s. For simplicity s and r may be assumed equal, as is often approximately the case, and Tables 1 and 2 may be obtained, giving the table travel per revolution of spindle for the above conditions under each of the systems.

TABLE 1 MILLING-MACHINE FEEDS: FEED SHAFT DRIVEN FROM SPINDLE

Spindle Speeds	Feed Per Revolution			
n	a	ra	r^2a	r^3a
rn	ra	r^2a	r^3a	r^4a
r^2n	r^2a	r^3a	r^4a	r^5a
r^3n	r^3a	r^4a	r^5a	r^6a

TABLE 2 MILLING-MACHINE FEEDS: CONSTANT-SPEED FEED SHAFT

Spindle Speeds	Feed per Revolution			
n	a	ra	r^2a	r^3a
rn	$\frac{a}{r}$	a	ra	r^2a
r^2n	$\frac{a}{r^2}$	$\frac{a}{r}$	a	ra
r^3n	$\frac{a}{r^3}$	$\frac{a}{r^2}$	$\frac{a}{r}$	a

By an analysis of the two tables the following points may be observed:

a In both systems the feed gear box gives a flexibility with the lowest spindle speed from a to r^3a inches feed per revolution of spindle

b In machine with feed train driven from spindle a feed per revolution of r^3a to r^6a is given with highest spindle speed

c In machine with constant-speed feed shaft, a feed per revolution of a down to a/r^3 is given with highest spindle speed.

In conclusion it may be stated that if a be adjusted in each case to make machines equally good with lowest spindle speed, then the constant-speed feed shaft machine has a region of finer feeds

[1] Supplement to Frederick W. Taylor's "On the Art of Cutting Metals," Carl G. Barth, *Industrial Management*, July 1920, pp. 49–52.

per revolution available with the highest spindle speed, whereas the other machine has coarser feeds per revolution available with the highest spindlespeed. This is just the reverse to requirements. (See statement 6.)

Similarly, if a be adjusted to make the machines equally advantageous with highest spindle speed, the machine with spindle-driven feedshaft would have inefficient slow feeds per revolution at the lower spindle speeds.

The constant-speed feed shaft projects the total flexibility furnished by the gear box into the region where needed. The spindle-drive machine does not, so a large part of the flexibility furnished by the gear box is wasted.

A study of the two tables bears out the following statement: If the same range in useful feed per revolution is insisted upon in both machines, then the spindle-driven machine must be furnished with *seven changes of feed gears instead of four*, namely, a/r^3, a/r^2, a/r, a, ra, r^2a, and r^3a, or r must be increased to p, say, where $p^3 = r^6$, or $p = r^2$, with a corresponding decrease of efficiency, of course.

The writer believes that there is no single tenable argument in favor of the machine with the feed mechanism operated from the spindle. Current practice would indicate that this is being more and more appreciated by leading milling-machine manufacturers.

John Airey.

Ann Arbor, Mich.

Appraisal Principles Applied to Industrial Properties

To the Editor:

A careful perusal of such articles concerning appraisals and valuations as have come to the attention of the writer within the past two years, has led him to the conclusion that opposite principles are in use by different engineers, and, moreover, that nearly all such articles deal only with one class of property to be appraised or valued, namely, public-utilities companies.

Within the period embraced from the signing of the armistice to the present day, business men and executives have had their attention focused on valuation of their property for many reasons, a principal one of which was the settlement of Government contracts, another the excess-profits taxes, and another the rapid rises in replacement costs of plant or equipment necessitating readjustment of insurance. Nearly all of these valuations fall within the industrial class. Some confusion exists in the minds of the average business man concerning the terms used by all in appraisal work. The writer would like to define an appraisal as "a measure of economic worth," and in explanation of this statement explain that the common medium or standard of this measure is money.

For the purpose of this discussion the division of appraisals into two classes is made so that a comparison may be readily instituted and in order to show that the governing principles of the appraisal as applied to the two divisions vary somewhat. The divisions consist of public-utility properties and industrial properties.

To ascertain just what should govern the appraisal, an examination of the use to which the appraisal is to be put should be made. With this end in view, the writer enumerates the principal uses of appraisals, either public-utility or industrial, as follows: They are as a basis for, first, establishing rates for service or product second, charges for depreciation and depletion; third, tax returns, federal, state, and municipal, fourth, amounts of insurance to be carried; fifth, issuance of bonds or capital stock; sixth, mergers or consolidations; seventh, bank credits; eighth, purchase, sale or lease of property; ninth, settlement of estates; tenth, settlement and adjustment of partnerships; eleventh, court decisions.

An analysis of the reason for the first use in connection with a public utility discloses that it is made invariably for the securing of a fair rate of return on the investment to the stockholder or bondholder, while in the case of its use by an industrial concern it is desired, in order to obtain a fair rate of return on the investment and in addition so that the concern may be in a position to secure the maximum rate possible under existing economic conditions. Therefore an appraisal of the property for this purpose in the case of public utility is usually based upon first cost, while in the case of an industrial company two appraisals may be made, the first on a basis of original cost and the second on a cost of reproduction of like plant today, new and under existing conditions. There has recently been handed down a decision by Judge Valkenburgh of the U. S. District Court, Kansas City, Mo., against the Missouri Public Service Commission enjoining them from enforcing a rate based on original cost on the grounds that the commission's original cost basis was in violation of the fourteenth amendment to the Constitution. Whether or not this decision by the Circuit Court will be upheld by the Supreme Court remains to be seen.

An examination of the second use—whether for public utility or industrial property—leads the writer to reason that if the appraisal is to be in conjunction with another it should be made upon the same basis as the appraisal it is to be used with, except in the case of Federal taxes noted below.

In the case of an appraisal for the third use, either public utility or industrial, only the first subdivision, Federal taxes, will be dealt with. We are here confronted by a law modified and restricted by decisions from the Treasury Department, which, roughly, may be summarized as follows: "Cost at date of acquisition shall be used; if cost is not ascertainable a fair value as of March 1, 1913, is to be used."

The first portion of the quotation from the revenue act quite clearly indicates that cost is the controlling element as of the date of building or purchase and that any rise in value was not intended to be considered. For the purpose of establishing depreciation rates in connection with Federal taxes, the fair value as of March 1, 1913, may be used. It may be well to state that under the restrictions of the revenue act as generally interpreted, the use of the word "appraisal" is erroneous. In reality, for the purpose of addition to capital an inventory at cost is the allowable use. But for the purpose of establishing a depreciation rate an appraised fair value as of March 1, 1913, of such inventory is used.

Space limitations will not permit the enumeration of appraisals as effected for use as a basis for the various state and municipal taxes, as there are many different regulations by different states and cities.

In the case of the fourth use, whether utility or industrial, it would seem ridiculous for any business concern to insure for its cost, when today the money derived from insurance would replace one-half or one-quarter of the plant. Therefore, the only basis the writer can see that is fair is one that is based on present reproduction under today's existing conditions, taking into consideration future prices during the period to be covered by the policy.

An analysis of the fifth use quite properly shows that the bondholder would wish to know the present value of the property behind his bond. He is only relatively concerned with the past cost but is most intimately concerned with its future value, and so likewise is the stockholder. Both bondholder and stockholder are concerned also with the company's earning power, and therefore to the writer's mind an appraisal falling under this class should be based on a cost of reproduction of the property under existing conditions and prices, keeping in mind any probable fall or rise in prices affecting its reproduction value in the future and as a further governor of value a very close examination of its future earning power.

Quite obviously the purpose of the sixth use of an appraisal for the merging or consolidation of either public utilities or industrial companies is to give each its relative present worth, measuring both in cost to reproduce today and in earning capacity. It should be easily seen that one company may have cost originally more but can be replaced cheaper today than another on account of changes in local conditions, and therefore the only correct basis of appraisal is on cost of reproduction today.

Bankers are concerned when using an appraisal the same as the seventh with, first, the present cost of the property and earning power, and second, the future value. The first cost to them is largely a gage of the growth of the concern, and while perhaps

the only one proper to use.

An examination of the eighth, ninth and tenth uses shows that they fall quite naturally into the same class as the fourth. The purchaser of a property will naturally be governed in his purchase by the reproduction of a like property under existing conditions today, that is, present cost. Should he fail to be offered the property at or near this cost he could very obviously build himself, whereas the seller is concerned with getting the worth of his property today as may be governed by existing economic conditions. These same reasons may be said to apply to an appraisal for the leasing of a property or the settlement of an estate or a partnership.

The eleventh use of an appraisal, as a basis of court decisions, will be governed as to whether it is based on first cost or present cost by its application. This may be illustrated by an example: If condemnation of property were made in the year 1918, the appraisal in this case would be based on cost as of 1918, for obviously if as of 1910 it would be unfair to the one who would receive the damages, and if as of 1920 unfair to the one who was to pay such damages. James S. Brown.

New York City.

A Plea for Proper Setting of Double-Reduction Marine Gears

To the Editor:

The following data were taken on board the S. S. *Carenco* en route from Glasgow to Baltimore in ballast: Mean draft, 14 ft. 11 in.; draft forward, 11 ft.; aft., 18 ft. 10 in.; length of hull, 401 ft.; beam, 54 ft.; full draft, 24 ft. 6 in.; deadweight tonnage, 7825; equipped with General Electric turbine and double-reduction gears of 2500 shaft hp.; engine speed, 3234 r.p.m.; gear reduction, each being an average of five readings taken in succession. After two diagonally opposite corners had thus been checked, the bridge arm was swung to the remaining corners and a similar check was made. It will be noted that there are three readings taken on November 9; in each case the ship was swung off her course to bring the sea on the port and the starboard bow as indicated, and in each case the deflections are the greatest in the gear case in the direction of the progress of the sea under the hull of the ship. It will also be noted that for the readings taken on November 16 and 17 the wind and sea conditions are exactly reversed and that in each case the deflections are the greater on the windward side of the ship.

It is also readily seen from the two sets of readings taken on November 17 that as the sea increases the deflections in the gear case increase in proportion. Also the readings taken on November 18 plainly show that the long swells which succeed a strong wind cause deflections fully as great as when the ship is operating in a storm. The readings taken on November 20 were after the ship had entered Chesapeake Bay, where no wind or sea was encountered, and serve to show the accuracy of the instrument with which these checks were made.

While this ship was en route from Baltimore to Glasgow in loaded condition, very heavy following seas were encountered, in some cases running as high as 20 ft., at which times deflections of 0.050 in. were recorded. When gears of this type are so mounted that deflections of the kind under consideration occur, the case is so warped that the pinions are thrown at an angle with the driving face of the gear; and at a time when the overload becomes 100 per cent, due to surges of sea on the propeller, and with about 50 per cent of the pinion face bearing on the gear face there is an overload on the driving face of the teeth of 400 per cent, this occurring approximately every eight seconds.

TABLE 1 DEFLECTIONS OF GEAR CASE OF DOUBLE-REDUCTION GEAR ON BOARD S. S. "CARENCO" UNDER VARYING CONDITIONS OF SEA AND WIND

Date	Direction of Sea	Direction of Wind	Condition of Sea	Condition of Wind	Ship Riding	Deflection in Inches: Port Forward	Starboard Forward	Port Aft	Starboard Aft
11-6-20	Stb. bow	Stb. bow	Moderate	Moderate	Rolling and pitching easy	0.014	0.020	0.012	0.022
11-7-20	Dead ahead	Dead ahead	Rough	Fresh	Pitching	0.016	0.024	0.014	0.024
11-8-20	Dead ahead	Dead ahead	Moderate	Fresh	Rolling easy	0.017	0.008	0.014	0.012
11-9-20	Dead ahead	Stb. bow	Heavy long swell	Light	Pitching	0.017	0.022	0.028	0.017
11-9-20	Port bow	Dead ahead	Heavy long swell	Light	Pitching and rolling	0.022	0.014	0.017	0.027
11-9-20	Stb. bow	Stb. side	Long heavy swell	Light	Rolling and pitching	0.015	0.025	0.022	0.016
11-10-20	Stb. side	Port bow	Moderate swell	Gentle breeze	Rolling easy	0.013	0.022	0.010	0.023
11-11-20	Stb. side	Port bow	Very light swell	Very light breeze	Rolling very easy	0.005	0.005	0.006	0.008
11-12-20	Stb. bow	Stb. bow	Calm—very light swell	Very gentle breeze	Steady	0.003	0.006	0.005	0.005
11-13-20	Port bow	Port bow	Moderate	Moderate breeze	Rolling and pitching easy	0.013	0.012	0.010	0.011
11-14-20	Dead ahead	Port bow	Moderate	Moderate breeze	Pitching easy	0.014	0.012	0.012	0.014
11-15-20	Astern	Stb. quarter	Moderate	Moderate wind	Rolling and pitching	0.017	0.020	0.015	0.025
11-16-20	Stb. side	Stb. side	Gentle sea	Gentle breeze	Rolling very easy	0.009	0.010	0.011	0.012
11-17-20 A.M.	Port side	Port side	Moderate	Light wind	Rolling easy	0.015	0.011	0.015	0.010
11-17-20 P.M.	Port bow	Port side	Rough	Strong wind	Rolling and pitching heavy	0.035	0.022	0.035	0.021
11-18-20 A.M.	Dead ahead	Dead ahead	Rough	Gale	Pitching and pounding	0.023	0.025	0.029	0.022
11-18-20 P.M.	Dead ahead	Dead ahead	Long swell	Light breeze	Rolling and pitching	0.024	0.027	0.022	0.030
11-19-20	Stb. bow	Stb. bow	Light sea	Light breeze	Rolling easy	0.005	0.007	0.006	0.006
11-20-20	No sea	No wind	No sea	No wind	Steady	0.002	0.002	0.002	0.002

35.9 to 1. The gear on which this check was made was 12 ft. 4 in. in length by 8 ft. 6 in. wide on the foundations.

Due to the considerable difficulty experienced in the operation of double-reduction marine gears for propulsion, a number of theories have been advanced for the cause of failure in the gear teeth. I will not attempt to enter into a discussion of the merits of the various theories, but simply give the results obtained that we may more fully appreciate the conditions under which these gears have to operate.

In order to obtain the figures given in Table 1, a tram was constructed with a revolving head similar to an engineer's transit, and equipped with a seamless drawn tube extending in opposite directions 7 ft. from the center, this tubing being trussed with piano wire to make it as nearly rigid as possible. This apparatus was secured to a pad bolted to the center of the gear-case cover. When the arms were swung diagonally across the gear case, a pin gage to which was attached a Starrett indicator was used at each corner of the gear, two engineers taking the readings between the corner of the gear-case frame and the under side of the bridge arm simultaneously.

To obtain a marine gear that will be entirely successful, therefore, it must, in my judgment, be mounted in such a manner that the deflections of the hull will not be transmitted to the gear case.

S. K. French.[1]

Hog Island, Pa.

Manganese steel, the invention of Sir Robert Hadfield—to whom the John Fritz Medal for 1921 has been awarded, even after special heat treatment is so hard and tough that it can only be machined by grinding. This is slow and costly, an article in the *American Machinist* of January 13, 1921, stating that it is the average occurrence for an 18-in. abrasive wheel with 2-in. face to wear away at the rate of one inch of diameter per hour of use. Wheels are usually run at a peripheral speed of 5000–6000 ft. per min., a feed of from $^1/_4$ to $^1/_2$ in. per revolution of the work, and a depth of cut of from $^1/_{64}$ to $^1/_{100}$ in. The wheels best suited for such work are from 10 to 24 in grit and from M to T in grade.

[1] Gen. Supt., Propulsion Machinery Dept., American International Shipbuilding Corporation.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 312, 313, 318, and 322 to 330 inclusive, as formulated at the meeting of December 6, 1920, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 312 (Reopened)

Inquiry: Is it necessary in the construction of small Star-type water-tube boilers for steam heating which are to carry more than 15 lb. pressure at times, to drill the inside and outside ends of staybolts? It is believed that it was the intent of the Committee to cover in this requirement the waterlegs at front and back ends which are considered as headers.

Reply: If the grate area is more than 15 sq. ft., the staybolts are less than 8 in. in length, and the pressure exceeds 15 lb., it will be necessary to drill the staybolts in order to comply with the Code requirements.

It is the opinion of the Committee that the staybolts in the side sheets and that portion of the tube sheets below the tubes of boilers of this type, need only be drilled on the outside ends as required in a boiler of the locomotive type, but that the staybolts in that portion of the tube sheets containing the tubes should be hollow or drilled at both ends as required for the waterlegs of water-tube boilers.

Case No. 313

Inquiry: Is it permissible, under the requirements of Par. 186 of the Boiler Code, to join by autogenous or fusion welding the butting edges of flanged plates to form the waterlegs of detached smokeless fireboxes, where the stress due to the steam pressure is fully carried by staybolting?

Reply: The welded construction described is allowable under the rules of the Code provided the strength of the structure is sufficient to meet the Code Rules without making any allowance for the holding power of the weld.

Case No. 318

Inquiry: Is it permissible, under Par. 331 of the Boiler Code, to omit the stamping from completed shells of miniature boilers which are formed by a cupping or hot-drawing process in which the stamping is necessarily obliterated?

Reply: It is the opinion of the Committee that the intent of Par. 331 would be met if a record of the heat numbers taken from the plates were checked with the mill test reports, and if found to meet the Code requirements, the inspector may authorize the manufacturer to proceed with cupping the plates, after which the manufacturer is to stamp the shell, in the presence of the inspector, with a lot number which will identify the sheet with the test sheet record.

Case No. 322

Inquiry: What material is it necessary to use under the requirements of the Boiler Code for the Y-fitting, also for the safety-valve body, for safety valves to be operated at a pressure of 225 lb.? May cast iron be used for this purpose?

Reply: Under the requirement of Par. 9 it is necessary that the Y-fitting be constructed of steel, but the safety-valve body need not be of steel unless to operate with superheated steam (see Par. 289).

Case No. 323

Inquiry: Does Par. 380 cover all classes of lap-seam boilers including boilers of the locomotive type, or does it apply solely to h.r.t. boilers? Is it the intent of the Boiler Code that the drums of water-tube boilers over 36 in. in diameter and over 20 years of age come under the requirements of Par. 380?

Reply: It was the intent of the Committee that the application of Par. 380 should be limited to h.r.t. and similar types of fire-tube boilers, the shells of which are exposed to the fire or products of combustion. It was not intended that Par. 380 should apply to the drums of water-tube boilers, or boilers of the locomotive type.

Case No. 324

(In the hands of the Committee)

Case No. 325

Inquiry: Is it necessary in existing installations that, under the requirements of Par. 315, the feedwater delivery pipe shall be carried through the shell of an h.r.t. boiler near the front end in all cases? With scale-forming water it is found that with the delivery pipes carried through the shell near the back end, they could be easily removed for cleaning out scale, etc.

Reply: Attention is called to the fact that Par. 315 appears in Part I, Section I, of the Boiler Code and therefore does not apply to existing installations.

Case No. 326

(Annulled)

Case No. 327

Inquiry: Is it necessary, under Par. 430d, that the fusible plug must be located in a tube not less than one-third the length of the tube above the lower tube sheet where such a boiler is fitted with an extra head and a water-heating compartment at the top of the shell?

Reply: It is the opinion of the Committee that where a top compartment is utilized for preheating of feedwater, the measurement of the tube may be construed as applying to that portion of the tube between the firebox tube sheet and the point where the tube enters the top compartment.

Case No. 328

(In the hands of the Committee)

Case No. 329

Inquiry: What tensile strength shall be used for the calculation of the maximum allowable working pressure of pressure parts formed of steel castings of Class B grade or of seamless steel tubing material?

Reply: It is the opinion of the Committee that the tensile strength used in the calculation of pressure parts formed of steel castings of Class B grade or of seamless steel tubing shall be the minimum tensile strength determined from tests made on the test specimens located and taken as given in Par. 88 of the Code.

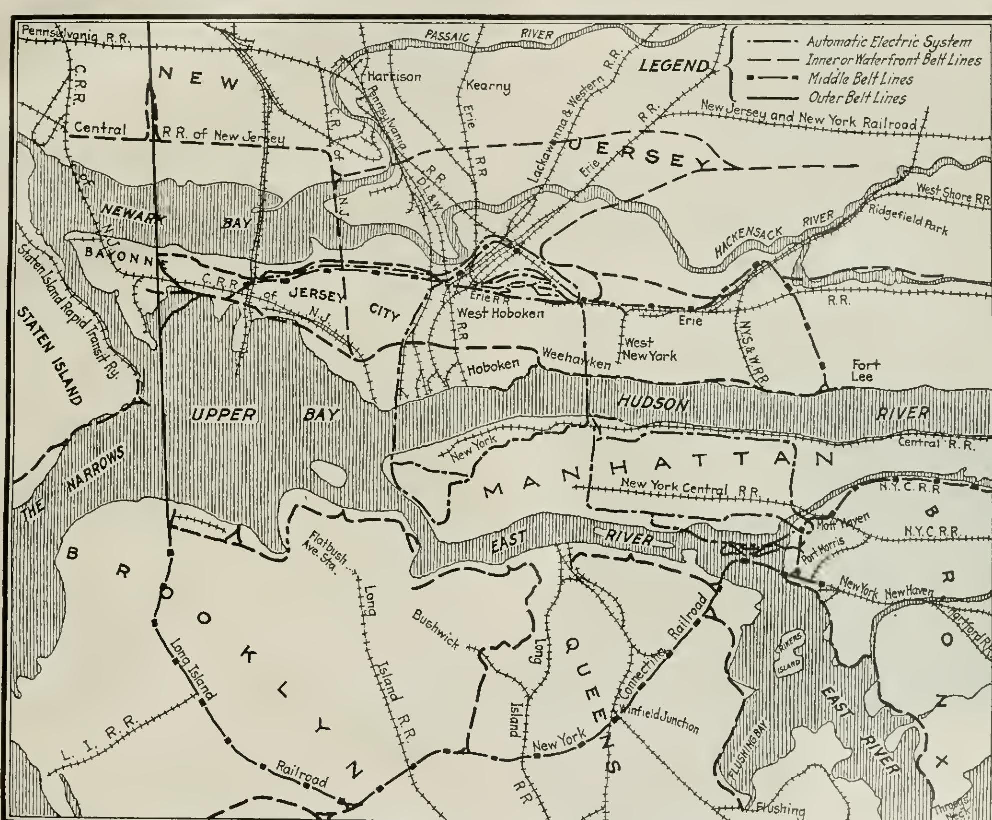
Case No. 330

Inquiry: Is it permissible to repair cracks in the tube sheets of water-tube boilers by autogenous or fusion welding? In the recommendations in the Appendix it is stated that no welding shall be allowed in cracks in shell plates or other plates subject to tensile strain, yet it is stated that where tube sheets of boilers have deteriorated not to exceed 25 per cent of their original thickness, the same may be reinforced and repaired by any process of autogenous welding.

Reply: It is the opinion of the Committee that such process of reinforcing and repairing may only be used on tube sheets which are not subject to tensile strain, as permitted by the Appendix.

New York, New Jersey Port and Harbor Development Commission should be of great interest to engineers. Briefly the recommendations of the Commission are as follows:

1 Adoption of a compact between the states of New York and New Jersey providing for the creation of a single port district administered by a single port authority
2 Construction of an automatic electric system connecting the



Map Showing Proposed Belt Lines and Automatic Electric System

trunk-line railroads with terminal stations in Manhattan for the distribution and collection of general merchandise, freight, and food products
3 Development of a standard belt-line railroad system for all parts of the port except Manhattan, embracing inner or waterfront belt lines in New York and New Jersey, middle belt lines in New York and New Jersey, and an outer belt line in New Jersey
4 Consolidation of railroad marine operation not eliminated by the automatic electric and extended rail service, with separate joint railhead terminals for car-float service and lighterage.

Further recommendations are made concerning food-receiving stations and terminal markets in Manhattan and the Bronx, provision of waterfront piers, warehouse facilities, dredging of channel, modifying bridges, zoning of steamship terminals by trade routes, from Manhattan Island itself. This problem is complicated by the need for eliminating the New York Central tracks at the grade on the west side of Manhattan and the congestion which prevents the bringing of freight cars to the sidings of the shipper and consignee.

Before reaching its final decision, the Commission gave careful consideration to:

a Railroads for standard rolling stock, both elevated and below ground
b Motor-truck service between New York and New Jersey similar to the Cincinnati trap-car system
c Cableway truck-conveyor system
d Improved water transfer service.

The plan evolved will release the Hudson River and New Jersey waterfronts from pier-station occupancy, will dispose of the New York Central's surface tracks, will provide ample capacity for the future and effect a large saving in terminal cost. This system, known as the Automatic Electric, will resemble a railroad but will function as a conveyor, electric circuits being used to hold the trains in fixed position with respect to each other. The elements of the systems are a belt-line railroad in New Jersey reaching all

(*Continued on page 220*)

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

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Recent Hydraulic Development on the Pacific Coast

Robert Sibley

Ever since the announcement was made at the Pasadena Convention of the National Electric Light Association by the Water Power Development Committee last spring that a program of expenditure amounting to $700,000,000 must be put under way immediately in the West for a ten-year development period, there has been a considerable stir throughout the nation in following the Pacific Coast situation. The year just brought to a close has seen more than this program outlined put into operation. Below is a summary of the present status of this work. The report of the California Railroad Commission shows that this state alone has issued some $60,000,000 in hydraulic securities during the past year under the approval of the Railroad Commission.

It is interesting to note some of the outstanding features of this development, as a number of records are being established. At the Kern River No. 3 power plant of the Southern California Edison Company are being installed two Pelton reaction turbines of 23,500 hp. capacity operating under a head of 802 ft. On the Pit River development of the Pacific Gas and Electric Company are being installed two 40,000-hp. turbine units of the Allis-Chalmers design. The Great Western Power Company in its Caribou plant is putting into service this month transmission of hydroelectric energy at 165,000 volts over a distance of 190 miles. Both the Pacific Gas and Electric Company and the Southern California Edison Company have under way the installation of 220,000-volt long-distance transmission. The copper for the Pit River development of the Pacific Gas and Electric Company, which is to operate at 220,000 volts, has recently been ordered from the Anaconda Copper Mining Company of Great Falls, Mont. The finished cable will have a 500,000-circular mil cross-section made up of seven conductors, seven-rope lay strand, and it is the largest rope strand which the company has had to build. Something over ten million pounds of copper will be required and it will require approximately two hundred freight cars or about eight average-size freight trains to haul the finished order.

It is impossible to go into detail in a brief sketch such as this in regard to the many interesting features, or even to outline the gigantic power program that is under way in the West. A general conception of its magnitude, however, may be gleaned from the fact that the Southern California Edison Company in its sworn statement before the California Railroad Commission states that it will complete its Big Creek development within the next fifteen years, developing a total of something over 800,000 hp. at a cost of $200,000,000. This energy is to be transmitted into Los Angeles at a distance of 240 miles over a 220,000-volt circuit. The company is now under active construction of this program and the first units in this new development will be put into commission during the current year. This same company has quite recently made announcement of the taking out of water rights on the Colorado River which will necessitate the building of a dam 500 ft. high and which will bring about the storage of 40,000,000 acre-feet. As the largest storage reservoir in the western hemisphere now stores but something like 2,600,000 acre-feet, being that of the Elephant Butte Dam in New Mexico, it is readily seen to what gigantic proportions such a development may arrive. The conservation of this water will bring about the development of 4,200,000 hp. By leaving out the Grand Canyon of the Colorado, the company expects to develop 2,500,000 hp.

The four principal companies that are now under active operation in development work in California are: The Southern California Edison Company, The Pacific Gas and Electric Company, The Great Western Power Company and the San Joaquin Light and Power Corporation, in addition to the work of the city of San Francisco and the city of Los Angeles.

The accompanying tabulation gives brief particulars regarding the outstanding features of the present development. It does not, however, give the completed capacity of all the plants that are in the proposed schedule of development, but only those that are actually now under way in construction.

ELECTRIC PLANTS UNDER CONSTRUCTION IN CALIFORNIA

Plants	Capacity in Kw.	Type	Expected Date of Completion
Great Western Power Co.:			
Caribou: Feather River (2 units)	40,000	Hydro	Apr. 1921
Pacific Gas and Electric Co.:			
Oakland	12,500	Steam	Jan. 1921
Hat Creek No. 1	6,100	Hydro	Apr. 1921
Hat Creek No. 2	8,200	Hydro	Apr. 1921
Fall River	44,300	Hydro	Mar. 1922
Spring Gap: Stanislaus River	7,500	Hydro	July 1921
City of San Francisco:			
Moccasin Creek (3 units)	49,500	Hydro	Jan. 1923
Southern California Edison Co.:			
Big Creek No. 2: 3d unit	16,500	Hydro	Dec. 1920
Kern River No. 3	30,000	Hydro	Feb. 1921[1]
Big Creek No. 8	22,500	Hydro	Aug. 1921
San Joaquin Light and Power Corpn.:			
Midway	12,500	Steam[2]	Apr. 1921
Kern River	8,250	Hydro	July 1921
Southern Sierras Power Co.:			
Owens Auxiliary	2,500	Hydro	Feb. 1921
Levining Creek	2,500	Hydro	Oct. 1922
Los Angeles Gas and Electric Corpn.:			
Los Angeles	10,000[3]	Steam	Jan. 1921
City of Los Angeles:			
San Fernando	7,000	Hydro	Jan. 1921
Franklin Canyon	2,500	Hydro	Jan. 1921
Total	289,850		

[1] First unit. [2] Gas fuel. [3] Limited to 7500 kw. on account of boilers.

The power shortage in California seems to be unabated, even though new developments have been put in during the past year. It would seem that the growth of the state, proceeding at the rate of about 44 per cent during the ten-year period, is bringing about such increased agricultural and industrial development that the power program will need exerted upon it all the energy possible in the way of financial support in order to satisfy the insistent demand for power on all sides. A great effort is being made throughout California and the West to put the problem before the public itself in order that it may see the necessity of backing up the various utility companies in their efforts to acquire the necessary financing that this program may go ahead unhampered.

Robert Sibley.

San Francisco, Cal.

Chordal's letters, written in the days of the contract system, tell how the Yankee contractor "Doolittle" produced remarkable results in the Western engine shop of "Pete and Cady." "Doolittle sails in," says the account. "The engine work is in his hands; the men are his. He pays them. He stops every man of them and sets them to work on tools, fixtures, jigs, etc., and keeps them there for a month. Doolittle goes through every piece and cuts the price down and the men's earnings up."

This is an optimistic view so far as the men are concerned. In too many cases the contractor adopted sweatshop methods and cut the men's earnings *down*. The real rub, however, is explained by Chordal, who intimates that Pete and Cady felt a bit sore at the profits Doolittle was making. They exclaimed: "We would think we were going to the dogs if we paid a superintendent the money as salary which Doolittle the contractor gets as profit."

In an article on Labor as a Business, Not a Commodity, in the *Manufacturers Record*, by George H. Cushing, Washington representative of the American Wholesale Coal Association, another scheme for contracting for labor is set forth which at least has the advantage of removing the objections to the older scheme which were due to the letting of contracts to individuals. It is, instead, to let the contract for labor to the men as a body, both manufacturer or operator (he is speaking of coal mining) and the contractor being incorporated and equally responsible under the law. For example:

> The coal-mine operator has, we will say, a proved productive capacity of 100,000 tons per month. He sells on contract 60 per cent of that output, or 60,000 tons per month. He can—with the same safety he moves in other directions—sign a contract for the labor to produce 60,000 tons a month. That is, he can, to that extent, contract with his men to give them that measure of a minimum wage and a minimum working time...... The operator, having received the labor as a unit, should pay for it as a unit. That is, only one pay check should pass. The employing company should pay the employee company for the labor even as it pays any other business house for its product. The employee company should distribute its own funds.

Mr. Cushing contends that "labor is *not a commodity*...... it is an act of production. Production is a business. For that reason, labor is a business. The main difficulty is that labor has not been organized—as a business." He holds, however, that labor is generally regarded as a commodity to be bought in the open market at the lowest price, the same as machinery or any other commodity is bought. While acting on that theory capital has paid labor for results only, often on the piece-work basis, and soon after came the cuts in piece-work rates and the many other points of contention that have given rise to so much strife. He says:

> Labor felt outraged. It believed that it was tricked. Perhaps it was. Even so, it had no different treatment than was customarily given to other producers of raw material. Instead of organizing for business defense as other producers had done, labor organized a voluntary union to fight it out along lines of reprisal. So labor came to stand firmly against any proposal to accept payment for results only. It demanded payment for time spent, regardless of results. Thus the issue was drawn. Labor demanded payment for time spent only. Capital offered to pay for results only. The two could not possibly have maneuvered themselves into positions farther apart. And each side began to organize its forces to impress its view upon the other. This building of competing organizations has been going on for 40 years. The organized movements on both sides have taken on a variety of names, but the animating purpose on both sides has remained constant.

With the sudden collapse of the tremendous demand for workers and the state of flux into which labor has lately been thrown, Mr. Cushing believes that the time is ripe for a new deal—perhaps a new labor organization, not a replica of the old, built upon hatred and with a lack of principles, but an organization built along business lines; and that labor will go into business as, incidentally, he says, it should have done 25 years ago. Perhaps labor will be organized "as a business" instead of remaining simply a "commodity."

to the English debenture holder who says: "I do not want big profits; I want an assured rate of interest with absolute security. I would rather have a sure 4 per cent or $4^1/_2$ per cent than I would the ordinary shares with a possible 10 per cent or a possible nothing; therefore, give me debenture."

National Board of Boiler and Pressure Vessel Inspectors

The first annual meeting of the National Board of Boiler and Pressure Vessel Inspectors brought together at the Hotel Statler in Detroit on February 2, 3 and 4 a group of about sixty men, including members of the Board itself, members of the Boiler Code Committee of The American Society of Mechanical Engineers, and others interested.

The first day was devoted to the hearing of addresses. Dr. D. S. Jacobus, acting chairman of the A.S.M.E. Boiler Code Committee, told of the genesis and development of the Code, emphasizing the fact that no action had been taken without consideration of the interests of all who were involved in the questions under discussion.

Charles E. Gorton, chairman of the American Uniform Boiler Law Society, told of the appointment of the first Boiler Code Committee by Col. E. D. Meier, when he was president of The American Society of Mechanical Engineers, how the Society had reached the limit of its functions in the formulation and interpretation of the Code, and the Uniform Boiler Law Society had been organized to promulgate it, and how the National Board of Boiler and Pressure Vessel Inspectors had been organized at the instigation of the American Uniform Boiler Law Society. He told of seeing on his recent trip to the Coast a boiler with the stamps of 22 different states upon it, which absurd practice, now not uncommon, would be avoided by the facilities and simple procedure offered by the organization of the National Board.

Of the other speakers E. R. Fish, vice-president of the Heine Safety Boiler Company, explained still further the advantage of a single stamp for boilers constructed in accordance with the Code. S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Company, spoke upon the advantages of uniform qualifications for boiler inspectors. F. R. Low, editor of *Power*, outlined some of the possibilities, opportunities and responsibilities before the National Board.

J. C. McCabe, commissioner of the city of Detroit, and chief inspector of boilers for the state of Michigan, spoke of the qualifications and duties of boiler inspectors.

On the second day the members of the Board attended a meeting and took part in the deliberations of the Boiler Code Committee of The American Society of Mechanical Engineers. This meeting of the Committee was held at Detroit instead of, as usual, at the headquarters of the Society in New York, in order to give the Committee the advantage of meeting and counseling with the men from all over the country who are enforcing the Code. Nineteen inspectors were present from almost as many different states in widely separated sections of the country.

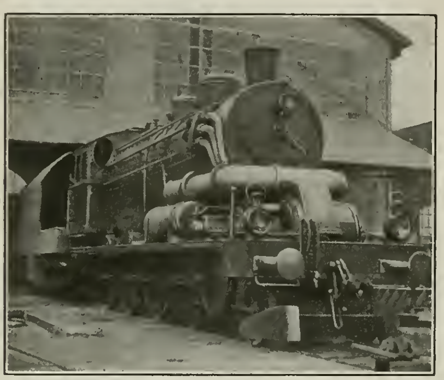
The objects of the Board of Boiler and Pressure Vessel Inspectors as stated in the Constitution adopted are as follows:

> To promote uniform boiler laws and rules throughout the jurisdiction of its members.
>
> To secure uniform approval of specific designs of boilers and other pressure vessels, as well as appurtenances and devices used in connection with their safe operation.
>
> To promote one uniform code of rules and one standard stamp to be placed upon all boilers constructed in accordance with the requirements of that code, and one standard of qualifications and examinations for inspectors who are to enforce the requirements of said code.
>
> To compile official statistics and other data.

Steam-Turbine Locomotive

When William Avery (who, by the way, was a relative of the late John E. Sweet) built his Hero reaction steam turbines nearly ninety years ago and used them for operating sawmills and woodworking shops in New York State and elsewhere, he took a chance at trying out one for the motive power of a locomotive on the Newark, N. J., meadows. Mr. Sweet has described the turbine as having a 7-ft. arm which rotated at enormous velocity and had a speed at its tips of 14½ miles per minute. It is not surprising that the machine ended its life in a ditch beside the track.

From that day to this there has been comparatively little effort to apply the steam turbine to locomotives. According to the *Railway Gazette* of London, however, a turbine-driven locomotive is now being tried on the Swiss Federal Railways. It is converted from a standard 4-6-0 type as used on the Federal Railways. The



Experimental Turbine Locomotive, Swiss Federal Railways

turbine is reversible and is placed in front of the smokebox, power being transmitted by 30 to 1 gearing to a horizontal crankshaft placed above the leading truck, the rods of the six coupled wheels being extended forward and connecting with the crankpin at each end of the crankshaft.

The engine is designed for a turbine speed of 8000 r.p.m., giving a running speed of 49 miles an hour. The boiler is equipped with a superheater and a condenser is fitted below it, utilizing water from the tender, to which latter it is returned for cooling by being allowed to fall in narrow streams from the roof extending over the tender, which is designed for the purpose. As there is no blast nozzle an air draft through ventilators is used for maintaining the required action on the fire, in conjunction with a blower. It is claimed that while making the trial trips the engine has shown a fuel economy 25 per cent under that of the compound locomotives in service, while it runs very smoothly at high speeds, this being accounted for by the reduction of the reciprocating parts. The special equipment was designed by Mr. Zoelly, of Escher Wyss and Company, Zurich, and applied to the locomotive at the Swiss Locomotive Works at Winterthur.

Rankine the Man

Back of the editor's desk in the editorial rooms of Mechanical Engineering hangs a finely executed portrait of Prof. William J. M. Rankine, whose textbooks on the steam engine and applied mechanics have thrown consternation into the hearts of many aspirants to the degree of M.E. in our technical schools, but who in after years have blessed the days of rigorous training prescribed by this master of engineering mathematics.

It may relieve the minds of some to learn what apparently is not well known, that Rankine was not only a profound technologist who delighted in disciplining the youthful mind, but he also was a humorist and a many-sided man.

A short time ago Mr. Frank E. Law, former chairman of the Finance Committee of the A.S.M.E., sat under the above-mentioned portrait in the editorial rooms and recited a humorous poem entitled The Mathematician in Love. Rankine's eyes appeared to twinkle, whereupon Mr. Law said that no other than Rankine himself had written it, and many more just as good.

Since then a letter received from Mr. Law gives the following interesting bits of information:

> Referring to our conversation today, the article on Rankine in the Encyclopaedia Britannica, Eleventh Edition, Vol. XXII, page 894, says,—after referring to Rankine's contributions to technical journals and to his textbooks—"These writings, however, corresponded to but one phase of Rankine's energy and many-sided character. He was an enthusiastic and most useful leader of the volunteer movement from its beginning, and a writer, composer and singer of humorous and patriotic songs, some of which, as 'The Three Foot Rule' and 'They Never shall have Gibraltar,' became well known far beyond the circle of his acquaintance."
>
> I think you would do a real service in calling attention to this human quality in Rankine. Most think of him only as a dry-as-dust writer.
>
> The Encyclopaedia article speaks of Rankine's Scientific Papers, published in London, 1881, and says the volume contains a memoir of Rankine by Prof. P. G. Tait. This memoir would doubtless supply many interesting details.

Industrial Disputes in Canada

The establishment of the industrial courts in Kansas less than a year ago has brought very forcibly to public notice the part the Government plays in the maintenance of operation of essential industry. Canada recognized the need for action and in 1907 Parliament enacted the Industrial Disputes Investigation Act for aid in the prevention and settlement of strikes and lockouts. This act, commonly known as the Lemieux Law, has been amended from time to time and as at present in force may be briefly outlined as follows:

Wherever a dispute arises between the employer and any of his employees, either of the parties may apply to the Minister of Labor for the appointment of a Board of Conciliation and Investigation consisting of three members appointed by the Minister. One of these shall be appointed on the recommendation of the employer, one on the recommendation of the employees, and the third on the recommendation of the members previously chosen. The Board holds office until its final report is placed in the hands of the Minister of Labor. The Minister is given discretion in the granting of an application for the appointment of a board, but after being appointed no court proceedings may be held to question the establishment of a board or its proceedings. The Board is charged with careful inquiry into the dispute and all matters affecting its merits and right settlement. It is given latitude in making suggestions that will induce the parties to the dispute to come to a fair and amicable settlement, and if a settlement is reached it is as binding as any recommendation of the Board. In case the Board cannot settle the dispute, a full report is made to the Labor Minister setting forth the evidence and making recommendation for its settlement according to the merits and substantial justice of the case. The Board is empowered to force the attendance of witnesses and administer oaths and it can require that books, papers and documents be produced for its investigation. Fines are prescribed for persons guilty of contempt of the Board. The proceedings of the Board may be conducted in public at its discretion, and if necessary it may employ experts to advise on technical matters. The members of the Board are paid at a per diem rate plus actual traveling expenses.

Strikes and lockouts prior to and pending the reference of dispute to the Board of Conciliation and Investigation are declared illegal, and both employer and employees must give at least thirty days' notice of any intended change affecting conditions of employment with respect to wages or hours. Penalties are provided for strikes and lockouts contrary to the provisions of this law. In some cases where the Minister of Labor discovers that a strike or lockout is imminent he may initiate action in the formation of a Board without application from any interested party. Some special treatment is authorized in case railroads or municipalities are parties to a dispute.

The Lemieux Law as outlined does not prohibit strikes or lockouts, merely insuring their consideration by an arbitration body.

The formation of the Board will tend to bring the parties in

firm step in the stabilization of the industry.

What may be accomplished by such arbitration as that conducted under the Lemieux Law is shown by the following figures:

Out of 323 disputes affecting mines, transportation, public utilities and war work referred under the Act from the time of its enactment until March 31, 1919, 300 were settled by arbitration, only 23 strikes taking place. From April 1, 1918, to March 31, 1919, there were only two strikes out of 75 disputes. Equally encouraging figures are given for 1920. On December 31, 1920, there were on record but four strikes, affecting 379 people. The Lemieux Law is proving itself to be a most effective means for establishing industrial peace.

News of Other Societies

American Institute of Electrical Engineers

Meeting at Akron and Cleveland, January 14. Sub-Committee on the Rubber Industry, of the Industrial and Domestic Power Committee, presented paper on Application of Electric Power in the Rubber Industry. A report of the committee on coördination of institute activities included a recommendation that the policy be established of awarding prizes for the most worthy papers presented before the institute. The board of directors approved the recommendation in principle and referred the matter back to the committee for the purpose of formulating a plan of procedure.

Society of Automotive Engineers

Meeting in New York, January—during the automobile show. At a session devoted to fuels, ways and means were discussed for improving the automobile engine so as to make the fuel supply last longer. Abstracts of five of the papers presented at this session are given in the Survey Section in this issue. An aviation session was held at which difference of opinion developed as to the advisability of using large, multi-motored planes, or smaller planes with single motors. It was subsequently agreed that the design of the plane depends entirely on the service required as to distance, loads and the character of the country over which the flight is made. Among the aviation papers were: Propellers, by F. W. Caldwell; Design Requirements of Commercial Aviation, by Grover C. Loening; Airplane Wings, by C. D. Hanscom; Commercial Aviation, by Glenn L. Martin; and Compression Pressures and Engine Performance, by S. W. Sparrow.

American Society of Civil Engineers

Annual Meeting in New York, January 19 and 20. Attention was chiefly centered in the election of officers as follows: George S. Webster, Philadelphia, president; Andrew M. Hunt, New York, and Edward E. Wall, St. Louis, Mo., vice-presidents; and O. E. Hovey, New York, treasurer. The committee on stresses in track supplemented its elaborate report of last year by giving details of tests and experiments conducted to demonstrate the effect of curves on the stress in the rail, and the action on the track of flat spots in wheels. Other special committees also presented reports. It was determined that the board of direction should act as a committee to decide on matters affecting the relations of the society with other technical organizations. Under this arrangement the board will keep in touch with the Federated American Engineering Societies and other organizations, and in this way with general activities of interest to engineers.

American Society of Heating and Ventilating Engineers

Annual meeting in Philadelphia, January 26, 27 and 28. Reports were presented by the society's respective committees on code for testing low-pressure heating boilers, on standard code for testing heating systems, on steam and return main sizes, on schoolhouse standards, on standard method for testing air washers, on furnace heating, and on research. A paper by A. B. Reck, of Copenhagen, Denmark, on the influence upon boiler economy of continuous firing with highly volatile fuel without intervening cleaning, is abstracted in the Survey Section in this issue. A theory of dust action developed from investigations carried out of this paper was published in the Survey Section of Mechanical Engineering for February, p. 130. Other technical papers of mechanical engineering interest were: Design of Large Boiler Plants, by J. Grady Rollow; Method of Utilizing Heating Systems for Cooling Rooms in Summer, by A. M. Feldman; Forced Hot-Water Circulation Heating System, by Robert Hughes; Accelerated Hot-Water Systems, by A. J. Wells; Pulverized Coal for Power Plants, by F. A. Scheffler; Briquetted Coal for Household Fuel, by I. H. Kennedy; Economizers, by W. F. Wurster; Transmission of Heat through Single-Frame Double Windows, by A. N. Shaw; and Comparative Tests of Sixteen-Inch Roof Ventilators, by Dryden, Stutz and Heald, of the U. S. Bureau of Standards.

Providence Engineers Consider Transportation

"One of the most important problems in the industrial life of New England is that of efficiently supplying raw material and distributing the finished product. The future prosperity of the country is dependent to a large extent on the ability of the railroads to meet out transportation requirements."

The above words were in the rallying call of the Providence Engineering Society to its Fifth Annual Banquet held February 1, 1921. In addition to addresses by the governor of the state and the mayor of Providence, Prof. William J. Cunningham spoke concerning the Federal Control of Railroads. Professor Cunningham is the James J. Hill Professor of Transportation at Harvard University and has had nearly twenty-five years of practical railroad experience in the traffic, operating and executive departments of various railroads throughout the United States. He pointed out that railway rates could not be increased beyond the point where they would tend to drive traffic away. He criticised the standard of wage rates established throughout the country by the Railroad Administration, and emphasized the fact that increased revenue, increased rates and further operating economies were necessary to make the roads self-supporting. He also decried as a national calamity the public ownership of railroads.

Arthur P. Russell, vice-president of the New York, New Haven & Hartford Railroad, outlined the financial difficulties of the New England railroads and took up the situation of the New Haven road in some detail. In the matter of railroad development he paid specific attention to the problems in Providence and told of plans for increased efficiency that will be derived from improved facilities in the Providence district.

John Fritz Medal for 1921 Awarded to Sir Robert A. Hadfield

At the annual meeting of the John Fritz Medal Board of Award held on January 21, 1921, the John Fritz Medal for 1921 was awarded to Sir Robert A. Hadfield, of London, for the invention of manganese steel. Manganese steel was first described in a paper read by Sir Robert before the International Engineering Congress in 1893. For uses in which toughness combined with great strength is demanded, manganese steel is invaluable. It is non-magnetic and its applications have been many and varied. During the war 9,000,000 Hadfield manganese-steel helmets were used by the English, American and Belgian armies, and at the close of the war the Hadfield helmets were rapidly replacing the French type.

Sir Robert A. Hadfield is one of the leading steel manufacturers of England and was the first to introduce the 48-hour week in his work, putting it into effect 25 years ago. During the war he was one of the largest producers of munitions for the British Navy. Besides manganese steel he invented a magnetic steel of high permeability, especially suitable for use in dynamos and motors; showed that steel containing a small percentage of silicon, after a double heat treatment, was far superior to the purest obtainable iron; and is responsible for other important developments in the steel industry. He has been a prolific technical writer and an energetic promoter of the scientific societies of Great Britain. He is a member of the American Institute of Mining and Metallurgical Engineers and The American Society of Mechanical Engineers, and is one of the greatest users by mail of the Engineering Societies Library.

Marine Electrical Engineering

Discussion of Use of Electricity in Marine Work at Joint Meeting of New York Sections of Electrical and Mechanical Engineers

THE immense tonnage of the American Merchant Marine presents engineering problems of great import. To consider the use of electricity in marine work, the third of the joint meetings of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of The American Society of Mechanical Engineers brought together a large, deeply interested audience in the Auditorium of the Engineering Societies Building on the evening of January 28, 1921.

The program of the evening was in charge of Alfred E. Waller, of the Marine Committee of the A.I.E.E. and chief engineer of the Ward Leonard Company.

Admiral W. S. Benson, chairman of the United States Shipping Board, outlined the steps necessary in the development of the American Merchant Marine and emphasized the present slow development of electric power and its application in our naval vessels. He stressed the necessity of meeting foreign competition in the cost of operation of ships. The principal problem in operation is one of fuel, and Admiral Benson insisted on oil rather than a return to the use of coal. He bespoke especially the development of an efficient internal-combustion engine for marine work.

H. L. Hibbard, of the Cutler-Hammer Manufacturing Company, presented a paper on Electricity Applied to Ship Auxiliaries. He outlined the development of the past four or five years and described the design requirements of auxiliaries, emphasizing the specific needs for ventilated and enclosed watertight motors. The various types of control for auxiliaries were also listed and the peculiar characteristics of motors for driving, engine-room auxiliaries, deck machinery and steering gear were treated in some detail. Concerning definite advantages of auxiliaries electrically driven, Mr. Hibbard said:

It has been shown by experience that the electric drive of the auxiliary machinery has resulted in a considerable saving in fuel consumption of a vessel. This applies particularly to vessels using steam for their main propulsion. For ships operated by Diesel engines or Diesel-electric drive it is obviously of great advantage to operate all the engine-room auxiliaries by electricity, as it is largely a question of the efficiency of electric transmission with a large and reliable generating unit against a number of small inefficient oil or steam engines, and it is naturally desired to avoid the generation of steam in any quantity on a motorship.

In the matter of first cost, it is also apparent from such figures as have been available to date that electrical auxiliary machinery is roughly about 20 per cent more expensive than steam, except in case of deck winches where the difference is more, sometimes 100 per cent. It is also found that an oil-engine-propelled motorship is about 30 per cent more expensive in first cost than a steam-driven vessel and that, strange as it may seem, the Diesel-electric-propelled ship is slightly less expensive than the straight Diesel owing to the smaller and higher-speed oil engines which it is possible to utilize.

As against these disadvantages of first cost and weight, are obtained the advantages of:

1 Suppression of heat in spaces adjacent to the gear and transmitting lines, which is of importance in certain cases
2 Elimination of accidents due to freezing and bursting of steam pipes, cylinders, etc.
3 Reduction of vibration and noise and an increase in the habitability of the ships due to these factors. This is particularly marked in the case of the steering gear
4 Simplification and flexibility of control, operation being obtained readily from the most convenient point
5 The obtaining of mechanisms as outlined above which are very much more efficient in operation than the steam equipments. This is the most important consideration.

Another important consideration is the fact that experience shows on motorships already constructed with electrical auxiliaries, that in port the power required during the period that the deck winches are handling the cargo is about three times the amount required with the auxiliaries at sea.

Commander C. S. McDowell, U. S. N., emphasized the need of proper terminals for proper shipping and the necessity for electrifying terminals, giving in detail suggestions as to the electrically operated devices that might be used in terminal operation.

Under the subject of Turbine Reduction Gears versus Electric Propulsion for Ships, Eskil Berg, of the General Electric Company, treated various types of ships and discussed the relative merits of the two types of drives in each case. The following is a résumé of his paper:

The Navy Department, after years of comparative study and having actual operating data on electrically propelled vessels available, has decided to equip all the larger Navy vessels with electric drive. Economical cruising speed can be obtained, machinery can be located in invulnerable places, plurality of generating units can be used, and maneuvering can be accomplished more quickly and accurately.

Geared turbine drive has an advantage in fast destroyers and light cruisers, where the power is large and the propeller speed high. The weight of propelling machinery in this type of vessel is of utmost importance and electric drive, being heavier, cannot be considered.

In merchant ships each individual case must be studied, considering the questions of service, economy, reliability, weight and cost. For fast passenger liners electric drive has an advantage, for transmission efficiency can be made practically equal to double-reduction gearing and a more efficient turbine can be built. Noise is practically eliminated with electric drive.

In moderate-power twin-screw ships of 6000 to 8000 hp., electric drive has a decided advantage both in economy, weight and price if one turbo-generating unit is used to drive both propellers.

In slow-speed single-screw freighters of 2500 to 3000 hp., the geared turbine is somewhat lighter. The actual transmission efficiency of the gears is also better. Considering losses of the reversing turbine, packing losses, and leakage of steam due to larger clearances, the transmission efficiency is in favor of electric drive. If, however, the motor is located aft, doing away with long shafting with its expensive bearings, supports and shaft alleys, the electric drive is the lightest, cheapest and most economical, as well as the most reliable method to use.

In freighters of 1500 hp. or less, geared turbines are lighter and cheaper. As the power is small, a gear can be designed which is less affected by sudden load variation or disalignment caused by springing of the hull or inaccurate workmanship.

In his paper on the Electric Propulsion of Ships, W. E. Thau, of the Westinghouse Electric and Manufacturing Company, discussed various types of power drives and described the installation of the propelling machinery on the U. S. S. *Tennessee*.

In discussing Commander McDowell's paper, R. H. MacLain, of the General Electric Company, stressed the necessity for structural changes in boats to permit more rapid stowing and breaking down of cargo, pointing out that the solution of the freight-handling problem on the Great Lakes was derived from the construction of the boats themselves.

G. A. Pierce, of The William Cramp & Sons Ship and Engine Building Company, in discussing Mr. Berg's paper, pointed out the advantages of the reciprocating engine in naval and coastwise ships. He further emphasized reliability, simplicity and ease of operation as points to be considered in a discussion of the relative merits of mechanical reduction-gear drive versus electric drive.

In a discussion of Mr. Thau's paper Commander Jones of the U. S. S. *Tennessee* testified that the records of the ships now in service show that electric-drive propulsion has established itself. and stated that operating personnel can be successfully trained in a comparatively short time to handle casualties to machinery and apparatus with as much facility as with the older types of propulsion.

Engineering Foundation Endowment

The Engineering Foundation, established in 1914 for the stimulation and support of research in science and engineering, is frequently obliged to refuse to support research projects brought to it because it lacks funds. The Foundation needs a large increase of endowment. Nine donations of $50,000 each are desired so that an offer of $50,000 toward a half-million may be claimed. Gifts to the Foundation are exempt from income tax and each donor of $250,000 or more will be honored as a Founder.

The Foundation is administered under the auspices of the United Engineering Society, American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, by the Engineering Foundation Board, consisting of thirteen representatives of these societies, and three members at large. Alfred D. Flinn, 29 West 39th Street, New York, N. Y., is Secretary and further information may be secured from him.

American Engineering Council in Session at Syracuse, February 14, Elects Executive Secretary of the New Organization—Herbert Hoover Gives Address on Industrial Waste

L. W. Wallace

THE American Engineering Council met at the Hotel Onondaga, Syracuse, N. Y., morning and afternoon, on February 14, for the transaction of business matters relating to the work of The Federated American Engineering Societies. The Council strongly endorsed the model bill on registration of engineers previously prepared by Engineering Council and reported in Mechanical Engineering for December 1920, p. 717. It also approved legislation proposed in connection with the Nolan Patent Bill providing for a reciprocal arrangement with foreign countries to remove discrimination against patents in foreign countries held by American inventors. Announcement was made of the membership of the Federation's Committee on Elimination of Waste in Industry, appointed in accordance with the suggestion of Herbert Hoover that the subject be taken up as one of the major activities of the Federation. The personnel of the Committee is as follows: J. Parke Channing, Chairman; L. W. Wallace, Vice-Chairman; Robert B. Wolf, Chas. E. Knoeppel, Robert Linton, J. H. Williams, Fred. J. Miller, L. P. Alford, Ira N. Hollis, George D. Babcock, Morris L. Cooke, E. E. Hunt, Harrington Emerson, H. R. V. Scheel, and F. G. Coburn. It was voted to recommend to President-Elect Harding that an engineer be appointed on the Interstate Commerce Commission. Before adjournment the next place of meeting of the Council was announced to be Philadelphia.

The most important action at the meeting was the election of L. W Wallace as secretary of The Federated American Engineering Societies. Mr. Wallace has already been serving as treasurer of the Federation and as vice-chairman of its Committee on Industrial Waste. In view of his election as secretary the position of treasurer became vacant and W. W. Varney of Baltimore was elected temporary treasurer.

Mr. Wallace was graduated in mechanical engineering from the Agricultural and Mechanical College of Texas in 1903. He afterward served a railroad apprenticeship and became instructor at Purdue University, then assistant professor of car and locomotive design, and finally, in 1913, head of the department of railway and industrial management, which position he held until 1917. He received the degree of M.E. from Purdue in 1912. Upon leaving the university he became assistant general manager of the Diamond Chain and Manufacturing Company, Indianapolis, Ind. At the close of the war, when the Red Cross Institute was established at Baltimore for the purpose of giving vocational training to blind soldiers, Mr. Wallace left Indianapolis to become director of the Institute and conducted the work until last January, when he was elected treasurer of The Federated American Engineering Societies.

In the conduct of his many activities he had displayed breadth of vision and has been actuated by altruistic motives, characteristics which, combined with an executive experience and a deep interest in the principles of management, admirably adapt him for the work he is to undertake. In various addresses on the subject of industrial management before The American Society of Mechanical Engineers and elsewhere he has shown insight into the fundamentals underlying industrial unrest and a sympathetic appreciation of the rights as well as the responsibilities of employee and employer. This latter will be a most favorable asset to Mr. Wallace in conducting the important investigation dealing with the elimination of waste in industry which is to be undertaken by the Federation.

Address on Industrial Waste by Herbert Hoover

In addressing the American Engineering Council of the F.A.E.S., Mr. Hoover said the Federation is in a position of disinterested service and wants nothing from the public, either individually or as a group. It has initiated services to the public in many directions. One of these is the preliminary survey of some of the weaknesses in our production system, recently organized by the Council. Mr. Hoover directed his attention mainly to an outline of these weaknesses, with suggestions of ways and means for increasing production and improving industrial relations. In concluding he said, "We do not believe it is necessary to effect those things by the Government. The spirit of coöperation that has been growing in our country during the last thirty years has already solved many things; it has standardized some things and is ripe for initiative toward coöperation of a widespread character. The leadership of our Federal Government is bringing together the forces as needed. No greater field of service exists than the stimulation of such coöperation. The first step is sane analysis of weakness and sober proposal of remedy. If the facts can be established to an intelligent people such as ours, action is certain even if it be slow. Our engineers are in unique position for this service, and it is your obligation to carry it forward."

An abstract of Mr. Hoover's summary of the most important elements in industrial waste is given below:

The waste in our production is measured by the unemployment, the lost time due to labor conflict, the losses in labor turnover, the failure to secure maximum production of the individual due either to misfit or lack of interest. Beyond this again is a wide area of waste in the poor coördination of great industries, the failures in transportation, coal and power supplies which reecho daily to interrupt the steady operation of industry. There are again such other wastes due to lack of standardization, to speculation, to mismanagement, to inefficient national equipment and a hundred other causes. There is a certain proof of deficient production by comparisons of our intense results in 1918, when, with 20 per cent of our man power withdrawn into the army, we yet produced 20 per cent more commodities than we are doing today. We are probably not producing more than 60 or 70 per cent of our capacity.

No one will ever suppose that it is ever possible to bring national productivity up to the full 100 per cent, but the whole basis of national progress, of an increased standard of living, of better human relations, indeed, of the advancement of civilization, depends upon the continuous improvement in productivity. While we currently assume that great advances in living standards are brought about by new and basic inventions, yet in fact even a greater field of increasing standard lies in the steady elimination of these wastes. The primary duty of organized society is to enlarge the lives and increase the standards of living of all the people—not of any special class whatever. We are therefore proposing to make a preliminary examination of the volume of waste in certain industries, the proportions that lie in each field of fault. And no engineering report is worth the paper it is written upon without constructive suggestions in remedy.

There is ofttimes a superficial dismissal of this subject of maximum production on the assumption that there are positive limits in production due to oversupply. Such assumption has no proper foundation in the broad view of industry as a whole. Too much economic thought on production has delimited its boundaries by the immediated volume of demand of a given commodity. There is no such thing as the nation overproducing, if it produces the right commodities. The commodities or services produced by the whole nation are capable of absorption by the whole nation if they are of the right character. When ten men or one hundred million men divide their united output, they can by doubling their output have twice the amount to divide. The problem in doubling output is to direct it to commodities or services that they can use. There is no limit to the increase of living standards except the limitations of human strain, scientific discovery, mechanical invention and natural resources.

It is true enough that any particular commodity or service can be overproduced, for each will reach a saturation point in demand when all the members of the community have been supplied. The absorption of increased productivity lies in the conversion of luxuries of today into necessities of tomorrow, and to spread these through the whole population by stimulation of habit and education. Wheat bread, railways, good roads, electricity, telephones, telegraphs, automobiles and movies were once luxuries. They are still luxuries to some parts of the population.

It is but a corollary that certain commodities can better be produced for exchange for commodities from outside our boundaries of more appro-

(*Continued on page 219*)

Engineering and Industrial Standardization

Standardization of Elevators

In the December 1920 issue of Mechanical Engineering an announcement was made of the calling of a conference on the Standardization of Elevators. As a result of this conference the American Institute of Architects, The American Institute of Electrical Engineers and The American Society of Mechanical Engineers were invited by the American Engineering Standards Committee to act as joint sponsor for this standardization project.

These societies have accepted this sponsorship and have formed the Sectional Committee which held its organization meeting on February 15. The members of this committee and the organization which they represent are listed below:

S. F. Voorhees and R. H. Shreve, American Institute of Architects
W. W. Chapin and Paul M. Lincoln, American Institute of Electrical Engineers
W. S. Atkinson, and (to be appointed) The American Society of Mechanical Engineers
B. Jones, joint appointee of three Sponsors
I. N. Haughton, N. O. Lindstrom, C. Reedy, H. F. Gurney and H. A. Pratt, Elevator Manufacturers Association of New York
R. P. Miller, American Institute of Consulting Engineers
S. F. Holtzman, American Society of Civil Engineers
D. E. Lindquist, American Society of Safety Engineers
H. L. Whittemore, Bureau of Standards, Department of Commerce
R. D. Spalding, Bureau of Yards and Docks, Navy Department
Capt. A. B. Fry, Office of Supervising Architect, Treasury Department
T. E. Barnum and W. H. Patterson, Electric Power Club
W. W. Lighthipe and, National Association of Building Owners and Managers
C. M. Hansen, National Association of Manufacturers
R. P. Miller, Building Officials' Conference.

Specifications and Codes Submitted to American Engineering Standards Committee for Approval

Three A.S.T.M. Specifications. The American Society for Testing Materials has submitted the following specifications to the American Engineering Standards Committee for approval as Tentative American Standards:

Standard Test for Toughness of Rock
Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment
Standard Method for Sampling Coal.

These specifications may be found in the 1918 volume of A.S.T.M. Standards. Copies may also be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York City.

National Electrical Code. The National Fire Protection Association has submitted its Regulations of the National Board of Fire Underwriters for Electric Wiring and Apparatus, edition of 1920, frequently referred to as the National Electric Code, to the American Engineering Standards Committee for approval as an American Standard. Copies of the Code may be obtained from the National Board of Fire Underwriters, 76 William Street, New York, or from the American Engineering Standards Committee, 29 West 39th Street, New York.

Mining Specifications. The Bureau of Mines has brought three of its publications to the attention of the American Engineering Standards Committee for consideration as Tentative American Standards. They are:

Permissible Portable Electric Mine Lamps (Schedule 6A)
Specification for Storage-Battery Locomotives (Schedule 15)
Suggested Safety Rules for Installing and Using Electric Equipment in Bituminous Coal Mines (Technical Paper 138)

Copies of these specifications may be obtained from the Bureau of Mines, Washington, D. C., or from the American Engineering Standards Committee, 29 West 39th Street, New York.

These specifications and codes are submitted for consideration in accordance with the special provision in the procedure of the Committee, under which important specifications in existence prior to 1920 may be approved without going through the regular process followed in new work. The Committee would be very glad to learn from those interested of the extent to which they make use of these specifications and rules, and to receive any other information regarding them in meeting the needs of the industry.

Cement Specifications. Complete agreement has been reached on specifications and tests for portland cement, so there is now one specification covering both commercial and governmental use. The revised specifications, which were agreed upon by Committee C-1 of the American Society for Testing Materials and the Government Departmental Committee on Cement, have also received the approval of the American Engineering Standards Committee. Copies may be obtained from this committee or from the American Society for Testing Materials.

Recent Foreign Engineering Standards

Copies of the following engineering standards, issued in 1920 by foreign national standardizing bodies, are on file with the American Engineering Standards Committee:

British Engineering Standards Association:
No. 1 Rolled Steel Sections for Structural Purposes, Lists of
No. 12 Portland Cement, Specification for
No. 94 Watertight Glands for Electric Cables, Specification for
No. 97 Watertight Fittings for Incandescent Electric Lamps, Specification for
No. 100 Body Spaces and Frame Ends for Chassis for Private Automobiles, Dimensions for
No. 106 Electrically Heated Cooking Range, Specification for
No. 122 Milling Cutters and Reamers, Standards for
No. 131 Notched Bar Test Pieces, Forms of

Canadian Engineering Standards Association:
No. 1 Steel Railway Bridges, Standard Specification for

Association Belge de Standardisation (Belgium):
No. 1 Construction of Metal Framework, Rules for
No. 2 Construction of Metal Tanks, Rules for
No. 3 Construction of Coverings and Partitions of Corrugated Galvanized Sheet Iron, Rules for
No. 4 Shafts and Transmission Pulleys, Standardization of
No. 5 Construction of Metal Bridges, Rules for.

Hoofdcommissie voor de Normalisatie in Nederland (Holland):
N–19 Compression Couplings
N–20 Flange Couplings
N–29 Loose Collars for General Construction
N–30 Loose Collars for Mill Gearing.

Normenausschuss der Deutschen Industrie (Germany):
DIN–187 Angle Arm for Fixed Bearings for Transmission Shafting
DIN–475 Widths of Spanner Jaws.

Commission de Normalisation du VSM (Switzerland):
VSM–10300 to VSM–10307 Technical Drawings—Oblique Script; Size of Letters; Graphic Presentation of Screw; Cross-Sections
VSM–12050 Whitworth Screw Threads; General Data
VSM–33900 to VSM–33914 "Sulzer" Attachment for Milling Cutters.

Sveriges Maskinindustriförening (Sweden):
SMS–1 Size for Standard Sheet
SMS–2 Metric Screw-Thread System
SMS–3 Whitworth Screw-Thread System
SMS–5 Hexagonal Nuts—Type B6M–BSW Screw-Thread System
SMS–7 Finished Hexagonal Screws—Type B6S–BSW Screw-Thread System
SMS–8 Series of Standard Diameters.

Photostatic copies of these standards can be furnished at a nominal cost, or the copies on file may be consulted at the offices of the American Engineering Standards Committee, 29 West 39th Street, New York.

Standardization of Wires and Cables

At a recent conference called by the American Engineering Standards Committee at the instance of the American Railway Engineering Association and attended by representatives of 14 national organizations, it was unanimously decided that the unification of specifications for wires and cables for other than telephone and telegraph use should be undertaken under one general plan, covering substantially all the more important uses. The proposed work, it is stated, will be carried out under the auspices and rules of procedure of the American Engineering Standards Committee.

Aeroplane Structural Design; a book for designers, draughtsmen and students. By T. H. Jones and J. D. Frier. Sir Isaac Pitman & Sons, Ltd., New York, 1920. Cloth, 6 × 8 in., 267 pp., plates, tables, charts, diagrams, $7.50.

Although several valuable treatises exist dealing with the problems of sustentation, stability and aerodynamics generally, the authors feel a need for a book treating the structural strength of the aeroplane, in which the loading of it and the methods of estimating its strength under load are discussed definitely and practically. The present volume treats in detail of the wings, fuselage, tail plane and elevators, landing gear and rear skid, control surfaces, flying controls and details, and is equipped with numerous tables of data needed by the designer. Complicated mathematical discussions are avoided.

Automotive Ignition Systems. By Earl I. Consoliver and Grover I. Mitchell. First edition. McGraw-Hill Book Company, Inc., New York, 1920. (Engineering education series.) Cloth, 6 × 9 in., 279 pp., illus., diagrams, $2.50.

This is a systematic course of study of the ignition systems used on automobiles, tractors and airplanes, for those who have to install, adjust and repair these systems in the factory and repair shop.

Concrete Work. By William Kendrick Hatt and Walter C. Voss. Vol. 1, N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1921. 451 pp., illus., diagrams, tables, 8 × 6 in., cloth, $4.00.

This is the first part of a two-volume manual intended to extend the scope of work now possible to the concrete worker of unguided experience by bringing him to an intelligent understanding of the scientific principles underlying his art, and by introducing him to the wider opportunities that exist for him in modern construction. The method used to present the subject is based upon the experience acquired by the Committee on Education and Special Training of the War Department, in training 130,000 soldiers in the various trades connected with military operations. The present volume of the manual contains the development of principles and information on methods of construction and standards necessary for the construction of the definite building.

Contracts in Engineering. By James Irwin Tucker. Second edition, seventh thousand. McGraw-Hill Book Co., New York, 1920. Cloth, 6 × 9 in., 331 pp., $4.

This book is intended as a practical course showing the contractual basis of engineering work and of business at large, and as a textbook for engineering students with no opportunity for extended study of legal principles. It aims to present those facts and rules that seem likely to be of most value to an engineer in his professional and business career and to give him substantial information upon many legal matters.

Drang und Zwang; Eine Höhere Festigkeitslehre fur Ingenieure. Von Aug. Föppl und Ludwig Föppl. R. Oldenbourg, München und Berlin, 1920. Paper. 2 vols. 7 × 70 in., 72 Marks.

The authors of these volumes discuss some of the more abstruse problems of stress and strain. The work is intended especially for engineers who are fitted, by practical experience, to follow a difficult investigation and apply its results. A knowledge of the elementary theory of the mechanics of materials is expected of the reader.

Exporter's Gazetteer of Foreign Markets, 1920–21. Compiled and edited by Lloyd R. Morris. The American Exporter, New York. Cloth, 6 × 9 in., 789 pp., maps, tables, $10.

This gazetteer is planned to present concisely facts about markets which have heretofore been obtainable only in scattered primary sources. The information includes the area and population of each country, the population of its principal towns, its commerce, production and industry, telegraphs, telephones and railroads, money, weights and measures, commercial language, principal shipping routes, customs tariff, consular regulations and representation, and similar matters. Maps of the principal countries are included. Foreign currencies and measurements have been converted into American equivalents.

This book is for officers of manufacturing corporations, works managers, superintendents, accountants, and those in charge of such activities as purchasing, stores, costs and production. The present edition has been revised to conform with the evolution of practice and standards, particularly in relation to organization, personnel problems and the functional control of production. An extensive bibliography is included.

The Gasoline Automobile; its Design and Construction. Vol. 1, The Gasoline Motor. By P. M. Heldt. Sixth edition. P. M. Heldt, Nyack, N. Y., 1920. Cloth, 6 × 9 in., 639 pp., illus., diagrams, charts, $6.

Continued development of the internal-combustion engine has made necessary a further revision of this volume. The chapters on the cylinder, crankcase and oiling system have been rewritten, and that on the piston, piston rings and piston pin revised to accord with modern practice. New material on other subjects has been added in an appendix and a number of new plates have been included.

Heat Engines; a Text-Book for Engineering Students. By David Allen Low. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 597 pp., illus., diagrams, charts, tables, $6.50.

The author has attempted to compress into one volume of moderate dimensions sufficient material for a two-years' course in the subject, in which its theoretical and practical sides would be combined, Numerous exercises for the student are included, most of which are original.

The Making of Herbert Hoover. By Rose Wilder Lane. The Century Co., New York, 1920. Cloth, 5 × 8 in., 362 pp., portraits, $2.50.

Upon the foundation of documents, letters and diaries, and information supplied by Charles K. Field, a friend and college classmate of Mr. Hoover, Mrs. Lane has prepared an informal, readable account of his life. The book is unusual in method, but achieves success as an interpretation of the man.

Tanks in the Great War, 1914–1918. By J. F. C. Fuller. E. P. Dutton and Company, New York, 1920. Cloth, 6 × 9 in., 345 pp., frontispiece, maps, plates, $9.

This volume, by a former Chief General Staff Officer of the Tank Corps of the British Army, is a readable account of the genesis of the tank and of the part played by it in the Great War. The work of the French, German and American tank corps is covered also.

Address on Industrial Waste by Herbert Hoover

(Continued from page 217)

priate character to our needs. Today we have capacity for production of some commodities not only in excess of our home need, but even beyond export demand under present financial conditions. As a matter of practical remedy, we must either reorganize these financial relations or alternately abandon some part of this kind of production and turn our idle men to making things of which we are not yet fully supplied.

The largest area of waste lies in the large periods of slack production and unemployment, due to the ebb and flow of economic tides between booms and slumps. The ideal would be steadily increasing production—an ideal of no likelihood of exact realization because of inability to ever gage in advance the growth in consumption or the approach of saturation. On the other hand, there are certain possibilities of stabilization worth consideration. Our studies of industries as a whole show that we usually expand our equipment just at the periods of maximum demand for their products instead of doing our plant expansion during periods of slack consumption. We thus make double demands on labor and we doubly increase unemployment in periods of reduced consumption. That is indeed one of the factors in our great unemployment today.

Everyone knows that for our normal productivity, our transportation facilities are today inadequate. We know that we are insufficiently housed, insufficiently equipped in our public roads and our public utilities; that we need an entire revision of our power supply, that we need expansion of our water ways; and yet armies of idle men are walking the streets.

The reasons why this occurs are not far to seek, in that it is at times of high productivity that capital is most easily obtained. It is then that the necessity of increased equipment most impresses men's minds and it is the high hopes of these periods that lead them into the adventure of expansion. Nor is it possible to expect that all industry can be so stabilized as to do its capital construction in periods of depression in commodity

demand. Nevertheless, there are some industries that could, by coöperation of the Government and coöperation among themselves, be led in this direction. More particularly does this apply to railways, telephones, telegraphs, power supplies and other public utilities, and to the expenditure upon our state, municipal and national public works.

Another variety of intermittent employment, and thus great waste, lies in certain industries now operating upon an unnecessarily wide seasonal fluctuation, as for instance the bituminous-coal industry. This is today one of our worst-functioning industries. These mines operate seasonally and erratically. They proceed from gluts to famines, from profiteering to bankruptcy. The mining engineers have already pointed out the direction in which the remedy lies, through storage, through railway rate differentials and other remedies. Through constructive action, an army of men could be released from this industry to convert some luxury into a necessity of tomorrow.

The second largest area of waste in productivity is the eternal amount of labor friction, strikes and lockouts. Fundamentally this is not alone a struggle for division of the results of production between capital and labor, but also in the element of purely human friction and loss outside the area of dispute on wages and hours. The growth of industry into large units has destroyed the old mutuality of interest between employee and employer. Our repetitive processes have tended to destroy the creative instinct and interest in employees; at times their efforts sink to low levels indeed. We will yet have to reorganize the whole employment relationship to find its solution. There is great promise in this field during the past two years, and the progress in this matter is one of the subjects under our inquiry.

Probably the next largest fraction of waste in productivity lies in a too high degree of individualism in certain basic products and tools. In other words, a standardization of certain national utensils makes for economy in distribution, in operation and in repairs. The necessity of maximum production during the war opened a great vista of possibilities in this direction. Such standardization as car couplings, or wheels, and cars generally, represents real progress in this direction. These possibilities lie in a hundred directions. There are all sorts of cases from sizes of chains to the size of automobile wheels. Today dozens of different sizes are placed in the market by manufacturers and entail not only special equipment and skill to produce these many varieties, but also great stocks are required in distribution and losses are entailed due to lack of interchangeability. Standardization does not mean that we stamp the individuality out of manufacture or invention or decoration; it means basic sizes to common and everyday things.

Another type of waste lies in our failure to advance our industrial equipment. The Super-Power Board will demonstrate the saving of 25,000,000 to 50,000,000 tons of coal annually by the electrification of our eastern power supply. The St. Lawrence Waterway Commission will demonstrate the saving of five to ten cents a bushel to the farmers of fifteen states by unlocking the lakes to ocean-going vessels.

Plans for Organizing Port of New York

(*Continued from page 211*)

railroads giving pier-station service; a joint yard and transfer station on this belt line; two parallel but independent tracks of standard gage in a loop in separate tunnels from the yard to Manhattan and back to the yard; a series of multiple-story terminals in Manhattan with car elevators to the surface from underground sidings; a fleet of special electrically operated cars and a fleet of special four-wheel trailer trucks. The tunnels will be far enough below surface so that rapid passenger transite development will not be hindered.

At the joint transfer station in New Jersey (see map) inbound freight will be transferred to trailer trucks, which will be borne by the electrically operated cars, mainly in a eight-car trains, to the Manhattan stations. The trains will be run at uniform rates of speed not exceeding 14 miles per hour, making it safe to move the trains at short intervals. At the stations the cars will be raised to the surface one at a time and their loads exchanged for trailers bearing outbound freight, after which they will be despatched in eight-car trains to the transfer station and unloaded into standard freight cars. The electric cars will move around the loop on either track in one direction only, each loop thus forming an independent line.

Figures prepared by the Commission show terminal costs of \$1.82 per ton with this scheme as compared to \$2.25 per ton with the present car float-pier station system and compared with \$3.50 for standard-equipment elevated or underground systems.

The automatic-electric system is a radical device for port development, although it has been tried on a smaller scale by the London Post Office. The proposed scheme with its deep-laid tunnels has the advantage of being cheap to operate, is not affected by weather conditions, and removes trucking congestion in the already overcrowded streets of Manhattan.

CLOTHS FOR MECHANICAL USES

(*Continued from page 180*)

2 Machine leaders for:

Back filling	Drying	Shearing
Brushing	Felt hardening	Singeing
Calendering	Ironing	Sprinkling
Crabbing	Pressing	Starching
Dewing	Sanding	Water mangling

e Jackets. (Woolen):
Fulling-mill rolls
Gig rolls.

f Jute Cloth:

Aprons on take-up rolls	Leader on felt hardeners
Aprons on loom beams	

g Laminated Cloth. (Cotton):

Check straps	Lug straps
Gears	Pickers
Harness straps	

h Printing. (Cotton, linen and wool):
See general head Printing

i Sheets. (Cotton or wool):

Extractor linings	Fulling-mill linings

j Steaming Blankets:
Wool

k Tapes and Webbing. (Cotton and asbestos):

Apperly feed bands	Harness straps	Slubbers
Can drier leaders	Mules	Spinning frames
Condensers	Machine belts	Spoolers
Doublers	Reducers	Twisters
Finishers	Roving frames	Winders

Asbestos. Asbestos cloth is such an unusual product, so unlike any other cloth that it is advisable to take it up separately. The two main fundamental differences in its use are, first, its heat- and flame-resisting qualities; and second, its neutrality to the actions of acids and alkalis. For these two reasons it can be used in places where no other fabric can. The cloth is usually of heavy yarns and a plain weave, varying in closeness of mesh and thickness as the purpose requires.

The great bulk of this cloth goes into steam packing. It is invaluable in this respect. In this is included gaskets and cut washers. The next largest amount goes into brake linings of all kinds, principally automobile. These may be entirely asbestos or wire warp with asbestos filling. Clutch facings come next in volume.

Filter cloths of various degrees of openness and thickness are used, mostly in chemical plants. Wire backings may be used in this work. This type of filter cloth is also used in making such gases as oxygen and hydrogen, and in such plants where refuse or sewerage has to be disposed of. The cloth is easily cleaned by subjecting to fire.

In the electrical industry asbestos cloth is used mostly in webbing or tape form in the manufacture of armatures, etc., and greatly in wire and cable manufacture. Tubing of this material is used also in cable manufacture and gives excellent protection.

For fire doors, heat screens, and curtains a heavy fabric is used, either plain or with a wire warp. Theater curtains are of this type. Iron and steel mills use this cloth around furnaces, etc. Light asbestos cloth is used to wrap asbestos or magnesia packing, but in general heavy cotton sheeting or light duck is best for this purpose.

The making of asbestos board, wall board, linings, shingles, etc., is practically dependent on a textile product, an endless woolen blanket a form of papermakers' felt. The sheet of asbestos is formed on this woolen blanket or felt, the stock being carried through press rolls and finally delivered in a formed but moist sheet to driers. This blanket is made of heavy woolen yarns about one-quarter to one-eighth run, twisted two, three or four strands together. It is a plain weave cloth, about six warps threads and six picks fulled heavily and lightly napped on one side to enable a new felt to easily start the stock. As to the exact workings of this endless woolen blanket or felt, see the paragraphs on Paper Industry, the principle being the same.

It will be found that in what has gone before there are a number of repetitions due to the unavoidable use of conflicting headings. The author by no means considers that every mechanical use is covered by the paper, but he does feel that it gives an idea of the tremendous use of cloth for mechanical uses and its importance in machine design, construction and operation.

THE ENGINEERING INDEX

(Reg. U. S. Pat. Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with item dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

100,000 r.p.m. Grinding-Wheel Spindle Operated at an Unusual Speed. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, p. 420, 2 figs. Spindle manufactured by A. A. Jones & Shipman Co., Ltd., Leicester, England, and designed to be operated at speed of 104,000 r.p.m. Drive is through intermediate shaft and special rubber belts are used. Spindle, which is in experimental stage, was shown at machine-tool exhibition recently held in London.

ACCIDENT PREVENTION

Foundry. Safe Shoes Reduce Hot-Metal Burns. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 51–53, 5 figs. One-sixth of total foundry accidents are ascribed to defective and unsafe foot-wear. Foot injuries are reduced by proper shoes.

ACCIDENTS

Dust Explosions. A Dust Explosion During the Handling of Cottonseed Meal, David J. Price. Am. Fertilizer, vol. 54, No. 1, Jan. 1, 1921, pp. 53–57, 5 figs. Account of dust explosion which occurred during handling and elevating of cottonseed meal.

Causes and Prevention of Dust Explosions. Colliery Guardian, vol. 120, no. 3128, Dec. 10, 1920, pp. 1677–1678, 1 fig. Account of German experiments. Translated from Zeitschrift für Berg-, Hütten- und Salinenwesen.

Engineering Problems in Dust Explosion Prevention, David J. Price. Chem. & Metallurgical Eng., vol. 24, No. 1, Jan. 5, 1921, pp. 29–32, 5 figs. Notes on causes and factors effecting dust explosions. Types of industrial plants affected. Ignition temperatures, propagation and velocity of flame, pressures developed and relation of humidity and prevention of explosions.

The Prevention of Dust Explosions, Hylton R. Brown. Am. Industries, vol. 21, no. 6, Jan. 1921, pp. 27–29, 2 figs. Tests at Bureau of Chemistry, U. S. Dept. of Agriculture.

Eye Injuries. Factory Eye Room Saves Workers' Sight and Increases Output, Sanford DeHart. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 23–24, 1 fig. Experience of R. K. LeBlond Machine Tool Co.

The Economic Aspect of Eye Injuries, T. Lister Llewellyn. Colliery Guardian, vol. 120, no. 3129, Dec. 17, 1920, p. 1749. Analysis of total accident claims made at a number of British coal and iron mines.

AERONAUTICAL INSTRUMENTS

Control Compass. A Remote Control Compass, Alfred Gradenwitz. Aviation, vol. 10, no. 1, Jan. 3, 1921, pp. 19–20, 7 figs. Bamberg remote control compass.

Route Indicator. Route Indicator (Le correcteur de route), M. Le Prieur. Aéronautique, vol. 2, no. 18, Nov.-Dec. 1920, pp. 227–232, 23 figs. Also Aérophile, vol. 28, no. 22–23, Nov. 1–15, 1920, pp. 326–332, 17 figs. Description of derivograph, an apparatus which indicates direction, corrected for wind, to follow in order to reach a certain place by flight in a straight line.

Turn Indiactor. Instruments for the Navigation of Aircraft, G. M. B. Dobson. Nature (Lond.), vol. 106, no. 2668, Dec. 16, 1920, pp. 504–506, 4 figs. Gyro turn indicator, gyro rudder control, pneumatic air log and bubble sextant.

AERONAUTICS

Flying Fish, Flight of. The Aeronautics of the Flying Fish, R. E. Dowd. Aerial Age, vol. 12, no. 18, Jan. 10, 1921, pp. 464–465, 4 figs. Study of forces acting. Mechanism of flight.

AEROPLANE ENGINES

Design. Some Possible Lines of Development in Aircraft Engines. H. R. Ricardo. Flight, vol. 12, no. 53, Dec. 30, 1920, pp. 1311–1316, 20 figs. Raising compression, proportioning mixture, and limiting size of cylinder. (Abstract.) Paper read before Royal Aeronautical Soc.

Engine Clearance Volumes. Instrument for Measuring Engine Clearance Volumes, S. W. Sparrow. Aerial Age, vol. 12, no. 16, Dec. 27, 1920, pp. 419–420, 6 figs. Apparatus designed and constructed under direction of Automotive Power Plants Section, Bureau of Standards.

Fuel. See GASOLINE, Hecter Fuel.

Hall-Scott. Building Motors on the Pacific Coast, Fred H. Colvin. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1215–1220, 29 figs., and vol. 54, no. 2, Jan. 13, 1921, pp. 46–47, 11 figs. Dec. 30: Machining of crankcases for both aircraft and marine types of motors. Jan. 13: Method of facing inside of aluminum-alloy piston.

Starting Torque. Starting Torque on Liberty, Hispano-Suiza, and Other Aviation Engines. Air Service Information Circular, vol. 2, no. 126, Nov. 6, 1920, 3 pp. Starting torque required for Liberty engine of 400-hp. rating and with 12 cylinders was 124 lb-ft. with throttle open and 143 with throttle closed; for Hispano-Suiza of 300 hp. with 8 cylinders, these figures were respectively 102 and 96.

AEROPLANE PROPELLERS

Design. The Metal Airscrew, M. A. S. Riach. Aeronautics, vol. 19, no. 375, Dec. 23, 1920, pp. 450 and 459, 2 figs. Metal versus wood for aeroplane propellers.

Gear Drive. Experience with Geared Propeller Drives for Aviation Engines, K. Kutzbach. Aerial Age, vol. 12, nos. 17 and 18, Jan. 3 and 10, 1921, pp. 442–445, 9 figs., and 466–469, 18 figs. Stresses in gear wheels; table of gears from captured engines; arrangements of gear. Translated from Technische Berichte.

AEROPLANES

Design. Aeroplane Design, F. S. Barnwell. Aeronautics, vol. 19, no. 376, Dec. 30, 1920, pp. 466–467, 1 fig. Present tendencies and future possibilities. (To be continued.)

Structural Analysis and Design of Aeroplanes, B. C. Boulton and A. S. Niles. Aerial Age, vol. 12, no 18, Jan. 10, 1921, pp. 469–470. Review of book by B. C. Boulton in charge of stress analysis and structural design, McCook Field.

Farman. Recent Farman Types of Aeroplanes (Die neueren Farman-Flugzeuge), Luftfahrt, vol. 24, no. 10, Oct. 7, 1920, pp. 145–147, 3 figs. Details of various Farman types which are then compared to corresponding German types, including the Dornier, Junkers, Sablatnig and Fokker, showing, in writer's opinion, the greater advance made in aeroplane construction in Germany during last six years.

Gastambide-Levavasseur. Aeroplanes in Which the Three Elements, Surface, Curvature and Incidents are Variable (L'avion a surface, courbure et incidence variables), Georges Blanchet. Aérophile, vol. 28, no. 22–23, Nov. 1–15, 1920, pp. 321–325, 4 figs. Description of Gastambide-Levavasseur machine.

Helicopters. See HELICOPTERS.

Large, Possibilities of. The Possibilities of the Large Airplane, F. H. Norton. Aviation, vol. 10, no. 2, Jan. 10, 1921, pp. 48–50, 10 figs. Structural and aerodynamic problems of large aeroplane.

Longitudinal Stability. Statical Longitudinal Stability of Airplanes, Edward P. Warner. Nat. Advisory Committee for Aeronautics, report no. 96, 1920, 28 pp., 14 figs. Results of experimental work, together with details of theoretical analysis of statical stability, of factors which affect it, and of methods which can be employed for its modification.

Model Tests. Value of Model Tests, J. W. Margoulis. Aviation, vol. 10, no. 2, Jan. 10, 1921, pp. 40–42, 1 fig. Influence of ratio of dimensions of model and speed of test to dimensions of full scale machine and its speed of flight.

Single-vs.-Twin-Engined. A Comparison of the Flying Qualities of Single and Twin-Engined Aeroplanes. Aeronautical Jl., vol. 24, no. 120, Dec. 1920, pp. 616–627. Factors in design which are most vital to pilot and how they influence his handling of aeroplane.

Stability. Diagrams of Airplane Stability. H. Bateman. Nat. Advisory Committee for Aeronautics, report no. 95, 1920, 25 pp., 28 figs. Effect on period and rate of subsidence of pitching oscillations of an airplane of a change in one of resistance derivatives when all others are kept constant.

Wind Tunnels. See WIND TUNNELS.

Wings. Slotted Airplane Wings. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 66–67, 2 figs. Handley Page wings of Venetian blind form.

The Handley-Page Wing (L'aile Handley-Page) E.-H. Lemonon. Aérophile, vol. 28, no. 22–23, Nov. 1–15, 1920, pp. 333–334, 9 figs. Wing is made up of separate elements which separate or come together like Venetian blind.

AIR

Dust-Content Determination. Efficiency of the Palmer Apparatus for Determining Dust in Air, S. H. Katz, E. S. Longfellow and A. C. Fieldner. Jl. Am. Soc. Heat. and Vent. Engrs., vol. 26, no. 8, Nov. 1920, pp. 687–700, 5 figs. Two methods of testing were used. In first efficiency was determined on basis of surface of particles entering apparatus as compared with surface leaving, by use of Tyndall effect. Second method was based on weight of dust, and used small laboratory Cottrell precipitator in series with Palmer washer.

AIR COMPRESSORS

Centrifugal. The General Behavior of the Centrifugal Compressor (Das allgemeine Verhalten der

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Kreiselverdichter), Gustav Flügel. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 49, Dec. 4, 1920, pp. 1027–1032, 4 figs. Under presumption of unchangeable air temperature the compression phenomenon with the multi-stage centrifugal compressor for any working conditions is investigated, first according to a very accurate method and then according to a simple approximate method. It is shown that the equations derived define the variable air temperature with the same accuracy, providing the mean temperature is calculated.

Heat Utilization. The Economic Utilization of the Compression Heat in Large Compressors (Die wirtschaftliche Ausnutzung der Kompressionswärme in grösseren Verdichtern), Erich Lampel. Fördertechnik u. Frachtverkehr, vol. 13, no. 21, Oct. 15, 1920, pp. 193–195, 2 figs. Heat resulting from compression said to be a drawback. Utilization of latent heat according to method heretofore used of introducing cooling water is claimed to be impossible, and a new arrangement is described for admission of cooling water and intermediate cooling, resulting in considerable reduction of volume of water and increase in temperature drop. Its useful possibilities are set forth.

High-Pressure. High-Pressure Air and Gas Compressors. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 829–831, 3 figs. Six-Stage 4500-lb. per sq. in. compressor built to order of British admiralty for naval experimental station described in second installment.

Steam-Driven High-Pressure Four-Stage Gas Compressor. Eng., vol. 110, no. 2868, Dec. 17, 1920, pp. 800–802, 12 figs., partly on supp. plate. Two types, one compressing to 2250 lb. in four stages and other to 4500 lb. in six stages. Former type is described in first installment. (To be continued.)

Manufacture. Building Air Compressors. Eng. Production, vol. 2, no. 14, Jan. 6, 1921, pp. 7–12, 14 figs. Manufacturing methods in plant of Reavell & Co., Ipswich, England.

AIR CONDITIONING

Humidifier. Physiological Heat Regulation and the Problem of Humidity, E. P. Lyon. Jl. Am. Soc. Heat. and Vent. Engrs., vol. 26, no. 8, Nov. 1920, pp. 677–685. Importance of using humidifier in connection with heating system in houses and factories.

AIR SERVICE, UNITED STATES

United Force. United Air Force - Pro and Con. Aviation, vol. 9, no. 15, Dec. 27, 1920, pp. 480–482. Survey of reasons which reflect position of many Naval officers for united service and reasons of many Army officers who favor separate department.

AIRSHIPS

Mooring. Airship Mooring and Handling. F. L. C. Butcher. Aeronautics, vol. 19, no. 374, Dec. 16, 1920, pp. 432–435. Advantages and disadvantages of windscreens. Experiments with drogues. Paper read before Royal Aeronautical Soc.

Piloting. Airship Piloting. G. H. Scott. Flight, vol. 12, no. 50, Dec. 9, 1920, pp. 1254 1258. Difficulties encountered in airship piloting and methods employed to overcome these difficulties. Paper read before Royal Aeronautical Society.

Rigid. Operation of a Rigid Airship, L. H. Maxfield. Aviation, vol. 10, no. 1, Jan. 3, 1921, pp. 15–16. Duties of airship crew.

ALCOHOL

See AUTOMOBILE FUELS, Alcohol.

ALUMINUM

Castings. Analyze Loss in Aluminum Shops—II, Robert J. Anderson. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 16–21. Effect on casting losses of stock used in melting charge and also of pouring temperature and melting practice, including type of furnace used.

Density. Density of Aluminum from 20 to 1000 Deg. Cent., Junius David Edwards and T. A. Moormann. Chem. & Metallurgical Eng., vol. 24, no. 2, Jan. 12, 1921, pp. 61–64, 3 figs. Experimental methods for measuring with precision density of liquid metals, and figures for results when applied to pure aluminum. Derived data of importance are solid shrinkage, or pattern allowance, and solidification shrinkage.

Soldering of. The Practicability of Soldering Aluminum, A. N. Fleming. Sheet Metal Worker, vol. 11, no. 15, Dec. 24, 1920, pp. 427 and 433, 1 fig. How aluminum transmission case was repaired by soldering.

ALUMINUM ALLOYS

Magnesium. The Constitution of the Alloys of Aluminium and Magnesium, D. Hanson and Marie L. V. Gayler. Eng., vol. 110, nos. 2867–2868, Dec. 10–17, 1920, pp. 788–791 and 17 figs., 819–821, 18 figs. Research carried out in Metallurgy Department of National Physical Laboratory, England. Determination of solidus. Photomicrographs. Abstract of paper read before Inst. Metals.

AMMONIA

Properties. Properties of Ammonia. Refrigerating World, vol. 55, no. 12, Dec 1920, pp. 21–28. Tables prepared by National Bureau of Standards with coöperation of American Society of Refrigerating Engineers.

AMMONIA COMPRESSORS

Development. The development of the Modern High Efficiency Ammonia Compressor Through the Application of the Worthington Feather Valve, Thos. D. McKee. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 13–15. Advantages of high speed ammonia compressors.

APPRENTICES, TRAINING OF

Machinists. Training Operators in a Machine Shop, John C. Spence. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 421–423, 2 figs. Methods employed in plant of Norton Co., Worcester, Mass., in training of machine-shop workers.

Work of the German Committee for Technical Instruction in the Training of Apprentices in the Metal Industry (Die Arbeiten des Deutschen Ausschusses für Technisches Schulwesen auf dem Gebiete der Lehrlingsausbildung in der Metallindustrie), A. Heilandt. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 13–20, 15 figs. Work already completed: Course for training of apprentices for machine construction; curriculum for schoolroom instruction of apprentices for machine construction; workshop textbook.

Training the Machinist of the Future, J. H. Moore. Can. Machy., vol. 25, no. 2, Jan. 13, 1921, pp. 33–38, 12 figs. Organization and operation of Hamilton Technical & Art School.

Railroad Shop. A Railroad Shop's Apprentice School, J. V. Hunter. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 97–98, 1 fig. Training school in Decatur locomotive and car shops of Wabash Railway Co. Current expenses defrayed by assessing apprentices. Regular and helper courses given.

Systems. Programs of Apprenticeship and Special Training in Representative Corporations—VIII, J. V. L. Morris. Am. Mach., vol. 54, no. 1, Jan. 6, 1921, pp. 13–14, 4 figs. System at plant of United Shoe Machinery Co., Beverly, Mass. Boys attend school and shop on alternate weeks and school work is given in coöperation with public-school system.

ASH HANDLING

Pneumatic Plants. Pneumatic Ash-Removal Installations in Heating Plants (Pneumatische Entaschungsanlagen in Heizwerken), W. Uhlig. Elektrotechnische Rundschau, vol. 37, nos. 16 and 17, Aug. 21 and Sept. 7, 1920, pp. 73–75 and 79–81, 6 figs. It is claimed that in spite of fact that power consumption of installations with impeller exhausters is generally high as compared to those with piston pumps, they have great advantages including lack of sensitivity to smoke and hot gases.

AUTOGENOUS WELDING

Cylinder Repair Work. Cylinder Repair Work, Wabash Shops, Decatur, Illinois, J. G. Cunningham. Autogenous Welding, Jan. 1921, pp. 36–38, 8 figs. Examples of repairs made at Wabash Railroad shops.

AUTOMOBILE ENGINES

Carburetors. See CARBURETORS.

Connecting Rods. Making Connecting-Rods for Franklin Cars, Franklin D. Jones. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 470–474, 11 figs. Machines and fixtures used at plant of H. H. Franklin Mfg. Co., Syracuse, N. Y., for drilling, boring, milling, grinding, reaming and gaging operations.

Cylinders. See CYLINDERS, Manufacture.

Design. Possible Fuel Savings in Automotive Engines, H. C. Dickinson and S. W. Sparrow. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 3–9, 14 figs. Notes on design of manifold and chemical operation of automotive engines. Paper read before Am. Petroleum Inst.

Gasoline Losses. Gasoline Losses Due to Incomplete Combustion in Motor Vehicles, A. C. Fieldner. A. A. Straub and G. W. Jones. Jl. Indus. & Eng. Chem., vol 13, no. 1. Jan. 1921, pp. 51–58, 7 figs. Results of tests under spring and summer conditions.

Horsepower Formulas. A Compilation of the Horsepower Formulas for Different Countries (Zusammenstellung der Steuerformeln für verschiedene Länder), Richard Bussien. Motorwagen, vol. 23, no. 28, Oct. 10, 1920, p. 527. Gives German, Belgian, French, English, Swedish. Italian, Japanese, Spanish, Hungarian and Californian formulas.

New York Show. Engines Exhibited at New York Show, P. M. Heldt. Automotive Industries, vol. 44, no. 2, Jan. 13, 1921, pp. 53–58, 15 figs. Survey of exhibits.

Suspension. A New Principle of Engine Suspension, S. E. Slocum. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 54–56, 1 fig. Suspension on three points so as to destroy synchronism between oscillating machine and support so far as transmission of vibrations is concerned.

AUTOMOBILE FUELS

Alcohol. Significance of Alcohol in the Motor Fuel Problem, Burnell R. Tunison. Automotive Industries, vol. 44, no. 1, Jan. 6, 1921, pp. 14–17, 5 figs. Advantages of and need for using synthetic fuel containing alcohol. Data regarding performance of engines using alcohol.

Benzol. The Manufacture of Motor Spirit in Gasworks. Gas World, vol. 73, no. 1900, Dec. 18, 1920, pp. 493–494. Stripping process of benzol recovery and its financial results.

Gasoline. See GASOLINE.

Palm Oil. Belgian Experiments on Palm Oil as Motor Fuel. Commerce Reports, no. 1, Jan. 3, 1921, pp. 10–11. Series of experiments begun 1914, but interrupted by war, has recently been resumed in Brussels on use of palm oil in internal-combustion motors. Tests have so far proven satisfactory.

AUTOMOBILES

Body Design. American and British Bodywork at Olympia Compared, M. W. Bourdon. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1256–1261, 12 figs. American bodies said to lack finish and comfort as compared to British product selling in England at same price. British cars generally have lower seats but thicker cushions tilted toward rear and greater freeboard.

Body Suspension. Study of Suspension on Automobile Bodies and of Shock Absorbers (Étude sur la suspension des véhicules et les amortisseurs), G. Puica. Vie Technique & Industrielle, vol. 2, no. 14, Nov. 1920, pp. 117–120, 4 figs. Formula for designing springs. Study of stresses in spring plates.

The Mutti Suspension. Autocar, vol. 46, no. 1315, Jan. 1, 1921, p. 8, 2 figs. Design employing variable-tension coil spring. It has been tested with trailer and is suggested as substitute for ordinary car suspension.

Brakes on Four Wheels. Another French Car Using Brakes on Four Wheels, W. F. Bradley. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1266–1268, 7 figs. Darracq now getting into production on eight-cylinder car, which has been modified since exhibit at Paris Salon a year ago. Engine has removable heads and uses battery ignition. Four-speed transmission and spiral-bevel final drive employed. Right-hand drive retained.

Design. European Automobile Design for 1921. Sci. Am., vol. 124, no. 1, Jan. 1, 1921, pp. 9 and 19–20. Comparison of European and American Practices.

Friction Drive. Friction Drive Revived in New Kelsey Six-Cylinder Car. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, pp. 1204–1206, 3 figs. Friction disk and wheel are located within rear axle housing, which is of aluminum alloy and is said to be lighter than standard type. Jackshaft carries helical pinion meshing with internal gear on wheel hub, giving 4.5 to 1 reduction. Wheelbase is 116 in. Engine $3^1/_8$ x $4^1/_4$ in. Falls.

Headlights. Report of the Committee on Automobile Headlighting Specifications. Trans. Illuminating Eng. Soc., vol. 15, no. 9, Dec. 30, 1920, pp. 848–866. Recommended practice in headlamp illumination.

Manufacture. More Power for Automobile Building. Power Plant Eng., vol. 25, no. 2, Jan. 15, 1921, pp. 101–110, 17 figs. New plant of Cadillac Motor Car Co., Detroit, Mich.

Metal Construction. Substitute Metals in Automobile Construction. Benno R. Dierfeld. Automotive Industries, vol. 43, no. 27, Dec. 30, 1920, p. 1309. How copper and aluminum were substituted for iron and steel in Germany during war.

Rear-Axle Housings. Machining Columbia Rear-Axle Housings. Fred H. Colvin. Am. Mach., vol. 54, no. 1, Jan. 6, 1921, pp. 27–30, 15 figs. Operations on drilling, boring, reaming, tapping machines. Press work assembling and testing.

Sheet Metal Work. Sheet Metal Work for Automobiles, Fred H. Colvin. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1165–1168, 16 figs. Machinery for stamping and cutting up strips into various lengths and also preparing material for presses.

Transmissions. Clutches, Transmissions and Universal Joints, Herbert Chase. Automotive Industries, vol. 44, no. 2, Jan. 13, 1921, pp. 79–81, 4 figs. Trend of design as revealed at New York Show.

Wheels, Steel-Disk. The Harvey Steel Disk Wheel. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, p. 1206, 2 figs. Design in which attempt has been made to reduce or eliminate rigidity characteristic of metal wheels.

AVIATION

Commercial. Commercial Aircraft, B. W. Townshend. Aeronautics, vol. 19, no. 373, Dec. 9, 1920, pp. 421–423, 1 fig. Position of airships and aeroplanes in future of aerial transport. Paper read before City and Guilds Engineering Society.

Commercial Aviation in Great Britain (La navigation commerciale aérienne en Grande-Bretagne) T. Génie Civil, vol. 77, no. 23, Dec. 4, 1920, pp. 456–460, 1 fig. Models submitted for air ministry competition held in September 1920. (To be continued.)

Developments. Recent Advances in Aviation, Thurman H. Bane. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 18–25, 26 figs. Aeroplanes and aeroplane engines developed during war.

Nationality Marks. International Aircraft Marking, Ladislas d'Orey. Aviation, vol. 9, no. 15, Dec. 27, 1920, pp. 484–486, 3 figs. Nationality and registration marks for aircraft. Proposed table of nationality marks.

Night Flying. Night Flying. Aeronautical Jl., vol. 24, no. 120, Dec. 1920, pp. 627–642 and (discussion) pp. 643–649. Experience during war. Best type of machine for night flying.

[See also FLIGHT.]

AVIATORS

Fatigue of. The Human Machine in Relation to Flying. Aeronautical Jl., vol. 24, no. 120, Dec. 1920, pp. 650–658 and (discussion) pp. 658–663. Reasons why pilots should have periodic intervals of rest. International convention fixed period of six months for civilian pilot.

Tests of. Observation, Selection, and Assignment. Air Service Information Circular, vol. 2, no, 120, Oct. 30, 1920, 8 pp. Qualities needed by aviators. Process of selecting from application.

Eng., vol. 110, no. 2866, Dec. 3, 1920, pp. 737–738, 2 figs. Machine devised by N. W. Akimoff for testing both static and dynamic balance of high-speed rotors.

BALLOONS

Sunlight, Effect of. Solar Radiation and Balloons, Junius David Edwards and Maurice Blaine Long. Aviation, vol. 9, no. 15, Dec. 27, 1920, pp. 487–490, 4 figs. Investigations at Bureau of Standards of effect of sunlight upon life and operating characteristics of lighter-than-air craft.

BEAMS

Vibrations from Shafting. See SHAFTS, Whirling Speeds.

BEARINGS

Manufacture. Modern Bearings (Les paliers modernes). Nature (Paris), no. 2428, Oct. 16, 1920, pp. 243–246, 2 figs. Developments in manufacture, with reference to type developed by Brown Boveri Co.

Self-Lubricating. Self-Lubricating Bearings. Iron Age, vol. 107, no. 2, Jan. 13, 1921, p. 146. Reliance type consisting of inner and outer casings joined by force fit. Tapered holes in inner casing are filled with lubricating mixture under pressure.

Testing. Testing Hardness of Bearings and Journal. Iron Age, vol. 106, no. 27, Dec. 30, 1920, pp. 1727–1730, 16 figs. Progress report of subcommittee on bearing metals of The American Society of Mechanical Engineers. Description of tentative scale of so-called microhardness that expresses in definite units relation of hardness between different materials.

BELTING

Balata. The Manufacture of Balata Belting. India Rubber World, vol. 63, no. 4, Jan. 1, 1921, pp. 236–238, 16 figs. Translated from Le Caoutchouc et la Gutta Percha.

Leather. A New Type of Leather Belt. Eng., vol. 130, no. 3389, Dec. 10, 1920, pp. 590, 2 figs. Patented by French inventor. Belt consists of backing 3 in. by 1/4 in. oak-tanned leather to underside of which are riveted three stips of chrome leather, each strip being about 3/16 in. wide by 3/32 in. thick. Attachment of strips to backing is effected by means of brass rivets pitched at 2 in. intervals.

Effect of Relative Humidity on Leather Belting, F. W. Roys. Belting, vol. 18, no. 1, Jan. 1921, pp. 40–48, 9 figs. Also Textile World Jl., vol. 59, no. 2, Jan. 8, 1921, pp. 93–97, 9 figs. Tests at Worcester Polytechnic Institute. With adjustments of regular oak belts at 55 per cent humidity, no change was found to either tighten or slacken belt so as to cause trouble.

BLAST-FURNACE GAS

Purification. Purification of Blast Furnace Gas (État actuel de l'épuration des gaz de hauts-fourneaux), M. Alexandre Gouvy. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 677–686, 7 figs. Dscription of Cottrell process using electricity at high tension.

BLAST FURNACES

Coke Efficiency. Blast Furnace Problems of To-day. C. E. Roberts. Eng. & Indus. Management, vol. 5, no. 1, Jan. 6, 1921, pp. 7–10. Coke efficiency, increase in moisture content, dust difficulty, scientific control of furnace working. Paper read before Staffordshire Iron & Steel Inst.

Operation, Chile. Green Wood in the Blast Furnace, François Prudhomme. Iron Age, vol. 107, no. 2, Jan. 13, 1921, pp. 121–122. Making pig iron of tofo ores at Corral, Chile. Wood charred in upper part of furnace and distillates recovered. Chilean Government report.

Reducing Reactions. Reducing Reactions in the Blast Furnace (Des réactions réductrices dans le haut fourneau), Em. Pierre. Revue universelle des mines, vol. 7, no. 5, Dec. 1, 1920, pp. 301–321, 5 figs. Researches showed that reaction by CO is best for reducing FeO. Studies of action of gas on minerals.

Slags. Sampling Blast Furnace Slags, W. M. Chegwidden. Iron Trade Rev., vol. 67, no. 26, Dec. 23, 1920, pp. 1750–1751. Relation of sulphur in slag to sulphur in pig iron.

BOILER FEEDWATER

Heating, Economic Advantages of. Exhaust Wastes. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 72–74, 2 figs. Chart showing percentage of fuel saved by heating feedwater by exhaust steam.

BOILER FURNACES

See FURNACES, Boiler.

BOILER ROOMS

Design. Design of Large Boiler Plants, J. Grady Rollow. Jl. Am. Soc. Heat. and Vent. Engrs., vol. 26, no. 8, Nov. 1920, pp. 715–734, 10 figs. Typical double-wall boiler plant with furnace for burning coal and dry wood waste.

Economical Operation. Reducing Operating Costs in Boiler Rooms, John Rusen. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 14–18, 8 figs. Advises mechanical conveying for coal and ashes will materially reduce costs.

Remodeling. Remodeling Old Power Stations—Boiler-Plant Improvements, L. R. Lee. Power, vol. 106, no. 26, Dec. 23, 1920, p. 1670. 2 figs. Swedish device for removing soot and scale from stationary boiler tubes.

BOILERS

Cast-Iron vs. Wrought-Iron. Cast Iron versus Wrought Iron (Gusseisen oder Schmiedeeisen?), Otto Ginsberg. Gesundheits-Ingenieur, vol. 43, no. 41, Oct. 9, 1920, pp. 479–487. Contribution to the boiler problem in central heating plants. It is concluded that in case of careful manipulation of boiler, cast iron is superior to wrought iron for small and medium-size plants, but for very large plants the wrought-iron boiler is preferable.

Electrically Heated. Bergeon-Frédet Electrically Heated Steam Boiler (Le générateur de vapeur "Bergeon-Fredet" à chauffage électrique). Chaleur et Industrie, no. 7, Oct. 1920, pp. 403–405, 3 figs. Horizontal cylindrical type boiler heated by three-phase current of 50 periods under tension of 6300 volts.

Electrically Heated Boilers. Elec. Times, vol. 58, no. 1523, Dec. 23, 1920, p. 491, 2 figs. Boilers manufactured by Sulzer Bros., London.

Manhole Cutting. Ellipsograph for Manhole Cutting. Eng., vol. 110, no. 2868, Dec. 17, 1920, p. 817, 3 figs. Patented device.

Marine. See MARINE BOILERS.

Massachusetts Board Boiler Rules. Changes in Massachusetts Boiler Rules. Power Plant Eng., vol. 25, no. 2, Jan. 15, 1921, pp. 121–122. Changes adopted at public hearing held by Board of Boiler Rules.

Performance. Exact Data on the Performance of Steam Boiler Plants—IV, David Brownlie. Eng., vol. 110, nos. 2867–2868, Dec. 10–17, 1920, pp. 759–761 and 797–799. Average figures for performance of a number of different types of steam boiders.

Tubes. Influence of Expanding of Tubes on the Deformation of Tube Sheets of Locomotive Boilers (Influence du sertissage des tubes dans les déformations des plaques tubulaires de foyer des chaudieres locomotives), M. Haffner. Revue generale des Chemins de Fer, vol. 39, no. 4, Oct. 1920, pp. 133–138, 5 figs. Comparison of various methods of expanding.

BOILERS, WATER-TUBE

Connelly. Connelly Water-Tube Boilers. Can. Manufacturer, vol. 41, no. 1, Jan. 1921, pp. 76–77, 2 figs. Boilers of large capacity built for working pressure of 300 tons per sq. in.

BORING MACHINES

Horizontal. Rockford Heavy-Duty Horizontal Boring Machine. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1197–1198, 2 figs. Machine intended chiefly for work encountered in automotive field.

Taper-Turning Head. New Taper-Turning Head for Vertical Boring Mills. Engr., vol. 130, no. 3385, Nov. 12, 1920, p. 485, 5 figs. Attachment manufactured by George Richards & Co., Ltd., Broadheath, England.

BRAKES

Street-Car. A New Tramcar Brake. Engr., vol. 130, no. 3391, Dec. 24, 1920, pp. 642–643, 4 figs. Spencer-Dawson brake.

The Force Action of Brake Riggings, H. M. P. Murphy. Elec. Ry. Jl., vol. 57, no. 3, Jan. 15, 1921, pp. 116–119, 11 figs. Forms of levers used in brake rigging of electric cars. Study of forces acting at various points of levers.

BUSES

Trolley-Operated. Trackless Trolley in Two British Cities. Elec. Ry. Jl., vol. 57, no. 2, Jan. 8, 1921, pp. 77–79, 5 figs. Bradford, with three routes in operation, is planning three more. Buses are used as feeders for trolley system. Double-deck trackless-trolley bus has just been put in service. Keighley, after five years' experience, has added to its equipment, and now has nine buses in service.

C

CABLEWAYS

Design. Didactic Study of Aerial Cableways (Étude didactique des transporteurs aériens sur cables), Giulio Ceretti. Génie Civil, vol. 77, no. 22, Nov. 27, 1920, pp. 430–435, 12 figs. Details of design of cable junctions and suspension methods. (Concluded.)

CANALS

Electric Haulage of Barges. New Systems of Electric Haulage in Canals (Nouveaus systèmes de halage électrique sur les canaux), Édouard Imbeaux. Comptes rendus des Séances de l'Académie des Sciences. vol. 171, no. 21, Nov. 22, 1920, pp. 981–985. Recent developments in France.

CARBURATION

Theory of. Contribution to the Problem of Carburation (Contribution au "sujet" de la carburation), A. Grebel. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 455–473, 15 figs. Technical study of principles upon which carburation is based and of their application to the carburation of gasoline engines and gas engines together with investigation of chemical pacticability of utilizing gas as fuel in automobile engines.

automobile carburetors, the Eureka, Graetzin, Lacharnay, Standard, Einhorn and Asmo carburetors.

Einhorn. The Einhorn Carburetor (Der Einhorn-Vergaser), Johannes Menzel. Allgemeine Automobil-Zeitung, vol. 21, no. 41, Oct. 9, 1920, pp. 26–28, 2 figs. Describes automatically adjustable carburetor for use of heavy fuels of all kinds, which won first prize at tests carried out by Gen. German Automobile Club in conjunction with Automotive Testing Commission.

Floatless. Floatless Carburetors Coming Into Use in Germany, Benno R. Dierfeld. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1262–1265, 11 figs. Developments in carburetor design in Germany.

CARS

Ball Bearings for. Ball Bearings for Railway Cars. Ry. Mech. Engr., vol. 95, no. 1, Jan. 1921, pp. 23–24, 5 figs. Graphs of train resistance with journal bearings and with disk bearings.

Diesel-Electric Self-Propelled. Diesel-Electric Self-Propelled Railway Coaches. Engr., vol. 130. no. P3386, Nov. 19, 1920, p. 511. Swedish design, Translated from Génie Civil.

CASE-HARDENING

Furnace for. A New Method of Case-Hardening Steel, Wm. J. Merten. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1169–1170, 1 fig. Regenerative type of furnace.

CASTINGS

Die. Die Castings, W. Betterton. Metal Industry (London), vol. 17, no. 24, Dec. 10, 1920, pp. 461–464, 8 figs. Manufacture of castings are accurately cast to limit of one-thousandth of an inch so that no machining is necessary. Alloys from which such castings can be made are discussed and advantages of die casting are pointed out.

Inspection. Precise Inspection of Large and Irregular Curves, Elbert O. Brower. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 60–66, 13 figs. Method for inspection of large and irregular curves, and its application to inspection of castings.

Iron. See IRON CASTINGS.

Malleable. Shop Specializes in Annealing Pots. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 11–15, 7 figs. Manufacture of malleable castings on production basis.

Steel. See STEEL CASTINGS.

CEMENT

Natural. Australian Company to Work an Island of Cement Rock. Cement, Mill & Quarry, vol. 18, no. 1, Jan. 5, 1921, pp. 19–22, 5 figs. Concessions for operating deposits of natural cement located on Maria Island on east coast of Tasmania have been secured by National Portland Cement Co.

Setting Time. Modified Vicat Apparatus for Study of Setting Time of Cement, O. L. Moore. Eng. News-Rec., vol. 86, no. 2, Jan. 13, 1921, p. 70, 3 figs. Principle consists in balancing rod and needle by means of beam and weight and determining load necessary at time intervals to cause needle to penetrate definite distance into neat paste.

CEMENT, PORTLAND

Consolidation. Judging the Quality of Portland Cement, R. J. Colony. Min. & Metallurgy, no. 169, Jan. 1921, pp. 30–31, 1 fig. Triangular concentration diagram showing end products of consolidation. (Abstract.)

Specifications. British Standard Specification for Portland Cement. Eng. World, vol. 18, no. 1, Jan. 1921, pp. 5–8, 4 figs. Specifications of British Standards Engineering Association, revised in 1920.

Wet Process. Development in Wet Process Portland Cement Plants—II. Rock Products, vol. 24, no. 2, Jan. 15, 1921, pp. 39–44, 12 figs. Description of process at plant of Bessemer Limestone & Cement Co., Bessemer, Pa., from kilns to finished product.

CENTRAL STATIONS

Isolated Plants vs. Power Development in the Future, Lazarovich-Hrebellianovich. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 744–747. Comparative study of central stations and isolated plants.

Mineside. Modern Central Power Station in Center of a Coal Mining District, F. G. Hickling. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 24–27, 7 figs. Riversville Central Station of Monongahela Valley Traction Co., Fairmont, W. Va. Two 12,500-kva. turbine generator units have been installed and additional 25,000 kva. unit has been ordered.

Operation in U. S. Output for 1920 Estimated at 46,700,000,000 Kw-Hr. Elec. World, vol. 77, no. 1, Jan. 1, 1921, pp. 45–46, 2 figs. Statistics of central station operations in United States.

CHIMNEYS

Steel, Copper-Smelter. Steel Chimneys and Their Linings in Copper Smelting Plants, A. G. McGregor. Min. & Metallurgy, no. 167, Nov. 1920, p. 34. It is concluded from experiments at various plants that unlined steel chimneys do not give satisfactory service when used for roaster furnaces or reverberatory furnaces, but they will prove serviceable for long periods when used for blast furnace and converter gases. Building tile has proved unsatisfactory for chimney linings or for construc-

tion of walls for flues and dust chambers where exposed to roaster furnace gases or cool reverberatory furnace gases. (Abstract.)

COAL

Pulverized. See PULVERIZED COAL.

Utah, Coking Properties. Low-Temperature Coking of Utah Coals, Osborn Monnett. Chem. & Metallurgical Eng., vol. 23, no. 26, Dec. 29, 1920, pp. 1246–1249, 2 figs. Summarized description of laboratory investigations made to determine coking property of series of Utah coals. Analysis of coals tested. Apparatus used. Tabulated results obtained.

COAL HANDLING

Hydraulic Conveyors. Conveying Bulk Material Through Pipes, George Frederick Zimmer. Eng. & Indus. Management, vol. 4, no. 25, Dec. 16, 1920, pp. 791–792, 3 figs. Scheme for handling coal hydraulically.

Power Plants. Fuel Handling. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 2–14, 19 figs. Comparison of various methods of handling fuel economically in power plant.

New Station at Baltimore Has Unique Coal-Handling Method, M. D. Engle. Elec. World, vol. 77, no. 3, Jan. 15, 1921, pp. 133–137, 7 figs. How coal, received by water is handled at Westport Station. Method of load division with holtwood hydroelectric plant. Provision against generator fires and ceiling condensation among other features.

COAL STORAGE

Methods. Coal Storage. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 14–23, 13 figs. Methods of storing coal in piles in the open, and arrangement of conveyors to carry coal to plant.

COAL TIPPLES

Construction. Mine of the Washington Gas Coal Company and Advances in Tipple Construction, J. O. Durkee and Frank A. Dowling. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 11–12 and 74–76, 5 figs. Tipple is arranged to coal locomotives, ship by truck or rail and supply Tyrler Tube Co. located near tipple.

COKE

Blast-Furnace. Determination of the Hardness of Blast-Furnace Coke. Owen R. Rice. Min. & Metallurgy, no. 167, Nov. 1920, pp. 34–35. Soft coke is deprecated for proper blast furnace operation. Methods of measuring coke hardness. (Abstract.)

House Heating with. By-Product Coke, Anthracite, and Pittsburgh Coal as Fuel for Heating Houses, Henry Kreisinger. Jl. Indus. & Eng. Chem., vol. 13, no. 1, Jan. 1921, pp. 31–33, 1 fig. Based on tests made at fuel laboratory of Bureau of Mines, Pittsburgh.

Metal Melting with. Coke and By-Products as Fuels for Metals Meltings, F. W. Sperr, Jr. Min. & Metallurgy, no. 167, Nov. 1920, p. 33. Growth of use of coke-oven tar as metallurgical fuel during past few years. With properly selected coals, modern by-product coke plant will produce straight gas having heating value of 560 B.t.u. per cu. ft. after removal of benzols. (Abstract.)

COKE MANUFACTURE

By-Product. By-Product Coking, F. W. Sperr, Jr., and E. H. Bird. Jl. Indus. & Eng. Chem., vol. 13, no. 1, Jan. 1921, pp. 26–31. Comparison of by-product and beehive ovens.

COKE OVENS

By-Product. By-Product Coke Oven Plants of Yesterday and Today, J. M. Hastings, Jr. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 44–47, 6 figs. Progress of art in 28 years as illustrated by old and new plants of Semet-Solvay Co.

Jones and Laughlin New By-Products Plant. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 47–51, 1 fig. Plant consists of five batteries of 60 ovens each of Koppers crossed regenerative type.

The By-Product Coke Oven Industry, 1920, D. J. Ramsburg. Coal Industry, vol. 4, no. 1, Jan. 1921, p. 52. First large battery of triangular flue type ovens completed and successfully operated during year.

COMBUSTION

CO_2 Recorders. The Unograph—An Automatic Continuous Analyzer without Chemical Absorption (L'"Unographe," analyseur continu et automatique sans absorption chimique), J. Izart. Chaleur et Industrie, no. 7, Oct. 1920, pp. 433–435, 3 figs. Principle and operation of Dommer CO_2 recorder.

CONCRETE, REINFORCED

Bond Resistance. Tests of Bond Resistance Between Concrete and Steel, W. A. Slater, F. E. Richart and G. G. Scofield. Technologic Papers, Bur. of Standards, no. 173, Nov. 1, 1920, 66 pp., 79 figs. Results of three dissimilar investigations which were made by concrete ship section of Emergency Fleet Corporation. One investigation was made to study effect on bond resistance of applications of various anticorrosive coatings on reinforcement; second investigation was made to study length of lap required for effective splicing of reinforcing bars in regions of high tensile stress; third investigation was made to study relative merits of different methods of anchoring ends of stirrups to meet certain conditions which arise in concrete ship construction.

CONDENSERS, STEAM

Naval Uses. Service Experience with Condensers, G. B. Allen. Power, vol. 52, no. 23, Dec. 7, 1920, pp. 914–916, 2 figs. Experience of British Admiralty. (Abstract.) Paper read before Inst. of Metals.

CONTRACTS

Cost-Plus. Cost-Plus Contracts, J. C. Keith. Jl. Eng. Inst. Canada, vol. 4, no. 1, Jan. 1921, pp. 8–11. Explanation of differences between cost-plus and unit-price form of contract, advantages and disadvantages, with examples of contracts on cost-plus basis.

CONVEYORS

Belt. General Types of Belt Conveyors, S. C. DeWitt. Can. Manufacturer, vol. 41, no. 1, Jan. 1921, pp. 62–64, 5 figs. Suitability of various types for different materials.

Factories. Conveyance in Workshop (Werkstättentransporte). Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 37–38. Preliminary program prepared by the Committee for Economic Production dealing with following subjects: Determination of fundamental principles for economical use; establishment of useful sphere of hand and motor conveyors; adaptation of conveyor to its particular useful sphere, etc.

Foundry. Foundry Conveyor Equipment Offers Ideas for Adaptation Elsewhere, Norman G. Shidle. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1274–1277, 9 figs. Methods of handling castings and other materials by means of various types of conveyors in foundry of Hercules Gas Engine Co.

Gravity. The Gravity Conveying System, L. T. Sylvester. Can. Manufacturer, vol. 41, no. 1, Jan. 1921, pp. 70–71, 9 figs. Typical installation.

Installations. A Highly Efficient Conveying Plant (Eine Förderanlage von hoher Wirtschaftlichkeit), G. Schlesinger. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 46, Nov. 13, 1920, pp. 949–953, 21 figs. Details of a mechanical hauling arrangement by means of which loading and unloading work at a drying plant for rifle stocks formerly requiring more than a hundred men can be carried out by two men. Notes on arrangement and manipulation of special cages and description of the drying plant.

COPPER METALLURGY

Smelter Stacks. See CHIMNEYS.

CORES

British Foundry Practice. Core Making Practice In Britain. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 69–71, 9 figs. Cores employed to form exterior as well as interior of castings are recognized as economical factor in reducing cost of molding.

COST ACCOUNTING

Charts. How Graphics Help in Estimating Costs, J. B. Carr. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 41–44, 4 figs. Method is illustrated by applying it to determine cost of Scotch boilers of various styles and sizes.

Making Statistics Talk—II, M. C. Rorty. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 45–50, 13 figs. Exemplifies values and importance of charts in cost accounting.

Comparative Records. Comparative Cost Records as an Aid to Manufacturing Profits, Stephen R. Gordon. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 17–22, 13 figs. How attention to details, such as decreasing waste in cutting cloth in textile mill and irregular stretching in dye house effected savings of more than $16,000 a year.

Overhead Expense. Machine-Hour Rate Method of Distributing Manufacturing Expense, C. Haigh. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 370–372. Comparison of man-rate and machine-hour rate method of considering overhead expense. Paper read before Am. Gear Manufacturers' Assn.

COTTON

Finishing Plants. Power Applications to Cotton-Finishing Plants, Leo Loeb. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 5–8, 7 figs. Generation of power and of steam and applications to driving of process machinery are traced from boilers to motor applications. Charts are presented showing steam consumption and proportion of exhaust steam converted into work and available at exhaust for different types of prime movers. Illustrations of typical drives are included.

CRANES

I-Beam Girders. Properties of Crane Girder Sections, John H. Sawkins. Eng. News-Rec., vol. 86, no. 1, Jan. 6, 1921, p. 13, 2 figs. Table of mechanical properties of I-beam crane girders with lateral stiffening channels.

Long-Span. A New Form of Long-Span Crane. Engr. vol. 130, no. 3391, Dec. 24, 1920, pp. 631–632, 5 figs. General feature is that although crane has overhead girder spanning site of its operations, load is not carried directly by this girder, but by cableway attached to its two ends.

Pontoon. Huge Pontoon Crane. Pacific Mar. Rev., vol. 18, no. 1, Jan. 1921, pp. 30–31, 3 figs. Self-propelled 200-ton pontoon crane built by A. F. Smulders Corp., Holland.

Ship. A 250-Ton Ship Crane for the United States Navy, A. F. Case. Pacific Mar. Rev., vol. 18, no. 1, Jan. 1921, pp. 29–30, 4 figs. Revolving crane to be mounted on hull of U. S. Battleship Kearsarge.

CUTTING TOOLS

Construction. Metal Cutting Tools, A. L. De Leeuw. Am. Mach., vol. 54, no. 1, Jan. 6, 1921, pp. 1–7, 21 figs. Analogy between actions of razor, hatchet and metal cutting tools. Formation of chips. Elementary considerations in construction of simple tools.

Grinding. Grinding Lathe and Planer Tools. Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 418–420, 2 figs. correct angle to use when grinding. Power consumption for different angles and position of lathe tools.

Inserted Cutters. The "Herbert" Patent High Duty Inserted Tooth Face Cutter. Practical Engr., vol. 62, no. 1766, Dec. 30, 1920, pp. 420–422, 5 figs. Invention is applicable to milling cutters, boring bars and generally wherever body of tool may be made of softer steel than that of tooth.

Screw Threads. Spring Tool for Cutting Threads. Iron Age, vol. 107, no. 3, Jan. 20, 1921, p. 208, 1 fig. Tool utilizes goose-neck principle to eliminate chatter and permit cutting of smooth threads on lathe work.

CYLINDERS

Castings. Make Marine Cylinders in New Shop, Herbert R. Simonds. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 1–4, 7 figs. Making of castings at Boston Navy Yard.

Manufacture. Cylinder Blocks Manufactured in an Efficient Manner, J. Edward Schipper. Automotive Industries, vol. 44, no. 2, Jan. 13, 1921, pp. 72–77, 14 figs. Manufacturing process used in machining cylinder block castings for Lexington car.

D

DIES

Compound. Compound Blanking, Forming and Piercing Die, F. H. LeJeune. Machy. (N. Y.), vol. 27, No. 5, Jan. 1921, pp. 441–442, 3 figs. Die for producing tractor-wheel spoke covering one operation.

Locomotive Parts. Special Railroad Machine-Forging Tools, J. V. Hunter. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 67–68, 7 figs. Description of dies used for forging locomotive grease cups, universal-joint jaws, connecting rods, valve handles, boiler-flue beading tools, etc.

Seamless Kettles. Drawing Operations on Seamless Kettles, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 433–437, 18 figs. Design of dies and step-by-step operations in making difficult drawn shape.

DIESEL ENGINES

Diesel-Sulzer. Diesel-Sulzer Two-Cycle Motor Exhibited at Crystal Palace Great War Exhibition in London (Moteur Diesel-Sulzer à deux temps., au Great War Exhibition du Crystal Palace, à Londres). Bulletin technique de la Suisse romande, vol. 46, no. 23, Nov. 13, 1920, pp. 265–267, 4 figs. Effective power is 425 hp. at speed of 200 r.p.m.; fuel consumption varies from 195 to 200 grams per effective horse-power-hour. Engine is directly reversible.

Doxford. The Doxford Diesel Engine. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 838 and 845–846, 2 figs. Opposed piston solid injection two-cycle reversible marine oil engine.

German Submarine. Modern German Submarine Diesel Engines (Neuere deutsche Unterseeboots-Dieselmaschinen), Max Wilh. Gerhards. Motorwagen, vol. 23, no. 27, Sept. 30, 1920, pp. 512–519, 8 figs. Details and data of construction and operation of different types of submarine oil engines built by the Machine Factory Augsburg-Nürnberg (M. A. N.).

Solid-Injection. The Solid Injection Engine, C. McTaminey. Trans. Inst. Mar. Engrs., vol. 32, Nov. 1920, pp. 161–178 and (discussion) pp. 179–194, 4 figs. Details of construction of Diesel marine installations developed by British Admiralty during war.

DOCKS

Testing U-Boats. German Marine Testing Dock (Prüfdock für die Deutsche Marine), H. Klitzing. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 51, Dec. 18, 1920, pp. 1074–1079, 19 figs. Dock built 1916–1918 for testing U-boats consists of a supporting pontoon, side compartments for insuring position of equilibrium, and a 116-m. pressure cylinder for housing of test boat, which has internal diameter of 12 m.; on both sides of the freely mounted pressure cylinder is room for docking two additional boats. Description of entrance shaft to test boat, manholes of pressure cylinder, pump plant, etc.

DRILLING MACHINES

Automatic. Automatic Drilling Machine with Gravity Feed. (Machy. Lond.), vol. 17, no. 431, Dec. 30, 1920, pp. 396–397, 2 figs. Each of two spindles operates independently, and feeding of drill into work is accomplished by weight which exerts constant feeding pressure during drilling operation.

Radial. Large Radial Drilling Machines. Eng. Production, vol. 2, no. 14, Jan. 6, 1921, pp. 22–23, 1 fig. Designed for use on large turbine work.

DRILLS

Twist. Helix Angle of Twist Drills, Bruce W. Benedict. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1175–1178, 5 figs. Concludes from experiments that with present design of flute, most efficient high-speed milled twist drill has helix angle of 35

Action, Theory of. Theory of Dust Action, C. ... Armspach. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 9, Dec. 1920, pp. 819–829, 6 figs. Report upon investigations carried out jointly by Research Bureau & U. S. Bureau of Mines. It is shown that dust content in room depends upon density of material, velocity of fall of particles and size of room; dust will accumulate until definite content is reached depending upon rate of fall and number of air changes.

DYNAMOMETERS

Variable-Speed. A Variable Speed Fan Dynamometer, Karl D. Wood. Aerial Age, vol. 12, no. 19, Jan. 17, 1921, pp. 491–492, 4 figs. Apparatus designed by automotive power-plant section of Bureau of Standards.

E

ECONOMIZERS

Installation. Economizers, W. F. Wurster. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 9, Dec. 1920, pp. 811–818, 6 figs. Typical installations of economizers in steam power plants.

Operation. Two Useful Suggestions in Regard to Operation of Economizers (Deux points utiles à connaître concernant les économiseurs), Henry Dieterlen. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 487–489, 3 figs. How to prevent trouble in pumps arising from hot water used, and how to prevent vapor condensation on outside of economizer.

EDUCATION, INDUSTRIAL

Coöperative High-School Course. The Industrial Coöperative Course of the Lansing High School, E. M. Hall. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 83–86, 13 figs. Course, open to youths of city of Lansing, intended to provide thorough training and experience in technical trades.

[See also VOCATIONAL EDUCATION.]

ELECTRIC DRIVE

Refrigerating Plants. Electric Drive for Ice Making and Refrigerating Plants, William J. Bray. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 23–25, 3 figs. Types of apparatus.

[See also ROLLING MILLS, Electrically Driven.]

ELECTRIC FURNACES

Annealing. Electric Annealing and Heat Treating Furnaces, George P. Mills. Jl. Engrs. Club of Phila., vol. 38–1, no. 193, Jan. 1921, pp. 25–31, 6 figs. Ni-chrome resistor type of electric furnace. Operating data on typical installations and probable trend of new applications.

Brass. New Casting Shop of the Bridgeport Brass Company, H. M. Lane. Metal Industry (N. Y.), vol. 19, no. 1, Jan. 1921, pp. 1–3, 5 figs. Construction and method of operation of shop running entirely on electric furnaces.

Booth Rotating. Booth Rotating Electric Brass Furnace. Metal Industry (Lond.), vol. 17, no. 26, Dec. 24, 1920, pp. 507–508. Features of later designs. Automatic electrode control.

Iron-Smelting. Swedish Electric Pig Iron Furnaces, Jonas Herlenius. Chem. & Metallurgical Eng., vol. 24, no. 3, Jan. 19, 1921, pp. 108–112, 3 figs. Description of Swedish electric furnace and summary of results obtained from its use.

Refractories for. Refractories for Electric Furnace, R. M. Howe. Chem. & Metallurgical Eng., vol. 23, no. 25, Dec. 22, 1920, pp. 1215–1218. Description of properties of refractory brick and of raw materials employed in their manufacture, with review of many factors involved in efficient use of refractories in general. Paper read before Elec. Furnace Assn.

Synthetic Pig Iron. See PIG IRON, Synthetic.

Uses. Electric Furnace Usage Fast Increasing. Elec. World, vol. 77, no. 2, Jan. 8, 1921, pp. 77–79, 3 figs. More than 220 non-ferrous furnaces installed during 1920. Total connected furnace load estimated at 880,000 kva., of which 410,000 kva. is in commercial furnaces. Electric steel output reduced.

ELECTRIC LOCOMOTIVES

C. M. & St. P. New Electric Passenger Locomotives in Operation on the C. M. & St. P. Railway, W. H. Munn. Jl. Western Soc. Engrs., vol. 26, no. 1, Jan. 1921, pp. 26–29, 2 figs. Characteristics: Total weight, 275 tons; number of driving axles, 6; classification, 4–6–2–2–6–4; tractive effort, continuous rating, 49,000 lb.; speed maximum, 65 m.p.h.

Switzerland. The Locomotives of the Swiss Railways (Les locomotives des chemins de fer rhetiques), Lucien Pahin. Revue générale de l'Électricité, vol. 8, no. 25, Dec. 18, 1920, pp. 872–878, 8 figs. Details of electric locomotives of Brown Boveri & Co.

ELECTRIC PLANTS

Interconnection. Coöperation for the Central Station and Isolated Plant. Elec. World, vol. 77, no. 1, Jan. 1, 1921, p. 11. Interconnection is economically sound and is shown to hold mutual advantages where isolated plants can be justified.

ELECTRIC WELDING, ARC

Boiler Repairing. The Electric Welding of a Corroded Boiler-Shell, A. Kenneth Dawson. Trans.

Car-Truck Frame. Arc Welding on Railway Properties, A. M. Candy. Elec. Ry. Jl., vol. 57, no. 3, Jan. 15, 1921, pp. 121–124, 17 figs. Truck frames manufactured by Government Electric Railways of Sydney, Australia, and other examples of applications of electric welding in manufacture of railway cars.

Equipment. Electric Welding, William T. Bonner, A. A. Nims, C. J. Holslag and H. E. Dralle. Jl. Engrs. Club of Phila., vol. 38–1, no. 193, Jan. 1921, pp. 7–23, 8 figs. Notes on selection of arc-welding equipment and fundamentals of its efficient operation.

Practice. Arc Welding Practice. J. H. Anderton. Jl. Elec., vol. 45, no. 12, Dec. 15, 1920, pp. 572–574. Greater flexibility and better control in arc welding are obtained by use of metal instead of carbon electrode. Records of tensile tests of welds are included.

The Welding of Metals by the Electric Arc (La soudure des différents métaux par l'arc électrique), Ch. Andry-Bourgeois. Électricien, vol. 51, no. 1266, Dec. 15, 1920, pp. 536–539, 1 fig. Welding of bronzes and aluminum alloys. (Continuation of serial.)

Steel. Electric-Arc Welding of Steel: I. Properties of the Arc-Fused Metal, Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan. Technologic Papers, Bur. of Standards, no. 179, Nov. 15, 1920, 63 pp. 28 figs. Research to determine in empirical way by actual welding tests carried out by skilled operators relative values and merits of different types of electrodes which are available commercially.

ELECTRICAL INDUSTRY

Developments in 1920. Some Developments in the Electrical Industry During 1920, John Liston. Gen. Elec. Rev., vol. 24, no. 1, Jan. 1921, pp. 4–49, 99 figs. Developments in turbo-generators, electric locomotives, electrical machinery, electric cranes, hoists, transformers, insulators and electric lighting.

EMPLOYEES' REPRESENTATION

Shop Committees. A Shop Committee that Failed, O. F. Carpenter. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 59–62. Experience of one firm that introduced industrial democracy.

Works Councils. Works Council after Two Years' Trial. Can. Machy., vol. 24, no. 27, Dec. 30, 1920, pp. 597–600, 6 figs. Experience of International Harvester Co.

EMPLOYMENT MANAGEMENT

Selecting Employees. Fewer Mistakes in Selecting Employees, William S. Dutton. Factory, vol. 26, no. 1, Jan. 1, 1921, pp. 38–39, 2 figs. Experiences of E. I. duPont de Nemours & Co.

ENGINEERING SOCIETIES

Progress in 1920. Progress of Engineering Societies in 1920, Calvin W. Rice. Power, vol. 53, no. 1, Jan. 4, 1921, pp. 22–23. Outstanding event is establishment of Federated American Engineering Societies which typifies "unselfish devotion on the part of the engineering profession to the good of the community and the nation."

ENGINEERS

Registration. Code of Practice and Schedule of Fees for Structural Engineers. Eng. & Contracting, vol. 54, no. 25, Dec. 22, 1920, pp. 603–605. Proposed code of practice for use of members of Structural Engineers' Association of Illinois prepared by committee of association.

Engineering Legislation for Out. Contract Rec., vol. 35, no. 2, Jan. 12, 1921, pp. 39–44. Draft bill for registration of engineers, drawn up by Advisory Conference Committee representing civil, mechanical, electrical and mining engineers.

Engineering Legislation in Canada, Fraser S. Keith. Eng. News-Rec., vol. 86, no. 1, Jan. 6, 1921, pp. 21–24. Outline of history of movement for statutory control of professional practice, with synopsis of acts passed by provinces.

Saskatchewan's "Engineering Profession Act." Can. Engr., vol. 39, no. 25, Dec. 16, 1920, pp. 615–618. Text of bill that has been introduced in Saskatchewan Legislature.

Remuneration. Fees and Services of Practicing and Consulting Engineers, W. L. Benham. Eng. News-Rec., vol. 85, no. 27, Dec. 30, 1920, pp. 1266–1267. Report of Committee on fees and services of practicing engineers of American Association of Engineers.

The Engineering Profession and Government Technology, R. S. McBride. Chem. & Metallurgical Eng., vol. 23, no. 26, Dec. 29, 1920, pp. 1265–1267, 3 figs. Need for increasing salaries of government professional employees is brought out by enumeration of series of facts on conditions now existing in different government technical bureaus.

Social Functions. The Engineer's Service to Society, Fred J. Miller. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 1–4 and 8. Discusses influence of engineer in constructive adjustment, property rights and human rights and relations between employer and employee. Presidential address at Annual Meeting of Am. Soc. Mech. Engrs.

ENGINEHOUSES

Design. Modernizing Locomotive Terminals, G. W. Rink. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 13–16, 5 figs. Location, size and general layout in this subject, which has important bearing on ability of railroads to handle increased traffic demands of country.

EXECUTIVES

Industrial. The Executive—and Today's Problem, Lewis E. Pierson. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 7–8 and p. 50 and 57–58. Suggestions to executives in regard to present business conditions.

F

FACTORIES

Oversize Construction. Oversize Construction Plant Demonstrates Value. Eng. News-Rec., vol. 86, no. 2, Jan. 13, 1921, pp. 82–85, 4 figs. Automobile body factory at Cleveland, Ohio, completed in quick time by concentrating equipment for peak-load construction.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT

FARM MACHINERY

Electrically Operated. Electric Farming (Le labourage électrique). Bulletin de la Société Française des électriciens, vol. 10, no. 86, Feb. 1920, pp. 57–78, 11 figs. Electric winch for operating plow, and other electrically operated machinery, together with portable transformer for taking power at various points of line.

London Show. The Smithfield Club Show. Engr., vol. 130, no. 3389, Dec. 10, 1920, pp. 582–583, 6 figs. Details of farm machinery exhibited at London Show.

FATIGUE

Blast-Furnace Men. Fatigue of Blast-Furnace Men. Iron & Coal Trades Rev., vol. 101, no. 2757, Dec. 31, 1920, pp. 910–911. Report issued by Committee of Industrial Fatigue Research Board, England.

FERROALLOYS

Iron-Vanadium. The Magnetizability of Iron-Vanadium Alloys (Die Magnetisierbarkeit von Eisen-Vanadium-Legierungen), R. Dieterle. Archiv. fur Elektrotechnik, vol. 9, no. 7, Nov. 8, 1920, pp. 314–318, 2 figs. Results of author's measurements are presented in curves and tables, from which it is concluded that vanadium has the same effect as silicon and aluminum on the magnetic properties of iron and could, therefore, be taken into consideration for the production of so-called alloyed sheet metals.

FIRE PREVENTION

Pulpwood Piles. Fire Prevention in Pulp Wood Piles, F. J. Hoxie. Paper, vol. 27, no. 15, Dec. 15, 1920, pp. 13–19, 13 figs. Spray nozzles forming artificial fog for protection of piles of pulpwood.

FLIGHT

Soaring. Soaring Flight (Le vol a voile), P. Idrac. Nature (Paris), no. 2434, Nov. 27, 1920, pp. 347–349. Forces acting.

Soaring Flight (Sur le probleme du vol à voile), Jean Constantin. Aéronautique, vol. 2, no. 18, Nov.-Dec. 1920, pp. 251–255, 3 figs. Theory of forces acting. Support of bird is found to depend on resultant of mass on wings, action of wind against inclined plane of body and curved surface of wings, and greater inertia of moving air.

The Gliding and Soaring Flight Contest in the Rhön Mountains (Der Gleit- und Segelflug-Wettbewerb in der Rhön), Ferdinand Trendelenburg. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 20, Oct. 30, 1920, pp. 295–297, 1 fig. Account of flights and details of aeroplanes figuring in contest. Report of the German Experimental Inst. for Aeronautics.

The Soaring Flight of Birds, Leon Bollee. Aerial Age, vol. 12, no. 16, Dec. 27, 1920, pp. 421, 3 figs. Study of forces acting.

FLOW OF AIR

Conduits. Measurement of Quantity of Air Flowing Through a Conduit (La mesure des débits de vent), M. Lebrasseur. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 474–477, 5 figs. Measurement by means of venturi is preferred.

FLOW OF STEAM

See FLOW OF WATER, Transmission Wastes

FLOW OF WATER

Concrete Pipe Lines. Flow of Water in Concrete Pipe Lines. Can. Engr., vol. 40, nos. 1 and 2, Jan. 6–13, 1921, pp. 101–105, 2 figs., and 124–126, 3 figs. Test data showing effect of variations in character and condition of pipe on coefficients of retardation for various formulæ. Test of big conduit at Niagara Falls.

Dredge Pipes. Velocity Tests in Hydraulic Dredge Pipe, Ivan E. Houk, Eng. News-Rec., vol. 86, no. 1, Jan. 6, 1921, pp. 18–19, 1 fig. Description of apparatus for measuring velocity of dredge pipe discharge, and tables of results obtained.

Transmission Wastes. Transmission Wastes. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 85–93, 11 figs. Chart of flow of water in pipes and loss of head by friction, also for determining loss of steam pressure per 100 ft. of pipe.

FLUE-GAS ANALYSIS

Graphical Method. A Graphical Method for the Interpretation of Flue Gas Analyses, Gilbert B. Howarth. Jl. Soc. Chem. Industry, vol. 39, no. 24, Dec. 31, 1920, pp. 329T–333T, 3 figs. Construction of diagram and its use for commercial purposes.

FLYWHEELS

Stresses in. Resistance of a Disk Subjected to Rapid Rotation (De la résistance des disques à rotation rapide), L. Anspach. Bulletin technique de l' Association des Ingénieurs sortis de l'École Polytechnique de Bruxelles, vol. 14, no. 1, 1920–1921, pp. 21–54, 1 fig. Fundamental formula developed in general case and applied to design and study of flywheels.

FORGING

Brass. Making Brass Forgings. Machy. (Lond.), vol. 17, no. 430, Dec. 23, 1920, pp. 341–346, 10 figs. Methods developed by Mueller Metals Co. in metal working.

Furnaces. The Construction of Ducts for Forge Exhaust and Blast Systems. Heat. and Vent. Mag., vol. 17, no. 12, Dec. 1920, pp. 35–39, 8 figs. Furnace installation at plant of General Vehicle Co., Long Island City.

Steel. The Forging of Steel and Fundamental Principles for the Design of Steam and Drop Hammers (Das Schmieden des Stahls und die Grundlagen zur Bemessung von Hämmern und Fallwerken), Erich Siebel. Werkstattstechnik, vol. 14, nos. 18, 20 and 21, Sept. 15, Oct. 15 and Nov. 1, 1920, pp. 492–496, 529–532 and 566–569, 17 figs. After a brief discussion of metallurgical conditions in connection with forging and annealing, the machine equipment for hot forging is discussed. Investigation of the pheuomena occurring with die forging and swaging, and especially of the relation between existing experimental results and operating experiences on one hand and the theoretical considerations on the other.

FOUNDRIES

Aluminum. Analyze Loss in Aluminum Shops—III, Robert J. Anderson. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 54–57, 2 figs. Conditions at several typical foundries described, including melting equipment and operation molding methods and inspection routine. Pyrometric control varies in different foundries.

Conveying Equipment. See CONVEYORS, Foundry.

Layout. Foundry Planning by Example, Charles K. Sumner. Metal Trades, vol. 12, no. 1, Jan. 1921, pp. 14–15. Data on twelve existing gray iron foundries in San Francisco and vicinity.

Scrap Recovery. Economy in the Recovery of Scrap in Iron and Steel Foundries (Ueber die Wirtschaftlichkeit der Rückgewinnung des Abeisens in Eisen- und Stahlgiessereien), Hubert Hermanns. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 66–67, 1 fig. Includes tabular data compiled from four different plants showing net production costs of recovered scrap, and curves showing results of calculation of operating costs.

[See also CORES.]

FUELS

Briquets from Wastes. Manufacture of Briquets from Waste Fuels (Brikettierung von Abfallbrennstoffen), Otto Brandt. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 72–76, 5 figs. For making briquets from waste wood, tan bark and garbage a process which does not employ a binder is described, also one with a binder for making briquets from coke, coal, lignite, flue and smoke-box dust, slag residue, etc. Profitableness of such briquet plants for use of waste material is discussed.

Colloidal. Colloidal Fuel as Developed by the Submarine Defense Association of New York. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 55–56, 2 figs. Chart giving comparative savings effected with colloidal fuel.

Colloidal Fuels, Their Preparation and Properties, S. E. Sheppard. Jl. Indus. & Eng. Chem. vol. 13, no. 1, Jan. 1921, pp. 37–47, 12 figs. Survey of developments.

Conservation. Fuel and its Conservation, L. P. Breckenridge, O. P. Hood, David Moffat Myers and Chester G. Gilbert and Joseph E. Pogue. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 22–28 and (discussion) pp. 28–31 and 38. Group of papers dealing with fuel supply of world, fuel conservation, distillation of fuels, and form value of energy, with discussion thereon, which were presented at 1920 Annual Meeting of Am. Soc. Mech. Engrs.

Economical Use. Rational Utilization of Fuels (L'utilisation rationnelle des combustibles), Georges Charpy, Emilio Damour, E. De Loisy, M. Ader, Ch. Berthelot. Mémoires et Compte rendu des Travaux de la Société des Ingenieurs civils de France, vol. 73, nos. 4, 5 and 6, April-June, 1920, pp. 245–393. Symposium on fuel economy. Principles of economic composition of various fuels, gaseous, liquid and solid. Suggestions in regard to their economic utilization in industrial works.

Oil. See OIL FUEL.

Patented Mixtures. Improvements in Furnace Installations for Hard Fuels (Neuerungen an Feuerungsanlagen für feste Brennstoffe), A. Pradel. Feuerungstechnik, vol. 9, no. 2, Oct. 15, 1920, pp. 13–17, 10 figs. Quarter-yearly report describing new foreign and domestic patents and innovations.

Turf. A New Process of Drying Turf for Fuel in Finland. Commerce Reports, no. 306, Dec. 30, 1920, p. 1359. Raw turf in swamp is freed from old roots and changed to thin mud by powerful jet of water under pressure of 20 atmospheres. This is pumped out on drying field and spread in layers from 20 to 30 centimeters in depth. When dry it is cut into bricks of uniform size by means of tractor.

[See also LIGNITES; PEAT; PULVERIZED COAL.]

FURNACES, BOILER

Design. New Patents for Steam-Boiler Furnaces (Neue Patente auf dem Gebiete der Dampfkesselfeuerung), A. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, nos. 40 and 42–43, Oct. 1 and 22, 1920, pp. 305–310 and 323–326, 34 figs. Quarter-yearly report giving review of recently patented foreign and domestic devices.

Forced-Draft. Forced-Draft Furnaces (Unterwindfeuerungen), L. Schmitt. Zeit. des Verbandes Deutscher Diplom-Ingenieure, vol. 11, no. 17–18, Sept. 1–15, 1920, pp. 91–92. Information concerning operating costs of different types of undergrate blowers.

Lignite-Burning. The Adaptation of Steam-Boiler Furnaces to the Burning of Lignite (Umstellung von Dampfkesselfeuerungen auf Braunkohle), H. Berner. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 42–43, Oct. 22, 1920, pp. 321–322. Points out advantages and disadvantages of the forced-draft horizontal grate.

Low-Grade Fuels. The Adaptation of Steam-Boiler Furnaces to Low-Grade Fuels (Die Umstellung der Dampfkesselfeuerungen auf minoerwertige Brennstoffe). Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 51, Dec. 18, 1920, pp. 1069–1070. Full report published by the Board of Heat Conservation giving experiences recorded at the convention of Board in Berlin, September, 1920.

Stephens. Grateless, Smokeless, Automatic Furnace for Steam Power Production at the Mines. Coal Industry, vol. 4, no. 1, Jan. 1921, pp. 19, 1 fig. Patented process tested at Stephens laboratory, U. S. Bureau of Mines, Pittsburgh.

FURNACES, OPEN HEARTH

Waste-Heat Boilers. Application of Waste Heat Boilers to Open Hearth Furnaces, Thomas R. Tate. Assn. Iron & Steel Elec. Engrs., vol. 2, no. 12, Dec. 1920, pp. 1–6 and (discussion) pp. 6–10. Method of determining proper size and type boiler for any installation.

G

GAGES

Checking. Keeping an Accurate Check on Gages, J. Edward Schipper. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, pp. 1225–1227, 7 figs. Method of checking gages at plant of Lincoln Motor Co.

Measurement of. Two Apparatus for the Measurement of Threads and Gages (Zwei Apparate zur Messung von Gewinden und Lehren), F. Göpel. Werkstattstechnik, vol. 14, no. 21, Nov. 1, 1920, pp. 559–563, 15 figs. Description of a measuring machine with spirit-level gage for determination of pitch of thread; and an angle meter for chasing tools based on principle of the goniometer. Both instruments designed by author.

GAS ENGINES

Blast-Furnace Gas. Cockerill Blast-Furnace Gas Engines, H. Hubert. Engr., vol. 130, no. 3386, Nov. 19, 1920, pp. 495–498, 11 figs. Performance tests.

Design. Recent Improvements in Large Gas Engines (Les derniers perfectionnements aux moteurs à gaz de grande puissance), H. Feron. Vie technique & industrielle, vol. 2, no. 13, Oct. 1920, pp. 14–17, 7 figs. Design of special fixtures and attachments for gas engines of more than 1000 hp.

Vertical. 120 H. P. Vertical Gas Engine. Engr., vol. 130, no. 3388, Dec. 3, 1920, p. 567, 2 figs. Three-crank vertical engine with one cylinder, 13-in. bore and 14-in. stroke for each crank, and capable of giving constant output of 120 b.hp. on producer gas.

GASES

Volume Measurement. Methods of Measuring Large Volumes of Gases, specially Applicable to Gas and Coke Works (Méthods de mesure de grands volumes gazeux spécialement applicables aux usines à gaz et aux cokeries), M. C. Berthelot. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 668–676, 6 figs. Classification and comparison of practices in common use. Description of Nurgue volume-recording apparatus.

GASOLINE

Hecter Fuel. Comparison of Hecter Fuel with Export Aviation Gasoline, H. C. Dickinson, V. R. Gage and S. W. Sparrow. Nat. Advisory Committee for Aeronautics, report no. 90, 1920, 10 pp., 13 figs. Investigation conducted at altitude laboratory of Bureau of Standards. Hecter fuel is mixture of approximately 30 per cent benzol, 70 per cent cyclohexane by volume. For flight at low altitudes Hecter fuel showed slight advantages in comparison with gasoline by affording small increase of power over and above that necessary to offset disadvantage of increased fuel consumption. At 14,000 feet and 25,000 feet no appreciable difference in power was obtained, whereas fuel consumption of Hecter was greater to extent of 15 per cent by weight.

Natural Gas. Treating Natural-Gas Gasoline to Meet the "Doctor Test," D. B. Dow. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2191, Dec. 1920, 4 pp. Basis for installation of economical treating process.

GASOLINE ENGINES

Exhaust Gases. Exhaust Gases of Petrol Engines. Times Eng. Supp., no. 554, Dec. 1920, p. 382. Methods of utilization.

Single Sleeve Valve. New Model of Single Sleeve Valve Engine. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1270–1271, 2 figs. Burt-MacCullum engine manufactured by Argylls, Scotland, has been revived in improved and simplified form. Removable port liners used in cylinder. Valve is given combined oscillating and reciprocating motion. Heads are detachable.

Variable Clearance Volume. An Engine with Clearance Volume and Valve Timing Both Variable. Automotive Industries, vol. 43, no. 27, Dec. 30, 1920, pp. 1314–1315, 4 figs. Experimental engine has hydraulic device for raising and lowering crankshaft. Tests indicated considerable saving in fuel under normal operating conditions, but mechanical complications were involved.

GEARS

Bevel. Chordal Thickness of Tooth and Corrected Pitch Depth of Bevel Gears. Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 423–424, 1 fig. Diagram showing dimensions and angles used in determining chordal thickness and corrected pitch depth of bevel gear teeth.

Horsepower Chart. Horsepower Chart for Gear Teeth. Machy. (Lond.), vol. 17, no. 430, Dec. 23, 1920, pp. 359–360, 1 fig. Chart for determining horsepower transmitted by gears when load is known.

Layout. Laying Out Gearing and Making Gear Patterns, H. J. M'Caslin. Can. Foundryman, vol. 12, no. 1, Jan. 1921, pp. 28–29, 3 figs. Study of gearing including spur, bevel and miter gears, involute and epicycloidal teeth, circular and diametral pitch and other features in connection with gearing.

Worm. The Efficiency of Worm-Gearing, W. S Atkinson. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 315–316, 2 figs. Formulæ for computing efficiency in various cases.

GRINDING

Cylindrical. Work Speeds in Cylindrical Grinding, Robert J. Spence. Machy. (N. Y.), vol. 27, No. 5, Jan. 1921, pp. 438–440. Importance of instructing operators concerning proper work speeds to be used. Results obtained by reducing work speed.

Pulverizing Hard Materials. Progress in the Fine Grinding of Hard Material, III and IV (Neuerungen der Hartzerkleinerung), Carl Naske. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 47 and 52, Nov. 20 and Dec. 25, 1920, pp. 980–985 and 1109–1113, 43 figs. Nov. 20: Discussion of kilns. Notes on revolving tubular kilns and utilization of waste heat; enlarged calcination zones; revolving tubular vs. shaft kilns; automatic shaft kilns; suggestions for automatic discharge devices; problems of fuel admission and mixture; a recommendation for burning of lime; Dec. 25: Description of plant for pulverizing castiron turnings for an analine factory; lime- and coke-crushing plant for a carbide factory; super-phosphate factory; plant for grinding and drying ammonium nitrate; lime-burning plant; soda-treatment plant; and portland-cement mill.

GRINDING MACHINES

Surface. Wilmarth & Morman Company's No 78 Surface Grinding Machine. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 41–42, 1 fig. Two precision screws used for adjusting wheel to cut. Clutch and all gears run in oil.

GUN METAL

Non-Corrodible. The Development of Non-Corrodible Gun Barrels. F. A. Fahrenwald. Monthly Bul. Can. Inst. Min. & Metallurgy, no. 105, Jan. 1921, pp. 27–48, 2 figs. Objections to present-day gun steels are pointed out and materials for purpose are suggested.

GUNS

Manufacture. A Method of Gun Construction by Radial Expansion, S. J. Brown. United States Naval Inst. Proc., vol. 46, no. 214, Dec. 1920, pp. 1941–1970, 11 figs. Principle is that if hollow thick tube is exposed to internal pressure great enough to stress all fibers to elastic limit. When pressure is removed external layers will shrink back on internal layers and leave them in state of compression.

H

HARDENING

Fire Cracks. Fire Cracks and Some of Their Causes. J. V. Emmons. Metal Trades, vol. 12, no. 1, Jan. 1921, pp. 22–25, 9 figs. From "Metal Heating" published by Tate, Jones & Co., Inc., furnace engineers, Pittsburgh.

HEAT PUMPS

Utilization of. The Heat Economy and Useful Forms of the Heat Pump (Wärmewirtschaft und Anwendungsformen der "Wärmepumpe"), Gustav Flügel. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 46 and 47, Nov. 13 and 20, 1920, pp. 954–958 and 986–989, 14 figs. Equations are presented for determining the heat economy of different concentration processes, both old and new, with special regard to utilization of the vapors given off and it is explained in what forms the heat pumps can be utilized for different purposes.

Industrial Applications. Industrial Applications of Heat Treating (Les traitements thermiques dans leur application actuelle), Arnould De Grey. Chaleur et Industrie, no. 7, Oct. 1920, pp. 419–428, 1 fig. Recent progress in tempering and hardening processes.

Thermal Analysis. Industrial Apparatus for Thermal Analysis in Heat Treating (Appareil industriel d'analyse thermique), M. Pierre Chevenard. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 687–695, 8 figs. Apparatus registers, in terms of time, temperature of sample submitted to regular heat-treating process and then left to itself to cool.

HEATING AND VENTILATION

Museums. The Heating and Ventilation of Museums (Die Beheizung, Luftzu- und abführung und Luftbefeuchtung der Museen), H. Hasak. Gesundheits-Ingenieur, vol. 43, no. 43, Oct. 23, 1920, pp. 508–510. Writer describes system planned by him and adopted by the Kaiser-Wilhelm Museum in Berlin, Germany, where it has given great satisfaction, with regard to uniform heating, removal of dust from air, supplying moisture to air, etc.

Paper-Machine Rooms. Heating and Ventilation of Paper Machine Rooms, Edward A. Ryan. Jl. Eng. Inst. Canada, vol. 4, no. 1, Jan. 1921, pp. 21–27 and (discussion) pp. 28–31, 7 figs. Analysis of heating and ventilation problem for paper machine room, need for adequate ventilation to remove moisture and description of systems in use and proposed.

HELICOPTERS

Problem of. The Problem of the Helicopter. Aeronautical Jl., vol. 25, no. 121, Jan. 1921, pp. 3–19, 10 figs. Probable characteristics of first type of helicopter which will be constructed.

HYDRAULIC TURBINES

Manufacture. Machining Large Water Turbines, Fred H. Colvin. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1234–1236, 5 figs. Examples of turbine work at shop of Pelton Water Wheel Co., San Francisco.

HYDRODYNAMICS

Vortices in Liquids. Motion of Liquids (Sur le mouvement permanent des liquides), L. Lecornu. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 881–885. Equations of vortex motion.

HYDROELECTRIC PLANTS

California. Forward Steps in California Hydro-Electric Designs. Eng. News-Rec., vol. 85, no. 27, Dec. 30, 1920, pp. 1260–1262, 3 figs. Unusual features include 200,000-volt transmission lines and larger units and higher reaction-turbine heads than have previously been used.

Chile. Braden Copper Company's Power System in Chile. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 730–734, 8 figs. Two hydroelectric plants supply power to copper mines. One 22,500-kw. plant operated under 1550-ft. head. Other plant, 15,000 kw., operates under 440-ft. head.

Ejector Sluice Valves. The Action of Ejector Sluice Valves (Die Wirkung von Ejektorenschützen), H. Krey. Zentralblatt der Bauverwaltung, vol. 40, no. 75, Sept. 18, 1920, pp. 472–473, 2 figs. As result of observation that the tailwater from water-power plants is lowered through the waste water flowing over dam, whereby the output of turbine is increased, the idea was conceived to utilize this water for increasing the water power by use of so-called ejector sluices which by their suction act to increase head on turbine. In present article writer attempts to calculate increase of head attainable in order to ascertain feasibility and manner of plant required.

France. Hydroelectric Project for Complete Utilization of water Power in Allier Valley (Aménagement hydraulique intégral de la vallée de l'Allier). Revue générale de l'Électricité, vol. 8, no. 26, Dec. 25, 1920, pp. 907–915, 10 figs. Study for utilization of water power. From report submitted by various official committees.

The Hydroelectric Plants at Louron (Usines hydroelectriques du Louron), Marcel Waternaux, Revue générale de l'Électricité, vol. 8, no. 22, Nov. 27, 1920, pp. 765–778, 20 figs. Description of plants and details of transmission lines. Energy is transmitted at 125,000 volts.

5000-ft. Head. A 5000-Ft. Head Hydro-Electric Plant. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 823–826, 7 figs. Installation at Fully, Switzerland. Generating station contains four sets each of 3000 hp., which run at 500 r.p.m., the Pelton wheels each having single jet which strikes wheel horizontally at its lowest point.

Lock Operation. The Influence of Lock Operation on the Hydroelectric Plants on the Canalized Neckar River (Der Einfluss der Schiffschleusungen auf die Wasserkraftanlagen an dem zu kanalisierenden Neckar.) Zentralblatt der Bauverwaltung, vol. 40, no. 77, Sept. 25, 1920, pp. 485–490, 7 figs. Gives results of locking experiments in the supply channel of the municipal electric power station in Poppen- ... the draft tube.

Niagara Falls Power Development. Switch and Control Equipment at Niagara Falls, Stephen Q. Hayes. Elec. Rev. (Chicago), vol. 78, no. 2, Jan. 8, 1921, pp. 47–53, 10 figs. Precautions taken to guard generating apparatus. Indicating devices and instruments important factors in station operation. Switchgear for main generating units housed in substation. (To be continued.)

Scotland. The Inshes Hydro-Electric Installation. Elec. Rev. (Lond.), vol. 87, no. 2248, Dec. 24, 1920, pp. 803–804, 6 figs. Details of 50-kw. hydroelectric scheme in Scotland.

I

ICE PLANTS

Motor-Driven. Motor-Driven Ice-Plants—Electrical Consumption per Ton of Ice, John E. Starr. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 742–743, 1 fig. Under usual conditions of pressures, loads, temperatures and volumetric efficiency, 48.5 kw.-hr. per ton of ice is usual result.

See also ELECTRIC DRIVE, Refrigerating Plants.

INDUSTRIAL EFFICIENCY

Health. The Cult of the Sound Body, T. V. Davidson. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 33–36, 12 figs. Apparatus employed in modern physiological laboratories to test physical development.

INDUSTRIAL MANAGEMENT

Drafting Department. The Industrial Organization of the Drafting Department (L'organisation industrielle du bureau de dessin), Danty-Lafrance. Vie Technique & Industrielle, vol. 2, no. 14, Nov. 1920, pp. 134–140, 7 figs. Suggestions in regard to adopting symbolic nomenclature, standardization of records, etc.

Employment Relations. Building Workman Morale by Advertising, Harry Botsford. Iron Age, vol. 107, No. 2, Jan. 13, 1921, pp. 131. Dodge Mfg. Co., manufacturers of pulleys and power transmission equipment, display their advertising literature on billboard to inspire workmen to make good tribute paid them in it.

Inspection. Inspection as an Aid to Planning, George S. Radford. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 25–30. How central inspection regulates flow of work.

Production Systems. Assuring Continuous Production. Elec. World, vol. 77, no. 3, Jan. 15, 1921, pp. 144–146, 3 figs. Standards of inspection adopted in several large plants in connection with successful maintenance work based on long experience under industrial conditions.

Fixtures for Quantity Production of Truck Parts—II. Metal Trades, vol. 12, no. 1, Jan. 1921, pp. 5–10, 10 figs.

Increasing Production with Standard Equipment. Machy. (Lond.), vol. 17, nos. 430 and 431, Dec. 23 and 30, 1920, pp. 437–355 and 380–382, 8 figs. Comparison of output and manufacturing costs for specific drilling operation under varying conditions.

Organization for Economic Production (Organisatorische Massnahmen bei der Fertigungssparwirtschaft), E. Springorum. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 59–60. It is shown how, through systematic superintendence of material, saving can be effected.

The Character, Effect, Possibilities and Limitations of Industrial Specialization (Die industrielle Spezialisierung, Wesen, Wirkung, Durchfuhrungsmöglichkeiten und Grenzen), H. Döhne. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 45, Nov. 6, 1920, pp. 937–939. Review and discussion of report of investigations of Committee on Economic Production.

Purchasing Materials. Purchasing Records and System, Wilfred G. Astie. Elec. Traction, vol. 16, no. 12, Dec. 1920, pp. 941–945, 8 figs. Forms for keeping of records.

Routing Work. Handling and Routing Large Work. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 358–364, 17 figs. Methods employed by Manning, Maxwell & Moore, Inc., in Putnam Machine Works, Fitchburg, Mass., for routing of work through factory.

Time Study. See TIME STUDY

INDUSTRIAL RELATIONS

Open Shop Movement in U. S. Government Demands Open Shop, T. C. Dickson. Iron Trade Rev., vol. 67, no. 26, Dec. 23, 1920, pp. 1734–1735. Refuses to deal with trade unions in operation of arsenals, though promoting shop committee system of representation. Commanding officer describes War Department's methods in dealing with labor problems. Paper read before National Founders' Assn.

... before National Founders' Assn.

Plans. Relations Between Employers and Employed. Monthly Labor Rev., vol. 11, no. 6, Dec. 1920, pp. 94–103. Portland, Oregon, plan of preventing labor disputes, and Rochester plan of industrial democracy.

INTERCHANGEABLE MANUFACTURE

Allowances. Designations for Allowances (Passungszeichen), C. Volk. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 41–43, 2 figs. Various such designations are shown in a table and chart, giving reasons for designation, advantages and disadvantages. Report of German Industry Committee on Standards.

Fit Allowances. A System of Fit Allowances, Sydney B. Austin. Machy. (Lond.), vol. 17, no. 431, Dec. 30, 1920, pp. 384–386, 3 figs. Curves showing relation of allowances for fits to various diameters. Comparison of theoretical curves with Brown & Sharpe system of fit allowances and with Newall Engineering Co.'s system of fits.

INTERNAL-COMBUSTION ENGINES

Accessories. Improvements in Construction of Internal-Combustion Engines (Neuerungen auf dem Gebiet der Verbrennungskraftmaschinen). Wirtschafts-Motor, no. 11, Nov. 1920, pp. 21–22, 7 figs. Describes starting handle patented by the Austrian Daimler Motor Corp'n which can be turned only within a certain angle; a joint between spark plug and cylinder patented by Marc Birkigt, Bois Colombes, France, for purpose of introducing a simpler and more effective packing than is now in use; and a new electric starting device patented by Louis Renault, Billancourt, France, in which the electro-magnet consists of two windings, one of fine and the other of large wire between which there is a contact for shutting off the current of starting motor.

Exhaust Gas Losses. A Meter for Measuring Heat Losses in Exhaust Gas (Ein Abgasverlustmesser als Hilfsmittel für die Feuerführung), Fr. Wiedemann. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 43, no. 44, Oct. 29, 1920, pp. 335–336, 2 figs. Consists of a resistance meter so connected that it indicates difference in temperature of thermometers measuring respectively temperature of stock gases for air and combustion.

Four-Stroke vs. Two-Stroke. Four-Stroke vs. Two-Stroke System for Marine Engines (Viertakt und Zweitakt beim Schiffsmotor), Max Wilhelm Gerhards. Motorwagen, vol. 23, no. 30, Oct. 31, 1920, pp. 567–572. Critical discussion of the relative merits of both systems.

Fuels. The Proper Selection of Fuel for the Oil Engine, Allen F. Brewer. Power, vol. 52, no. 25, Dec. 21, 1920, pp. 972–974. Comparative properties of typical oils.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; OIL ENGINES; TRACTOR ENGINES.]

IRON

Metallography. The Practical Application of the Metallography of Iron (Die praktische Anwendung der Metallographie des Eisens), G. Berndt. Zeit. der Deutschen Gesellschaft für Mechanik u. Optik, nos. 13–14, 15–16, 17–18 and 19–20, July 15, Aug. 15, Sept. 15 and Oct. 15, 1920, pp. 73–78, 86–91, 98–103 and 109–114, 31 figs. Notes on thermal analysis for determining the relation of different portions of texture appearing in iron and other metals. Various examples are given of solution in liquid and solid state. Photomicrographs. Report from the mechanical laboratory of the C. P. Goerz Optical Works.

IRON CASTINGS

Fluid Pressure in Molds. Pressure Due to Fluid Iron in Moulds, C. Webster. Mech. World, vol. 68, no. 1772, Dec. 17, 1920, pp. 442–443, 16 figs. Influence of pressure of fluid iron in straining, bursting and lifting of molds.

IRON METALLURGY

Control of Mixtures. Chemist Controls All Iron Mixtures. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 59–62, 5 figs. Melting department in foundry of large plant with diversified output regulated by laboratory. Inclined skip hoist charges cupola.

Elements in Iron Control Mixtures, Fletcher Collins. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 64–65. Hardness of cast iron mainly determined by state of carbon which is controlled by other elements. Silicon tends to free carbon and sulphur to hold it in combination.

K

KEYWAYS

Depth. Computing the Depth of Keyway inG ear and Pulley Hubs, Henry R. Bowman. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, p. 69. Formula.

L

LABOR

Child. Child Labor. Monthly Labor Rev., vol. 11, no. 6, Dec. 1920, pp. 126–131. Industrial instability of child workers in Connecticut.

LATHES

Zimmermann Automatic. The Zimmermann Automatic Lathe for the Rounding of Gear-Tooth Edges (Der Zimmermann-Zahnkanten-Abrund-Automat). Der praktische Maschinen-Konstrukteur, vol. 53, no. 44, Nov. 4, 1920, pp. 189–192, 10 figs. Machine for rounding off ends of gear teeth by means of an end mill, and rounding off automatically pinions up to 400 mm. diam.

LIGHTING

Direct vs. Diffused Light. Pleasing Proportions of Direct and Diffused Light from a Floor Lamp, J. R. Cravath. Trans. Illuminating Eng. Soc., vol. 15, no. 9, Dec. 30, 1920, pp. 631–644, 6 figs. Results of tests to determine pleasing proportions of direct and diffuse light from floor lamp under certain specified conditions.

Industrial. Significant Developments in Illumination During 1920, Preston S. Millar. Elec. World, vol. 77, no. 2, Jan. 8, 1921, pp. 82–85, 6 figs. Types of industrial lighting. Survey of progress in automobile headlight design.

Reflectors. The Standardization of Reflectors for Industrial Lighting. Illuminating Engr., vol. 13, no. 9, Sept. 1920, pp. 253–254, 2 figs. Photometric device for comparing efficiency of reflectors.

LIGNITE

Briquets. Lignite Bricks Pave Canada's Way to Fuel Independence, Walter Noble Burns. Coal Age, vol. 19, no. 2, Jan. 13, 1921, pp. 65–66, 1 fig. Lignite utilization board to place briquets on market. If they prove commercial success 300 new plants will be erected.

Canadian. Carbonization of Canadian Lignite, Edgar Stansfield. Jl. Indus. & Eng. Chem., vol. 13, no. 1, Jan. 1921, pp. 17–23, 4 figs. Laboratory tests by chemical staff of Fuel Testing Division of Mines Branch, Department of Mines, Ottawa.

LOCOMOTIVES

Auxiliary Tractor. Development of the Locomotive Auxiliary Tractor, J. Snowden Bell. Ry. & Locomotive Eng., vol. 34, no. 1, Jan. 1921, pp. 19–21, 5 figs. Survey of patented devices.

Axle Pressure. Axle-Pressure Variations in Locomotives Due to the Tractive Effort Exerted (Achsdruckänderungen bei Lokomotiven durch die ausgeübte Zugkraft), Paul Ritter. Annalen für Gewerbe u. Bauwesen, vol. 87, no. 6, Sept. 15, 1920, pp. 47–48, 2 figs. Examples are given showing change brought about in axle pressure distribution by tractive effort exerted; increase in many cases amounts to 15 per cent and in some cases to 25 per cent.

British. British Locomotive Progress. Railroad Herald, vol. 25, no. 1, Dec. 1920, pp. 16–18, 1 fig. Three-cylinder engine has become standard on one road. Large articulated compound engine not yet used. Superheaters increase.

Bureau of Locomotive Inspection. Report of the Bureau of Locomotive Inspection. Ry. Mech. Engr., vol. 95, no. 1, Jan. 1921, pp. 18–20, 4 figs. Application of water columns and other devices advocated; accidents increase in fiscal year 1920.

Report of Chief Inspector of Boilers, A. G. Pack. Ry. Jl., vol. 27, no. 1, Jan. 1921, pp. 17–25, 7 figs. Statistics of defects on parts and appurtenances of locomotive and tender, including boiler, together with casualties resulting from failures.

Compressed-Air. Study of the Triple-Expansion Compressed-Air Locomotive and the Utilization of Exhaust Steam in the Compression of Air at High Pressure (Etude sur les locomotives à air comprimé à triple expansion et l'utilisation de la vapeur d'échappement à la production de l'air à haute pression), M. P.-E. Leroux. Bulletin et Comptes rendus mensuels de la Société de l'Industrie minerale, vol. 19, no. 6, Nov.-Dec. 1920, pp. 249–305, 60 figs. Technical and economical study.

Cylinders. Tests of Cast Iron for Locomotive-Cylinder Parts. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1221–1222. Mechanical tests at Bureau of Standards.

Electric. See ELECTRIC LOCOMOTIVES.

Internal-Combustion. Internal Combustion Locomotives and Rail Cars of McEwan and Pratt, Ltd., George Frederick Zimmer. Eng. & Indus. Management, vol. 4, no. 27, Dec. 30, 1920, pp. 849–851, 2 figs. Locomotives used on rail tracks in factories, works, plantations, quarries, mines and also for light transitory purposes for erection of contract work. Special attention is given to reversing mechanism.

Lubrication. Lubrication of Locomotives (Lubricación de locomotoras), J. W. D. Ayre. Ingenieria internacional, vol. 5, no. 1, Jan. 1921, pp. 18–23, 25 figs. Details for economical lubrication.

Manufacture. Production Methods in Railway Locomotive Plants. Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 405–410, 11 figs. Practice of Sir W. G. Armstrong, Whitworth & Co., Ltd., Scotswood, Newcastle-on-Tyne.

Mine. Changes in Electric Locomotives to Meet Demands for Heavier Duty, Graham Bright. Coal Age, vol. 19, no. 2, Jan. 13, 1921, pp. 51–56, 11 figs. Frames of bar steel resist damage and assist ventilation of motors. Leaf spring has advantage over helical. Thrust resisted by removable lid of boxing. Detachable rims and split gears are of questionable merit. Tandem locomotives and fan ventilation meet demand for more power.

Oil-Burning. Oil Burning Tests in the Locomotives of the Paris-Lyons-Mediterranee (Essais de chauffage au mazout effectués par la compagnie P. L. M.), M. Pouillon. Revue générale des Chemins de Fer, vol. 39, no. 1, July 1920, pp. 3–7. Burner used was of nappe type with pulverization by means of steam. Tests proved satisfactory in all respects.

Reconstruction. Increasing the Capacity of Old Locomotives, C. B. Smith. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 12 and 16. Problems of adapting old-type locomotives to suburban and local service are discussed and items which are to be considered in any program for increasing locomotive capacity are listed. Examples of satisfactory reconstruction are cited.

Speed Capacity. The Speed Capacity of Locomotives, Cecil J. Allen. Ry. Engr., vol. 41, no. 491, Dec. 1920, pp. 489–491. Discussed more particularly in relation to diameter of driving wheels and coupling of axles.

Superheater. Determination of the Best Cylinder Diameter for Superheated Steam Locomotives (Die Bestimmung der zweckmässigsten Zylinderdurchmesser für Heissdampflokomotiven), H. Velte. Annalen für Bewerbe u. Bauwesen, vol. 87, no. 9, Nov. 1, 1920, pp. 65–68, 4 figs. Based on method described by author in same journal (vol. 87, pp. 2–7, 9–14 and 17–22), a number of superheated-steam freight-train locomotives are investigated and a method developed with which it is possible to establish cylinder diameters of such locomotives in such a way as to positively ensure operating qualities required of them.

LUBRICATING OILS

Specifications. Lubricating Oils. Air Service Information Circular, vol. 2, no. 118, Oct. 20, 1920, 7 pp., 3 figs. Specifications and method for testing.

Testing. Methods of Examination of Lubricating Oils, G. F. Robertshaw. Jl. Instn. Petroleum Technologists, vol. 6, no. 24, Oct. 1920, pp. 324–364 and (discussion), pp. 364–378, 1 fig. Methods of testing. Bibliography of lubricating oils.

LUBRICATION

Developments. Advances in the Practice of Lubrication, Henry M. Wells and James E. Southcombe. Can. Chem. & Metallurgy, vol. 5, no. 1, Jan. 1921, pp. 10–13. Experimental work connected with introduction of fatty acids in place of fatty oils. Results of trials on all types of machinery.

Oil-Circulating Systems. Preventing Emulsification in Oil-Circulating Systems, R. E. Langston. Power, vol. 52, no. 19, Nov. 9, 1920, pp. 470–741, 2 figs. Kind of oil to use in circulation systems to avoid forming emulsion.

Problems of. Some Problems of Lubrication, W. B. Hardy. Nature (Lond.), vol. 106, no. 2670, Dec. 30, 1920, pp. 569–572. Experiments to study relation of lubricating power to chemical constitution.

Research. British Lubrication-Research Report. Commerce Reports, no. 9, Jan. 12, 1921, pp. 211–213. Final report of British Department of Scientific and Industrial Research. (Abstract.)

Lubricants and Lubrication. Engr., vol. 130, no. 3390, Dec. 17, 1920, p. 605. Report of Lubricants and Lubrication Inquiry Committee appointed by Advisory Council of Department of Scientific and Industrial Research.

Lubrication. Times Eng. Supp., no. 554, Dec. 1920, p. 381. Report of Lubricants and Lubrication Inquiry Committee set up by Department of Scientific and Industrial Research.

M

MACHINE SHOPS

Layout. Accessibility, Convenience and Cleanliness Make This Machine Shop Efficient, Dever C. Ashmead. Coal Age, vol. 18, no. 26, Dec. 23, 1920, pp. 1269–127', 4 figs. Layout of machine shop near Hazleton, Pa.

MACHINE TOOLS

Automatic. The Galco Automatic Machines (Les machines automatiques "Galco"), M. Bousquet. Vie technique & industrielle, vol. 2, no. 13, Oct. 1920, pp. 38–44, 15 figs. Swedish machine for cold drawing of rivets, bolts, etc.

Axle-Machining Equipment. Axle Machining Equipment. Engr., vol. 130, no. 3386, Nov. 19, 1920, pp. 508 and 512, 6 figs. Axle facing and centering machine and axle turning lathe exhibited at machine tool exhibition at Olympia.

Belt Drive. Group vs. Individual Drive for Machine Tools, R. F. Jones. Belting, vol. 18, no. 1, Jan. 1921, pp. 59–62, 2 figs. Group offers practically all advantages of individual and in addition first cost is much lower, maintenance charges less and depreciation slower.

Developments. The Shipbuilding, Engineering and Electrical Exhibition, Kelvin Hall, Glasgow. Machy. (Lond.), vol. 17, no. 428, Dec. 9, 1920, pp. 282–285, 8 figs. Developments in machine-tool field.

Power Consumed. Influence of Shape of Chips on the Power Consumption of Machine Tools (Einfluss der Spanform auf den Kraftverbrauch von Werkzeugmaschinen), Th. Damm. Werkstattstechnik, vol. 14, no. 19, Oct. 1, 1920, pp. 507–508, 1 fig. Results of tests carried out on a planing machine, shown in table and chart.

Working Speeds. Alignment Chart for Operating Speeds (Fluchtlinientafel für Laufzeiten), Alfred Leistikow. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 120–123, 1 fig. Presents chart with eight scales, namely, (A) feed in mm.; (B1) and (B2) cutting speed per sec. and per min.; (C) diam. and length in cm.; (D) minutes for 1 cutting; (E) minutes for two and three cuttings; (F) diam. of workpiece in mm.; and (G) revolutions per min.

Alignment Charts for the Calculation of Working Speed of Machine Tools (Fluchtlinientafeln zur Berechnung von Laufzeiten der Werkzeugmaschinen) F. Gabriel. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 115–120, 8 figs. Describes lathe, shaping, and milling-machine calculators introduced by the "Stugra" Central Bur. for Graphic Tables, Waidmannslust, near Berlin, and based on alignment transformation principle.

MALLEABLE IRON

Manufacture. American Malleable Cast Iron—II. Iron Trade Rev., vol. 68, no. 3, Jan. 20, 1921, pp. 213–218, 2 figs. Developments of malleable industry in U. S.

See also CASTINGS, Malleable.

MANGANESE STEEL

Machining. Manganese Steel and Methods of Machining It, S. A. Hand. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 43–45, 3 figs. Grinding is only method of machining.

MARINE BOILERS

Electric Welding. A Revolution in Marine Boiler Construction, Francis Butt-Gow. Boiler Maker, vol. 21, no. 1, Jan. 1921, pp. 1–4, 9 figs. Electric welding of Scotch marine boilers at works of R. & W. Hawthorn Leslie & Co., England.

Manufacture. Willamette's War Work, Fred H. Colvin. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 105–107, 6 figs. Production manufacture of marine boilers.

MARINE ENGINES

Governors. The Ramsay Marine Governor. Practical Engr., vol. 62, no. 1764, Dec. 16, 1920, pp. 388–391, 6 figs. Anticipating valve comes automatically into action when lift of ship's stern brings propellor dangerously near surface.

[See also OIL ENGINES, Marine.]

MEASUREMENT

Optical Devices. Improvements in Measuring Tools (Neurungen an Messwerkzeugen), Max Kurrein. Werkstattstechnik, vol. 14, nos. 19 and 20, Oct. 1 and 15, 1920, pp. 513–517 and 538–544, 46 figs. Details of various new measuring-tool constructions by the Fried. Krupp Corp., and of accurate measuring apparatus by firm of Carl Zeiss, particularly optical measuring devices.

METALS

Fatigue. The Relation of Recoverance to the Fatigue of Metals, Robert G. Guthrie. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 65–68, 2 figs. Description of modulimeter, an apparatus for measuring recoverance. Recoverance is capacity of material to return immediately energy that has been imparted to it by any external force.

METEOROLOGY

Atmospheric Pressure-Temperature Relations. The Relationship Between Pressure and Temperature at the Same Level in the Free Atmosphere, E. H. Chapman. Proc. Royal Soc., vol. 98, series A, no. A691, Dec. 3, 1920, pp. 235–248, 1 fig. Correlation coefficients between pressure and temperature at same level in free atmosphere.

METRIC SYSTEM

U. S. Senate Bill. A New Metric System Bill. Iron Age, vol. 106, no. 26, Dec. 23, 1920, pp. 1677. Principal features of bill introduced into Senate on Dec. 21, 1920, to establish Metric System in United States.

The Metric System Bill Introduced in the Senate. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1248–1249. Text of bill providing for compulsory use of Metric System in United States recently introduced in Senate.

MILLING

Continuous. Continuous Milling of Pump Bodies. Am. Mach., vol. 54, no. 3, Jan. 20, 1921, pp. 108–109, 5 figs. Table revolves to feed work, and castings are replaced while machine is cutting.

MILLING MACHINES

Cutter Selection. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 31–32. Proposal of the Committee for Economic Production (AWF) for a new instruction sheet containing directions for the selection and manipulation of milling cutters.

Horizontal. Horizontal Milling Machine. Eng., vol. 110, no. 2869, Dec. 24, 1920, pp. 834–836, 8 figs. Single pulley type machine constructed by Alfred Herbert, Coventry, England. Pulley is mounted on ball bearings, which are fitted to fixed sleeve attached to body of machine.

Locomotive-Frame. Milling Machine for Locomotive Frames, Hartwig Orenstein. Eng. Progress, vol. 1, no. 12, Dec. 1920, pp. 365–366. Three-column milling machine for milling frames having 11 meters in length, used at locomotive works in Berlin.

Multiple. Large Multiple Milling Machines (Grosse Mehrfach-Fräsmaschine), Der praktische Maschinen-Konstrukteur, vol. 53, no. 38, Sept. 25,

other large Diesel-engine parts. Operates with three double spindles, each of which independently is driven by a special motor, resulting in a great simplification of driving parts.

MINE HAULAGE

Colliery Plant. Electric Haulage and Ventilating Plant at the Easington Colliery. Eng., vol. 110, no. 2868, Dec. 17, 1920, pp. 804–806 and 808, 10 figs. Various electric haulages comprise two large main-and-tail haulages of 600 hp. and 450 hp., respectively, and three endless haulages, two of which are of 160 hp. and third of 85 hp.

Continuous. Continuous Hoisting from Great Depths (Stetige Förderung aus grossen Teufen), A. Winkel. Fördertechnik u. Frachtverkehr, vol. 13, nos. 19, 20 and 21, Sept. 17, Oct. 1 and 15, 1920, pp. 173–176, 184–188 and 195–198, 12 figs. Notes on the development of continuous hoisting systems for deep shafts and determination of the economically and technically most advantageous type. Comparison of electric and steam installations of same capacity.

MOMENT OF INERTIA

Unsymmetrical Sections. Calculating the Strength of Unsymmetrical Sections, G. S. Chiles and R. G. Kelley. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 345–348. Methods of determining moment of inertia, together with formulas for obtaining section modulus and radius of gyration.

MOTOR BOATS

Engines. Commercial Motor Boats and the Diesel Engine, G. D. Cavison. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 46–50, 7 figs. Chart showing comparative operating costs of Diesel, hot-bulb and gas engines.

MOTOR PLOWS

Wheel Design. Plowing by Machinery (Le problème de l'adhérence), F. Mirès. Vie technique & industrielle, vol. 2, no. 15, Dec. 1920, pp. 207–211, 21 figs. Types of wheels required to develop sufficient adherence between wheels and soil. (To be continued.)

MOTOR-TRUCK TRANSPORTATION

Germany. Development of Public Motor Transport in Germany, Benno R. Dierfeld. Automotive Industries, vol. 43, no. 26, Dec. 23, 1920, pp. 1251–1254, 3 figs. Vehicles are operated in large fleets by trained staffs, service being controlled by motor transportation companies owned by local governments. Post Office Department operates passenger vehicles.

MOTOR TRUCKS

Axles. A New Dual Reduction Truck Axle, P. M. Heldt. Automotive Industries, vol. 44, no. 1, Jan. 6, 1921, pp. 10–13, 6 figs. Dual reduction axle with drop-forged housing of double banjo type.

Body Design. Engineering Features of New British Trucks at Olympia, M. W. Bourdon. Automotive Industries, vol. 43, no. 25, Dec. 16, 1920, pp. 1207–1212, 20 figs. Careful attention to details heretofore neglected and many refinements in design feature new models. Bristol 3 to 4-ton has electric lights, new transmission and 16-in. single-plate clutch. Halley uses 6-cylinder engine, shaft brake at rear of worm and novel steering connections. Austin has only unit powerplant. Single plate clutch, propeller shaft brakes, overhead worms, plain bearing rear axles and steel wheels, generally used.

Design. The Trend of Motor Truck Design for 1921, Victor W. Page. Sci. Am., vol. 124, no. 2, Jan. 8, 1921, pp. 30–31 and 38–40, 12 figs. Brief survey of features displayed by 682 American models.

German-Built. Motor Lorries, Rudolf Urtel. Eng. Progress, vol. 1, no. 12, Dec. 1920, pp. 360–363, 5 figs. Survey of recent developments in Germany and record of standardization work.

Quantity Production. Fixtures for Quantity Production of Truck Parts—I. Metal Trades, vol. 11, no. 12, Dec. 1920, pp. 489–493, 8 figs. Fixtures used by Fageol Motors Co. (To be continued.)

Specifications. Complete Mechanical Specifications of all Makes of 1921 Gasoline Motor Trucks. Commercial Vehicle, vol. 23, no. 11, Jan. 1, 1921, pp. 356–378. Details of 527 gasoline, 22 electric and one steam motor truck chassis as produced by 227 American truck manufacturers.

Internal-Combustion Truck Specifications. Power Wagon, no. 194, Jan. 1921, pp. 42–59. List of specifications of 570 makes.

Wheels. Machining Motor Truck Wheels. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 349–355, 15 figs. Also Machy. (Lond.), vol. 17, no. 432, Jan. 6, 1921, pp. 411–417, 15 figs. Practice of Clark Equipment Co., Buchanan, Mich., in production of steel truck wheels.

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NAVIGATION

Hydrophone. U. S. Navy MV Type of Hydrophone as an Aid and Safeguard to Navigation, H. C. Hayes. Proc. Am. Philosophical Soc., vol. 59, no. 5, 1920, pp. 371–404, 12 figs. Uses of apparatus developed during war for determining direction of submerged submarine.

NICKEL

Properties. Physical Properties of Nickel, Paul D. Merica. Chem. & Metallurgical Eng., vol. thermal, electrical and optical properties of pure nickel.

NICKEL STEEL

Instability. Cause of Instability of Nickel Steels, and Its Removal (Cause de l'instabilité des aciers au nickel; son élimination), Ch.-Ed. Guillaume. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 22, Nov. 29, 1920, pp. 1039–1041. Instability is due to slow transformation of cementite. Addition of third metal having greater affinity for carbon than iron prevents formation of cementite and thus increases stability of alloy.

NICKEL-CHROMIUM STEEL

Uses. Applications of Alloy Steels in Automotive Industries, H. J. French. Automotive Manufacturer, vol. 42, no. 9, Dec. 1920, pp. 24–28, 9 figs. Nickel-chromium steels and their advantageous properties, especially for transmission and other gears, aeroplane and other crankshafts, and other highly important parts.

O

OIL ENGINES

Manufacture. Prospects and Problems in Construction of Oil Engines (Aussichten und Aufgaben des Oelmaschinenbaues), Paul Rieppel. Zeit. des Vereines deutscher Ingenieure, vol. 64, nos. 49 and 50, Dec. 4 and 11, 1920, pp. 1021–1026 and 1051–1055, 10 figs. Prospective development of the injection-type and carburetor engines; the injection-type engine for marine purposes; combustion phenomenon and control of heat, the compressorless engine. Special technical problems: Wheel gearing and reversing; construction materials and lubrication; the injection-type engine as locomotive; starting and power transmission; hydraulic drives; carburetor engines for agricultural work and in factories, for automobiles and aeroplanes. Carburation inside and outside of cylinder.

Marine. Modern Marine Oil Engines. Shipbuilding & Shipping Rec., Special Number, Jan. 5, 1921, pp. 58–60, 5 figs. Survey of different types of internal-combustion engine available for propulsion of merchant ships.

Solid-Injection. The Solid-Injection Oil Engine, Edgar J. Kates. Power, vol. 52, no. 26, Dec. 28, 1920, pp. 1008–1010, 3 figs. Fuel consumption test on 200-hp. solid injection oil engine.

OIL FUEL

Coal and Gas vs. Fuel Oil. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 51–55, 9 figs. Chart for determining relative costs of oil, gas and coal for equal economy.

Specifications. Specifications for Oil Fuel (Au sujet des conditions de recette des combustible liquides), Pierre Appell. Chaleur & Industrie, no. 8, Nov.-Dec. 1920, pp. 490–495. Specifications of French and British navies and of U. S. Bureau of Mines.

Uses. Uses of Oil Fuel (Les emplois de mazout), Norbert Lallie. Vie technique et industrielle, vol. 2, nos. 13, 14 and 15, Oct., Nov. and Dec., 1920, pp. 25–32, 121–125 and 217–223, 42 figs. Oct.: Industrial uses, and methods of combustion; Nov. and Dec.: Types of burners.

OILS

Slushing. Slushing Oils, Percy H. Walker and Lawrence L. Steele. Technologic Papers, Bur. of Standards, no. 176, Oct. 14, 1920, 23 pp. Desired properties of slushing oils. Laboratory tests on slushing compounds. Proposes specifications for slushing greases suitable for protection of exposed bright metal.

OPEN-HEARTH FURNACES

Manganese Utilization. The Utilization of Manganese in Basic Open-Hearth Furnaces (Beiträge zur Frage der Manganausnutzung im basischen Martinofen), Erich Killing. Stahl u. Eisen, vol. 40, no. 46, Nov. 18, 1920, pp. 1545–1547. States that utilization can be increased (1) if meltings are tapped from slag at moment of greatest reduction of manganese; (2) if manganese charge is not measured too high (1.6 to 1.8 per cent); (3) if the bases are admitted in such quantities that there is neither excess nor deficiency in proportion to absorption capacity of slag; (4) by as low a charge of lime-binding elements as possible; (5) by as high temperature as possible; and (6) admission of manganese in metallic form.

OXY-ACETYLENE CUTTING

Steel Plate. Cutting Steel Plate with a Torch. Gas Age, vol. 47, no. 1, Jan. 10, 1921, pp. 9–10, 2 figs. Machines for operating oxy-acetylene-cutting torch adopted to irregular surfaces and with automatic feed.

Torch Tips. Drilling Davis-Bournonville Cutting Torch Tips. Autogenous Welding, Jan. 1921, pp. 3–8, 14 figs. Description and illustration of drilling operation.

OXY-ACETYLENE WELDING

Efficiency of. Efficiency of Oxy-Acetylene Welding, Benjamin Heyman. Welding Engr., vol. 5, no. 12, Dec. 1920, pp. 29–32, 2 figs. Results of tests. Welding efficiency was calculated as ratio of ultimate strength of welded material in pounds per square inch and ultimate strength of unwelded material in pounds per square inch. Efficiencies thus computed varied from 77.2 to 90.5 per cent.

PEAT

Briquets. Manufacture of Peat Briquets in Sweden (Möjlighet för torvbrikettfabrikation i Sverige), Alf. Larson. Teknisk Tidskrift (Veckoupplagan), vol. 50, no. 42, Oct. 16, 1920, pp. 461–471, 12 figs. Made from deposits containing 50 per cent water.

Pulverized. The Utilization of Pulverized Peat, C. F. Herington. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 60–62, 2 figs. Experience of plants in Minneapolis, Minn.

PENDULUM

Complex Motion. Study of Complex Pendular Systems (Études sur les systèmes pendulaires complexes), Luc Denis. Vie technique & industrielle, vol. 2, no. 15, Dec. 1920, pp. 235–236, 4 figs. Pendulum mounted on mass possessed of alternating rotary motion. (To be continued.)

PETROLEUM

Products of, Transporting. Hazards of Handling and Transporting Volatile Petroleum Products, C. P. Bowie. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2195, Dec. 1920, 2 pp. Experiments showed that highly explosive mixtures of hydrocarbon vapors and air are produced when mixture contains 1.4 to 6 per cent hydrocarbon vapor and dangerous flashes may be produced with mixtures containing less or more than these proportions.

Refining. Petroleum Refining Process and Problems, H. H. Hill. Jl. Soc. Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 51–53. Common types of refining plants.

Sulphur in. Sulphur in Petroleum Oils, C. E. Waters. Technologic Papers Bur. of Standards, no. 177, Oct. 20, 1920, 26 pp., 1 fig. Theories concerning origin of sulphur and sulphur compounds which are found in crude petroleum. Tests for detection of sulphur are described and copper test is shown to be of great delicacy.

PIG IRON

Synthetic. Furnace Earns Cost in Two Months, Herschell L. Hatt. Foundry, vol. 49, no. 1, Jan. 1, 1921, pp. 30–32, 1 fig. Experience with home-made electric furnace operated for producing synthetic pig iron from steel scrap.

Makes Pig Iron in Novel Furnaces, Herschell L. Hatt. Iron Trade Rev., vol. 68, no. 2, Jan. 13, 1921, pp. 149–151, 1 fig. Home-made electric furnace of simple construction operated for producing synthetic pig iron from steel scrap.

PIPE, CAST IRON

Founding. Cast Iron Pipe Founding at Fort William Plant, P. R. Hurley. Can. Foundryman, vol. 12, no. 1, Jan. 1921, pp. 17–19, 4 figs. Method and equipment of manufacturing cast-iron water and gas pipe.

How Soil Pipe Castings Are Made, Pat Dwyer. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 43–47 and 50, 7 figs. Standardized manufacturing practice at plant of Somerville Iron Works, Somerville, N. J.

PIPE LINES

Calculation. The Scientific Calculation of Pipe Lines (Une méthode scientifique pour le calcul des pipe-lines). Vie technique & industrielle, vol. 2, no. 15, Dec. 1920, pp. 229–233, 4 figs. Equations deduced from theory of flow of fluids on solids.

Valves. Effect of Small Gate or Valve in Larger Pipe Line, T. E. Lally. New England Water Works Assn., vol. 34, no. 4, Dec. 1920, pp. 302–311, 4 figs. Tests to determine loss of pressure.

PISTONS

Aluminum Alloys. Aluminum Alloy Pistons, Ernest V. Pannell. Metal Industry (N. Y.), vol. 19, no. 1, Jan. 1921, pp. 15–17, 8 figs. Advantages of aluminum, alloys in use, their treatment and design, and manufacture of pistons for gasoline motors.

PLANERS

Electrically Driven. Electrically Driven Planing Machine. Engr., vol. 130, no. 3390, Dec. 17, 1920, p. 619. Machine has stroke of 30 ft. and can accommodate work up to 12 ft. in width and 8 ft. in height. Including electrical equipment machine weighs about 100 tons. Driving motor is of 70 b.hp.

Practice in Machine-Tool Plants. Production Planing in Machine Tool Plants, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 409–419, 15 figs. Planer practice in number of plants building milling machines.

Safety Devices. Safety Arrangements for Plate-Edge Planing Machines (Sicherheitsvorrichtungen für Blechkantenhobelmaschinen), Hugo Becker. Zeit des Vereines deutscher Ingenieure, vol. 64, no. 49, Dec. 4, 1920, pp. 1033–1037, 8 figs. Different electric drives for plate-edge planing machines with right-angled beds; safety devices for preventing the tables from colliding at the junction of beds.

PLATES

Stresses in. The Bending Stress of Plates Under Concentrated Loads (Die Biegungsbeanspruchung von Platten durch Einzelkräfte), A. Nádai. Schweizerische Bauzeitung, vol. 76, no. 23, Dec. 4, 1920, pp. 257–260. Stress is determined by author in and near the pressure surface of a thick circular plate bent by a single force.

POWER GENERATION

Development in 1920. Review of the Year. Power, vol. 53, no. 1, Jan. 4, 1921, pp. 2–21. Tendencies in design and practice in power plant field, and economic problems that must be met. Adoption and promulgation of A.S.M.E. boiler code. Studies of steam engine, uniflow engine and high-speed turbo-blowers. Progress in accident prevention.

POWER PLANTS

Development. Engineering Developments of 1920–21. Elec. World, vol. 77, no. 1, Jan. 1, 1921, pp. 17–38, 35 figs. Important developments are classified under (1) generation and protection; (2) transmission and distribution; (3) science and research, and (4) lighting and industrial. Recent tendencies and practices as revealed by prominent installations carried out in 1920 are studied for each one of these divisions.

POWER STATIONS

Design. Unit Idea in Power Station Design, Louis R. Lee. Elec. Ry. Jl., vol. 57, no. 2, Jan. 8, 1921, pp. 73–76, 1 fig. Application of unit principle to generating plants as a whole.

POWER TEST CODES

Reciprocating Steam Engines. See STEAM ENGINES, A.S.M.E. Test Code.

POWER TRANSMISSION

Pneumatic. Essential Properties of Pneumatic Transmission in a Closed Cycle (Propriétés essentielles des transmission pneumatiques en cycle fermé), Jacques de Lassus. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 21, Nov. 22, 1920, pp. 992–995. Laws governing polytropic changes in cycle proposed in Comptes rendus, Nov. 8, pp. 899–901.

Power Transmission by an Invariable Mass of Gas in a Closed Space (Sur une transmission d'énergie méchanique utilisant unemassei nvariable de gaz en circuit fermé), Jacques de Lassus. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 899–901. Adiabatic compression in a closed space.

PRESSES

20-Ton. Power Press with Pressure Range to 20 Tons. Iron Age, vol. 107, no. 2, Jan. 13, 1921, p. 140, 1 fig. Pressure exerted upon work ranges from few pounds to 20 tons and is applied by operator on foot pedal.

PRESSWORK

Electric Motor Plant. Press Work in an Electric Motor Plant—II. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 340–344, 11 figs. Methods used in Power Press Department of General Electric Co., Lynn, Mass.

PROFIT SHARING

England. Teaching Workers to Think "Production," Cecil Chisholm. Factory, vol. 26, no. 1, Jan. 1, 1921, pp. 40–42. Experience in English works with profit-sharing systems.

PULVERIZED COAL

Advantages. Pulverized Coal. Power Plant Eng., vol. 25, no. 1, Jan. 1, 1921, pp. 56–60, 9 figs. Graph showing comparative heat values for various fuels.

[See also STEEL CASTINGS, Annealing.]

PUMPS, CENTRIFUGAL

Induction Motors for. Variables Speed Induction Motors for Centrifugal Pumps. Eng. News-Rec., vol. 85, no. 24, Dec. 9, 1920, pp. 1126–1127, 3 figs. Comparison of overall efficiencies for centrifugal unit, based on tests on motor-driven three-stage pump run at normal speed throttled or variable speeds unthrottled.

Turbine. New Contributions to the Theory of Side Thrust, Side-Thrust Equalizing Devices and Clearance Losses in Turbine Pumps (Neue Beiträge zur Theorie des Achsschubes, der Achsschubausgleichsvorrichtungen und Spaltverluste in Turbinenpumpen), L. W. Weil. Zeit. für das gesamte Turbinenwesen, vol. 17, nos. 25, 26, 28, 30 and 31, Sept. 10, 20, Oct. 10, 30 and Nov. 10, 1920, pp. 289–294, 301–307, 331–335, 356–358 and 369–372, 28 figs. Describes theoretically developed, practical and useful methods for calculation of side-thrust forces in turbine pumps and arrangements for combating them.

R

RAILS

Failure. Rail Failure Statistics for 1919, M. H. Wickhorst. Bul. Am. Ry. Eng. Assn., vol. 22, no. 229, Sept. 1920, pp. 47–87. Statistics of rail failure collected for year ending Oct. 21, 1919, furnished by railroads of United States and Canada, in response to circular sent out by American Railroad Association.

Flat-Bottom vs. Bull-Head. The Case of the Bull-Head Rail. Ry. Gaz., vol. 33, no. 23, Dec. 3, 1920, pp. 736–737. Comparison of relative advantages of flat-bottom and bull-head rails for railway track purposes.

RAILWAY CONSTRUCTION

Economics. Reeders for Railroads, Charles A. Morse. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 19–20. Economical factors involved in construction of branch lines.

RAILWAY ELECTRIFICATION

Canada. Electrical Operation on the Canadian National. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 25–29, 9 figs. Modification of original plan as result of amalgamation of Canadian Northern with Government railways.

Chicago. Chicago Electrification and Elevation C., M. & St. P. Ry. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, pp. 1226–1230, 9 figs. Third-rail passenger and trolley freight service on Evanston suburban line. Concrete walls and trestle. Precast and poured bridge decks.

European Developments. Status of Heavy Traction Abroad. Elec. Ry. Jl., vol. 57, no. 1, Jan. 1, 1921, pp. 31–36. Survey of practice in Great Britain colonies and in Continental Europe.

France. Partial Electrification of the French Railways (Electrification partielle des Chemins de fer français), A. Tretél. Électricien, vol. 36, no. 1265, Dec. 1, 1920, pp. 505–514. Progress in carrying out projects for electrification of three of principal French railways.

India. The Electrification of Indian Railways. Engr., vol. 130, nos. 3387–3388, Nov. 26–Dec. 3, 1920, pp. 530–531, 3 figs, 550–551, 4 figs. Comparative performance of electric and steam locomotives of Indian Northwestern Railway.

Operating Results from. The Electrification of Steam Railroads. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 101–106, 8 figs. Brief survey of operating results on Norfolk & Western and C. M. & St. P.

Tunnels. New Catenary Construction for the Hoosac Tunnel. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 17–20, 6 figs. Tunnel is $4^3/_4$ miles in length, being longest in U. S. Renewal of overhead equipment under traffic.

St. Clair Tunnel Operation Most Successful, R. L. Herman. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 21–24, 6 figs. Grand trunk electrical installation. Tunnel is single-track tube 6032 ft. in length with approaches totalling 5603 ft.

Sweden. The Electrification of the Swedish State Railroads (Die Elektrisierung der schwedischen Staatsbahnen), Axel F. Enström, Emil Alm and Carl A. Rossander. Elektrotechnische Zeit., vol. 41, nos. 45 and 46, Nov. 11 and 18, 1920, pp. 893–896 and 913–916. Expert testimony of a commission appointed by the Royal Swedish State Railroad Administration setting forth relative merits of direct current and single-phase alternating current. For the section Gothenburg-Stockholm preference is given to the single-phase alternating current, and it is recommended that motive power be generated in part directly in power station and in part through conversion from three-phase current at one or a few points.

Switzerland. Electrification of the Sion-Lausanne Lines of the Swiss Federal Railways (Electrification de las ligne Sion-Lausanne des C F F). Bulletin Technique de la suisse romande, vol. 46, no. 24, Nov. 27, 1920, pp. 277–278. Details of project.

The Electrification of the Swiss Railways (L'électrification des chemins de fer Rhétiques), H. Lang. Bulletin technique de la Suisse romande, vol. 46, no. 25, Dec. 11, 1920, pp. 289–294, 9 figs. Single-phase system at 10,000-volts and $16^2/_3$ periods per second has been decided upon.

RAILWAY OPERATION

Train Control. The Marvel of Train Control, Robert G. Skerrett. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 63–65, 4 figs. System for automatic action of air and steam hose of railway cars.

RAILWAY SIGNALING

Block System. Absolute Block-System with Closed Sections Worked by Means of the Telephone on the Belgian State Railways, L. Weissenbruch and J. Verdeyen. Bul. Int. Ry. Assn., vol. 2, no. 12, Dec. 1920, pp. 878–888. Records of operation.

Wireless Waves. Repetition of Track Signals on Board the Locomotive (Étude sur la répétition des signaux de voie à bord des locomotives), J. Bethenod. Radioélectricité, vol. 1, no. 6, Nov. 1920, pp. 292–297, 5 figs. Survey of applications of principles of wireless telegraphy to the repetition of danger and other signals on the cab of locomotive. Comparative study of schemes developed in France with those devised in United States. (To be continued.)

RAPID TRANSIT

New York City. Functions of Rapid Transit Lines in Cities, Henry M. Brinckerhoff. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, pp. 1235–1239, 1 fig. Capabilities of subways, elevated railways and surface lines compared from statistical records of New York City.

REFRIGERATING MACHINES

Carbon-Dioxide. The Escher Wyss & Co. Carbon-Dioxide Ice and Refrigerating Machine (Kohlensäure-Eis- und Kühlmaschine System Escher Wyss & Co.). Zeit. für Sauerstoff- u. Stickstoff-Industrie, vol. 12, no. 19–20, Oct. 1920, pp. 77–80, 3 figs. Based on evaporation of CO_2 and its condensation through compression and cooling. Advantages are said to be that machine consists of only three parts. Refrigerator, compressor and condenser, and no distillation or rectifying apparatus are required; the CO_2 is chemically inactive and, therefore, does not affect any of machine parts or packing material; purity of cooling water remains unchanged. Other advantages are durability, easy manipulation, low cost, minimum depreciation, lack of danger, etc.

REFRIGERATING PLANTS

Fish Freezers. St. Pierre Fish Freezer. Refrig. World, vol. 56, no. 1, Jan. 1921, pp. 11–16, 9 figs. Fish freezing and storing plant built for French Government on Island of St. Pierre. Machinery equipment and storage facilities are designed to take care of freezing of 200,000 bbls. of fish in 24 hr. and storing of 6,000,000 lb. of frozen fish, boxed ready for shipment.

Gas Power for. Gas Power for Refrigerating Plants, Geo. H. Trout. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 9–10. Cost of operation. Advantages of gas power.

Packing Plants. New Armour Plant at Kansas City. Power, vol. 52, no. 25, Dec. 21, 1920, pp. 966–969, 5 figs. Horizontal ammonia compressor of 500-ton capacity and generating units with mixed-pressure turbines of extraction type.

Safety Regulations. Safety Regulations for Refrigerating Plants, G. H. Crawford. Power, vol. 53, no. 1, Jan. 4, 1921, pp. 28–30, 7 figs. Study of regulations of various cities and states.

REFRIGERATION

Fish. Fish Research Committee. Interim Report on Its Investigations. Cold Storage, vol. 23, no. 273, Dec. 16, 1920, pp. 310–312, 1 fig. Suggested model low-temperature brine-freezing fish tank.

Standard Ton. Standard Ton of Refrigeration, F. E. Matthews. Refrig. World, vol. 56, no. 1, Jan. 1921, pp. 16–17. It has been defined by adoption of recommendations of special committee by Am. Soc. Refrigerating Engrs. at 288,000 B.t.u.

Standard Unit of Refrigeration, F. E. Matthews. Ice & Refrigeration, vol. 60, no. 1, Jan. 1921, pp. 49–50. Unit of 288,000 B.t.u. has been officially adopted by Am. Soc. Refrigerating Engrs.

RESEARCH

Developments in. 1920: A Retrospect. Chem. Age (Lond.), vol. 4, no. 81, Jan. 1, 1921, pp. 4–6. Developments in research, industry and invention.

Engineering Foundation. Engineering Foundation: Its Work and Needs, Alfred D. Flinn. Min & Sci. Press, vol. 122, no. 3, Jan. 15, 1921, pp. 86–87. Advisability of establishment by Engineering Foundation of Engineering Research Institute and Laboratory.

Industrial Associations. Industrial Research Associations—IV, Arnold Frobisher. Nature (Lond.), vol. 106, no. 2666, Dec. 2, 1920, pp. 443–446. British Research Association for woolen and worsted industries.

Industrial Research Associations—V, S. G. S. Panisset. Nature (Lond.), vol. 106, no. 2667, Dec. 9, 1920, pp. 475–476. British Portland Cement Research Association.

Industrial Research Associations—VII, H. S. Rowell. Nature (Lond.), vol. 106, no. 2669, Dec. 23, 1920, pp. 538–540. Research Association of British motor and allied manufacturers.

Lumber Industry. Research and Boards, Ovid M. Butler. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 59–62, 6 figs. Need of establishing laboratories to study problems of lumber industry.

Machinery. Complete Laboratory for Research in Machinery. Iron Trade Rev., vol. 68, no. 2, Jan. 13, 1921, pp. 152–153, 4 figs. Research laboratory of National Lamp Works of General Electric Co., Cleveland installed to test and to study further development of machines used in manufacture of lamps.

Paper. Progress of U. S. Paper Laboratory in 1920. Paper, vol. 27, no. 18, Jan. 5, 1921, pp. 14–16. Important work has been done on paper-testing machines, paper substitutes, determination of sizing, quality of paper, fibre studies, etc.

RIVETS

Heating by Electricity. Heating Rivets by Electricity, J. R. Bower. Jl. Engrs. Club of Phila., vol. 38–1, no. 193, Jan. 1921, pp. 1–7, 14 figs. Principle of operation and details of construction of electric rivet heater. Comparison of heating rivets by electricity with other methods of heating.

Standards. Report of the German Industry Committee on Standards (N D I) (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 69–81, 14 figs. Proposals of the Board of Directors for round-head rivets for boiler and steel construction, symbols for rivets and screws in iron structures; countersunk-head rivets, etc. Proposed standards for concrete boundary and milestones; drain-pipe laterals; sheet-metal rivets; rules of the Committee for Units and Formular Values (AEF).

ROLLING MILLS

Electrically Driven. Electric Blooming Mill in Delaware. Iron Age, vol. 106, no. 27, Dec. 30, 1920, pp. 1733, 1 fig. Plant of Penn Seaboard Steel Corp. Rolling capacity consists of 34-in. two-high reversing blooming mill.

Operation. Practical Pointers on Rolling Mill Operation, W. S. Standiford. Can. Machy., vol. 24, no. 26, Dec. 23, 1920, pp. 555–558, 2 figs. Comparison of English and American methods of rolling

S

SAFETY

Compressed-Air Work. Revised Rules on Compressed-Air Work in New York. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, p. 1225. Conference of engineers, contractors, workmen and state departments adopts measures for safety of men and work.

Industrial. Securing Safety Through Competition. Iron Age, vol. 106, no. 26, Dec. 23, 1920, p. 1679, 1 fig. Plan of Dodge Mfg. Co. consists in dis-

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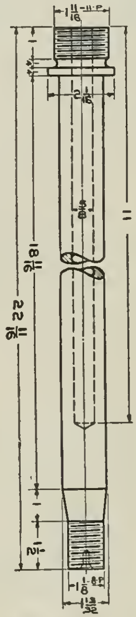

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DAYTON OFFICE: 518 Mutual Home Building INDIANAPOLIS OFFICE: 940 Lemcke Annex

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Young & Vann Supply Company, Birmingham, Ala.
Woodward, Wight & Company, New Orleans, La.
Salt Lake Hardware Company, Salt Lake City, Utah.
Smith-Booth-Usher Company, Los Angeles, Calif.
Fred Ward & Son, San Francisco, Calif.
Portland Machinery Company, Portland, Ore.
Hallidie Machinery Company, Seattle, Wash.
Hendrie & Bolthoff Mfg. & Supply Company, Denver, Col.
Peden Iron & Steel Company, Houston, Texas.

Canadian Agents:
A. R. Williams Machinery Company, Ltd., Toronto, Winnipeg, Vancouver, St. John.
Williams & Wilson, Ltd., Montreal.

Foreign Agents:
Charles Churchill & Company, Ltd., London, Birmingham, Manchester, Bristol, Newcastle-on-Tyne, Glasgow.
Allied Machinery Company, Paris, Turin, Zurich, Barcelona, Brussels.
Wilhelm Sonesson Company, Malmo, Copenhagen, Stockholm, Gothenburg.
R. S. Stockvis en Zonen, Rotterdam.
Benson Brothers, Sydney, Melbourne, Adelaide.
Yamatake & Company, Tokyo, Osaka, Nagoya, Fukuoka, Dairen
McLeod & Company, Calcutta.
Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong

ENGINEERING INDEX (Continued)

tributing small cash prizes to workers and arousing competition in departments.

Standards. Safety Standards of the Industrial Board. Commonwealth of Pennsylvania. Dept of Labor & Industry, vol. 1, no. 4, 9 pp. Railings, toe boards, platforms and runways.

SAND BLAST

Apparatus. Sand-Blasting, C. W. Starker. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 458–462, 11 figs. Types of apparatus, abrasives, nozzles, air pressures, dust exhausting, etc.

SCIENTIFIC INSTRUMENTS

Manufacture. Operations in the Manufacture of Scientific and Optical Instruments—I. Machy. (Lond.), vol. 17, no. 431, Dec. 30, 1920, pp. 389–395, 13 figs. Works of T. Cooke & Sons, York, England.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCRAP

Crushing Metal Chips. The Crushing of Iron, Steel and Metal Chips (Zerkleinerung der Eisen-, Stahl- und Metallspäne), R. Philipp. Betrieb, vol. 3, no. 3, Nov. 10, 1920, pp. 67–72, 20 figs. Account of a number of tests carried out by different concerns, and description of special machine said to operate on what resembles the American Hartness process, differing from this only in the forced travel of the chips. Its useful possibilities are pointed out.

SCREW MACHINES

Circular Forming Tools. Design of Circular Forming Tools, Earl H. Smiley and J. H. Davis. Machy. (N. Y.), vol. 27, no. 4, Dec. 1920, pp. 366–369, 6 figs. Calculations for designing circular forming tools having top rake.

SCREW THREADS

Milling, Side-Cutting of Hobs in. Side-Cutting of Thread-Milling Hobs, Earle Buckingham. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 9–11 and 62, 5 figs. Mathematical study of side-cutting action of hob. Corrections in form of thread-milling hobs to produce threads sufficiently correct as to form for all practical purposes are pointed out.

SCREWS

Manufacture. The Economical Manufacture of Rolled and Cut Screws (Die wirtschaftliche Herstellung von blanken und blank bearbeiteten Schrauben), Curt Güssow. Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 91–92, 3 figs. States that economic production of such screws and nuts is dependent upon number of pieces and resulting loss of material. Explains when work should be done on hand lathe, automatic lathe and on hot press.

SCREWS

Optical Work. Cutting and Gaging Screws. Machy. (Lond.), vol. 17, no. 428, Dec. 9, 1920, pp. 286–288, 4 figs. Method used by Taylor, Taylor & Hobson, Leicester, England. Table of tolerances for screw gages for optical work. Report of Committee of Department of Scientific and Industrial Research on Standardization of Elements of Optical Instruments.

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, nos. 3 and 4, Nov. 10 and 25, 1920, pp. 29–40 and 49–62, 31 figs. Nov. 10: Proposals of Board of Directors for square washers for channels and I-beams. Proposed new standards for Whitworth fine thread, metric fine thread, and sizes for paper sheets; Nov. 25: Proposals for Whitworth pipe threads; lock washer; square washers for wooden joints; knob screws and nuts. Proposed standards for set screws and of screws with slotted heads, set screws; metric extra-fine thread.

SEMI-STEEL CASTINGS

Experiments. Remarks on Semi-Steel Castings (Remarque sur la fonte aciérée). Fonderie Moderne, no. 11, Nov. 1920, p. 262. Experimental study of casting temperature.

SHAFT HANGERS

Reinforced-Concrete Plants. Securing Shaft Hangers to Beams in Reinforced Concrete Plants, S. R. Stone. Belting, vol. 18, no. 1, Jan. 1921, pp. 32–38, 15 figs. Providing for expansion of departments or changes. Preplanning necessary to avoid alterations. Sleeved slits for belt drives between floors.

SHAFTS

Whirling Speeds. The Transverse Vibrations of Beams and the Whirling of Shafts Supported at Intermediate Points, E. R. Darnley. Lond., Edinburgh & Dublin Phil. Mag., vol. 41, no. 241, Jan. 1921, pp. 81–96, 1 fig. Equations giving periods of transverse vibrations of uniform beams and whirling speeds of uniform shafts, when beams or shafts are simply supported at any number of intermediate points.

Torsional Oscillations. Torsional Oscillations of Transmission Shafts (Studio sulle oscillazioni torsionali degli alberi di trasmissione), Ottorino Sesini. Associazione nazionale degli Ingegneri italiani Giornale Ufficiale, vol. 1, no. 33, Nov. 30, 1920, pp. 255–260, 7 figs. Mathematical study.

SHIP PROPULSION

Air-Propeller. Hydrogliders and Barge Propelled by Air Propellers (Hydro-glisseurs et chalands a propulsion aerienne), René Pacaud. Revue de l'Ingénieur et Index Technique, vol. 27, no. 4, Oct. 1920, pp. 257–263, 3 figs. Technical application of air propeller to barges.

Hydro-Aerial Propellers. Hydro-Aerial Propulsion for Ships (Bateaux a propulsion hydro-aérienne), A. Breton. Nature (Paris), no. 2434, Nov. 27, 1920, pp. 351–352, 5 figs. Invention of M. A. Gambin. Two propellers are placed on parallel shafts in stern of ship. About $^1/_4$ of diameter of propellers goes under water, and propellers rotate in opposite directions. Reaction of stream of water sent against stern as well as propulsive action due to part immersed in water, propel the boat.

SHIP SALVAGE

Dredger. The Salvage of the Dredger "Silurus." Eng., vol. 111, no. 2871, Jan. 7, 1921, pp. 5–8, 11 figs. Vessel was 260 ft. by 46 ft. by 20 ft. She rested on her port bulwarks and top of port sheerstrake and with part of her funnel embedded in mud about 54 ft. below water level. Detailed account of salvage work. (To be continued.)

SHRINKAGE

Stresses in. Shrinkage Stresses in Hubs, Rings, Cranks, etc. (Strumpfspannungen in Naben, Ringen, Kurbelarmen, etc.), Karl Stösser. Der praktische Maschinen-Konstrukteur, vol. 53, no. 41–42, Oct. 14, 1920, pp. 353–359, 6 figs. Describes method for approximate determination of shrinkage stresses resulting from the hot and cold fitting of crank arms, hubs, rings, etc., to shafts; the stresses are shown graphically and an example is given.

SPRINGS

Helical. Chart and Simplified Formulæ for Helical Springs of Tempered Steel. Machy. (Lond.), vol. 17, no. 429, Dec. 16, 1920, pp. 318–319, 1 fig. Chart for determining carrying capacity, deflection and dimensions of tempered steel helical springs, tension or compression.

STANDARDIZATION

Machine Tools. The Effect of Standardization on Lathe Centers (Wirkung der Normung von Drehbankspitzen), H. Plumpe. Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 94–97, 3 figs. An example is cited showing advantages of a comprehensive standardization of the parts of machine tools which must be frequently renewed.

System of Fit Allowances. A System of Fit Allowances, Sydney B. Austin. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 452–454, 3 figs. Curves showing relation of allowances for fits to various diameters. Comparison of theoretical curves with B. & S. system of fit allowances and with Newall Engineering Co.'s system of fits.

STEAM-ELECTRIC PLANTS

Design. Tendencies in the Design of Power Stations, Peter Junkersfeld. Elec. World, vol. 77, no. 1, Jan. 1, 1921, pp. 5–7, 5 figs. Economies resulting from skillful arrangement of station and layout of equipment and operating tendencies in boiler and turbine rooms. Survey of principal achievements in 1920.

France. The Electric Plant of the French State Railways at Nanterre, Seine (L'usine électrique des chemins de fer de l'etat à Nanterre (Seine), Lucien Pahin. Industrie électrique, vol. 29, no. 684, Dec. 25, 1920, pp. 466–470, 2 figs. Turbo generators of 5500 kw. each generating 3-phase current at 50,250 volts.

Signal Indicators. Adapting Signal Indicators to Power Plant Use, H. P. Sparkes. Elec. World, vol. 76, no. 26, Dec. 25, 1920, pp. 1251–1252, 2 figs. Apparatus consists of two synchronous motors connected so that when rotor of one transmitter, is placed in certain position rotor of other, indicator will be in exact synchronism and will thus indicate position at which transmitter is set. Apparatus was constructed during war for use on board U. S. Navy vessels and is being applied to transmitting signals from switchboard to boiler room in electric plants.

280,000-Kw. Building 280,000-Kw. Plant in New York City. Elec. World, vol. 77, no. 3, Jan. 15, 1921, pp. 140, 1 fig. Generator room adjacent to river to eliminate suction tunnels. Four units of 35,000 kw. each to be installed at outset.

STEAM ENGINES

A.S.M.E. Test Codes. Power Test Codes. Mech. Eng., vol. 43, no. 1. Jan. 1921, pp. 32–36, 1 fig. Preliminary draft of test code for reciprocating steam engines, formulated by Am. Soc. Mech. Engr. Test Code Committee.

STEAM TURBINES

Lubrication. The Lubrication of Steam Turbines (La lubrification et le système de graissage des turbines à vapeur), C. P. Roux. Revue générale de l'Électricité, vol. 8, no. 25, Dec. 18, 1920, pp. 870–872, 1 fig. Suggested specifications for oils and greases.

Small Machines. Small Steam Turbines, W. J. A. London. Proc. Engrs. Soc. Western Pennsylvania, vol. 36, no. 8, Nov. 1920, pp. 539–564 and (discussion) pp. 565–573, 15 figs. Study of reliability, simplicity, cost and efficiency. Turbines considered are those having output of from 5 to 300 hp.

STEEL

Defects. Defects Arising in Steel During Fabrication, Austin B. Wilson. Chem. & Metallurgical Eng., vol. 23, no. 25, Dec. 22, 1920, pp. 1209–1213, 24 figs. Microscopic appearances caused by surface defects, cold-working, overheating, and burning. Nuclei of fatigue fractures are associated with phosphorus bands. Photographs of changes in structure during annealing of steel castings are also given.

Magnet. On K. S. Magnet Steel, Kotaro Honda and Shozo Saito. Physical Rev., vol. 16, no. 6, Dec. 1920, pp. 495–500, 7 figs. Also Elecn., vol. 85, no. 2222, Dec. 17, 1920, pp. 706–708, 7 figs. Alloy developed in research work at Tokyo University. Composition is cobalt 30 to 40 per cent, tungsten, 5 to 9 per cent, and chromium $1^1/_2$ to 3 per cent. Tempering is best effected by heating to 950 deg. cent. and quenching in heavy oil. Measurements of residual magnetism for specimens of different composition gave values from 920 to 620 C. G. S. units; coercive force for same specimens ranged from 226 to 257 gauss.

Manganese. See MANGANESE STEEL.

Nickel. See NICKEL STEEL.

Nickel-Chromium. See NICKEL-CHROMIUM STEEL.

Research. Research on Steel Conducted in Germany During the War (Etudes faites en Allemagne durant la guerre, sur la connaissance des aciers), Gaston Paris. Chaleur et Industrie, no. 7, Oct. 1920, pp. 408–418, 10 figs. Influence of chemical composition and mechanical properties. Graphs showing properties of specimens subjected to different treatments.

Shock Values after Heat Treatment. Comparative Shock Values of Steel after Varied Heat Treatments, F. C. Langenberg and J. F. Fetterely. Army Ordnance, vol. 1, no. 2, Sept.-Oct. 1920, pp. 99–100. Results of tests.

Structural. See STRUCTURAL STEEL.

Welding. The Welding of Steel in Relation to the Occurrence of Pipe, Blowholes and Segregates in Ingots, Harry Brearley. Iron & Coal Trades Rev., vol. 101, no. 2755, Dec. 17, 1920, pp. 821–822. Experimental studies. Paper read before Cleveland Instn. Engrs.

Woody Fractures. The Woody Fracture in Steel (Ueber den Holzfaserbruch im Stahl), E. H. Schulz and J. Goebel. Stahl u. Eisen, vol. 40, no. 44, Nov. 4, 1920, pp. 1479–1485, 21 figs. With the aid of sample pieces the different formations of woody fractures in steel are discussed and it is shown that the causes therefor can be of very different origin. The two main groups of such fractures are described.

STEEL CASTINGS

Annealing. Anneal Steel with Pulverized Coal, C. H. Gale. Foundry, vol. 49, no. 1, Jan. 1, 1921, p. 29, 4 figs. Results of annealing steel castings with pulverized coal. Paper read before Am. Foundrymen's Assn.

Strength. Steel Castings of High Strength and Toughness—I, Frederico Giolitti. Chem. & Metallurgical Eng., vol. 24, no. 3, Jan. 19, 1921, pp. 113–118, 22 figs. Data on improvement to be expected after properly heat-treating steel castings, with illustrative tests on strong, tough castings which have replaced forgings on gun mounts. Advance copy of chapter of forthcoming book entitled, "Heat Treatment of Soft and Medium Steels."

STEEL MANUFACTURE

Electric-Furnace. Heat Modifies Acid Furnace Reaction, James W. Galvin and Charles N. Ring. Foundry, vol. 49, no. 2, Jan. 15, 1921, pp. 72–74. Electric furnace develops such high temperatures that chemical affinities in still are reversed. Steep sides with deep bath increase melting efficiency and compact charge is advocated.

STEEL WORKS

Coal Consumption. Coal Consumption in Steel Metallurgy (La consommation de charbon dans la grosse métallurgie). Génie Civil, vol. 77, no. 25, Dec. 18, 1920, pp. 499–503. Records of coal consumption of steel works producing 300,000 tons per year.

Two-Shift vs. Three-Shift System. The Three-Shift System in the Steel Industry, Horace B. Drury. Indus. Management, vol. 61, no. 1, Jan. 1, 1921, pp. 63–68, 5 figs. Survey of adoption of three-shift system in European countries, and account of its operation in about 20 American plans where it has been adopted. Paper read before Taylor Society.

STREET RAILWAYS

Brakes. See BRAKES, Street-Car.

STRESSES

Determining by Polarized Light. Determining Stresses by Polarized Light, George Weed Hall and Arthur L. Kimball, Jr. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 49–53, 7 figs. Apparatus which permits visualization of stress distribution.

Stress Determination by Means of the Coker Photo-Elastic Method, A. L. Kimball, Jr. Gen. Elec. Rev., vol. 24, no. 1, Jan. 1921, pp. 73–81, 13 figs. Optical system for determining stress by polarized light.

Safe Loads. Chart for Determining Safe Loads, J. B. Conway. Am. Mach., vol. 53, no. 27, Dec. 30, 1920, pp. 1241–1242. Chart for determining safe load for parts in tension, compression and shear where part does not exceed in length, ten times its diameter. Chart is based upon formula for determining safe load in different materials.

Study of. Plane Stress and Plane Strain in Bipolar Co-Ordinates, G. B. Jeffery. Philosophical Trans. Royal Soc. Lond., vol. 221, series A, Aug. 11, 1920, pp. 265–293, 4 figs. Mathematical study.

Theories. Comparison of the Extension and Shearing Stress Theories (Beitrag zum Vergleich der Dehnungs- und Schubspannungstheorie), H. Boote.

ENGINEERING INDEX (Continued)

Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 51, Dec. 18, 1920, pp. 1071–1073, 7 figs. The sudden yielding of the test pieces of ordinary soft low-carbon steel at upper yield point is used to demonstrate superiority of the formula for the simultaneous tensile and twisting stress over analogous formulas. Results of experiments are said to be particularly valuable due to fact that according to shearing stress theory, cross-sections would be greater, whereas the extension theory in this respect gives not only more correct values of stress, but also smaller construction weights.

STRUCTURAL STEEL

Specifications. Belgian Standard Specification for Structural Steelwork. Eng. News-Rec., vol. 86, no. 2, Jan. 13, 1921, pp. 71–72. Specifications for design and fabrication of steelwork for buildings and miscellaneous steel structures adopted by Belgian Standards Association.

T

TARGET

Towed, for Battleships. See WARSHIPS, Towing Target.

TERMINALS, RAILWAY

Management. Utilizing Motive Power on the Lines of the Delaware & Hudson. Ry. Rev., vol. 67, no. 26, Dec. 25, 1920, pp. 961–967. Methods of terminal management.

Operation. Railway Terminals and Terminal Yards, William Barclay Parsons. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 21 and 62. Cost of terminal operation and possibilities of reducing it.

TESTS AND TESTING

Flexure. An Apparatus for Delicate Flexure Tests and Some Results of Such Tests, W. J. Francke. Am. Mach., vol. 54, no. 2, Jan. 13, 1921, pp. 48–52, 5 figs. Apparatus designed to test thin, tempered strip-steel shims used in flexible couplings. Paper read before Am. Soc. for Testing Matls.

Million-Pound Machine. Million Pound Testing Machine for Forest Products Laboratory, L. J. Markwardt. Eng. News-Rec. vol. 86, no. 1, Jan. 6, 1921, pp. 31–32, 2 figs. Machine is of two-screw type and has overall height of 45 ft., including superstructure above weighing platform, which will enable it to accommodate columns up to 30 ft. or tension members up to 27 ft. in length.

Motion Pictures, Use in. Motion Pictures in Physical Testing Laboratory, H. J. French. Chem. & Metallurgical Eng., vol. 24, no. 3, Jan. 19, 1921, p. 131, 4 figs. Application of moving-picture camera to testing of materials.

Notched-Bar Tests. Experimental Study of Notched-Bar Impact Tests (Étude expérimentale sur les essais au choc des barreaux entaillés), M. André Cornu-Thénard. Revue de Métallurgie, vol. 17, no. 10, Oct. 1920, pp. 648–667, 6 figs. Case of extra-mild steel crystallized in large drains. Photomicrographs. (Concluded.)

Photo-Elastic Testing. Photo-Elasticity for Engineers—III, E. G. Coker. Gen. Elec. Rev., vol. 24, no. 1, Jan. 1921, pp. 82–88, 10 figs. Discussion of photo-elastic investigation of testing materials in tension. It is shown that if enlarged ends of test bar are connected with parallel part by arcs of circle stress near joint of arc with parallel portion is somewhat greater than that in parallel portion.

THERMODYNAMICS

Carnot-Clausius Principle. Application of Carnot-Clausius Principle to Impact Waves in Elastic Solids (Application du principe de Carnot-Clausius aux ondes de choc des solides élastiques), E. Jouguet. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 904–907. Conditions which Carnot-Clausius principle imposes on impact waves of solids when these waves originate discontinuities of not too great an amplitude.

TIDAL POWER

Development. Tidal Power Development, A. H. Gibson. Eng., vol. 110, nos. 2867–2868, Dec. 10–17, 1920, pp. 778–780, 6 figs., and 793–795, 11 figs. Outline of more promising schemes which have been suggested and patented.

Utilization of. Blue Coal (La houille bleue), R. Gouedard. Vie technique & industrielle, vol. 2, no. 13, Oct. 1920, pp. 17–24, 8 figs. Scheme for utilization of tidal power by means of low-head turbines. (Concluded.)

Report on Tidal Power. Engr., vol. 130, no. 3390, Dec. 17, 1920, pp. 614–615. Third interim report of Water Power Resources Committee appointed by British Board of Trade. Discussion of question of tidal power, with reference to project for utilizing 500,000 hp. of tidal energy in estuary of Severn River.

Studies in Tidal Power, Norman Davey. Engr., vol. 130, nos. 3388–3392, Dec. 3, 10, 17, 24 and 31, 1920, pp. 556–558, 578–580, 603–604, 634–636, and 652–654, 25 figs. Dec. 3: Classification and study of systems for conservation and use of tidal power; Dec. 10: Quantitative estimate of tide power cycles; Dec. 17: Analysis made of gross power available from tides under various systems of working, and change in this power factor examined under variations in tidal range; Dec. 24: Survey of tidal power available in England; and Dec. 31: Minimum constant hp. available from tides in England and Scotland is computed at 489,000 hp.; this value rising during springs to 1,555,000 hp. Gross totals of intermittent power are, minimum during neaps, 3,550,000 hp. and during springs, 15,300,000 hp.

Tidal Hydro-Electric Scheme for the Severn. Engr., vol. 130, no. 3388, Dec. 3, 1920, pp. 562–563, 1 fig. Discussion of scheme formulated by Civil Engineering Department of Ministry of Transport.

Utilization of Tidal Power and Energy of Wave Impact (Utilisation de la force des marées et du choc des vagues de la mer), H. Parenty and G. Vandamme. Comptes rendus des Séances de l'Academie des Sciences, vol. 171, no. 19, Nov. 8, 1920, pp. 896–898, 2 figs. Cement structure containing parallel cells along coastal region subjected to ebb and flow. Impact of water in cells compresses air in tanks behind cement structure.

Utilization of Tidal Power on the Coast of France (De l'utilisation des courants de marée sur les côtes de France), M. La Porte. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 24, Dec. 13, 1920, pp. 1205–1207. Study of points where utilization is most practicable.

TIME STUDY

Machining Operations. Determination of the Time Required for Machining Operations (Bestimmung der Arbeitszeiten für die Vorkalkulation im Maschinenbau), H. Eipel. Motorwagen, vol. 23, nos. 22 and 23, Aug. 10 and 20, 1920, pp. 409–413, 23 figs. 4 on 2 supp. plates. Calculating charts for determining time employed in turning and grinding, drilling and cutting thread, planing and slotting and milling and sawing.

Siemens-Schuckert Works. Application of Time Study in Large Industrial Plants (Anwendung der Zeitstudie im Grossbetrieb), C. W. Drescher. Betrieb, vol. 3, no. 5, Dec. 10, 1920, pp. 128–135, 7 figs. Describes practice and experiences in the electric motor plant of the Siemens-Schuckert Works.

TRACTOR ENGINES

Manufacture. Methods in a Tractor Engine Plant. Machy. (N. Y.), vol. 27, no. 5, Jan. 1921, pp. 424–427, 9 figs. Special machinery and unusual equipments for standard machine tools.

TRACTORS

Tests. More Results of Tractor Tests at Nebraska. Automotive Industries, vol. 43, no. 27, Dec. 30, 1920, pp. 1306–1308. Of Sixty-six tractors tested, eight have increased their rated engine speed, six lowered their horsepower rating, fourteen changed some item of equipment and three have withdrawn.

TRANSPORTATION

Coal Industry. The Transportation Problem in the Coal Industry, A. G. Gutheim. Ry. Age, vol. 69, no. 27, Dec. 31, 1920, pp. 1149–1152. Remarks of experience during war period.

Conditions in U. S. The New Era of Railroad Transportation in America, Lewis J. Spence. Ry. Age, vol. 69, no. 27, Dec. 31, 1920, pp. 1153–1154. Importance, both to carriers and shippers, of maintaining spirit of friendly coöperation. Paper read before National Industrial Traffic League.

Inland Waterways. Some Inland Waterway Transportation Problems, V. E. Lacy. Jl. Soc., Automotive Engrs., vol. 8, no. 1, Jan. 1921, pp. 59–62, 5 figs. Motive power for canal traction.

Railways. How the Need for More Motive Power Will be Met. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 43–46, 3 figs. New locomotives, remodeled old locomotives and improved operation of all locomotives imperative.

Railroad Transportation, Daniel E. Willard. Mech. Eng., vol. 43, no. 1, Jan. 1921, pp. 17–18. Fundamentals for developing a complete and well-articulated national transportation system.

Repair Shop and Enginehouse Equipment Needs. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 50–52. Large numbers of unserviceable locomotives and cars furnish strong argument for better facilities.

The Next Step Toward Preventing Depressions. Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 33–38, 11 figs. Stability of railway purchases offered as remedy by railway business association committee.

What Additions to Physical Property are Necessary? Ry. Age, vol. 70, no. 1, Jan. 7, 1921, pp. 39–43, 3 figs. Little increase in traffic possible without betterments in terminals and other facilities.

V

VALVES

Globe. Use and Abuse of Globe Valves. Ry. Rev., vol. 25, no. 67, Dec. 18, 1920, pp. 946–948, 2 figs. Recommends that railroads select one make of valve as standard for all their uses and maintain special globe valve repair and testing service.

Power Plants. Valves for Inconvenient Locations, Charles L. Hubbard. Power Plant Eng., vol. 25, no. 2, Jan. 15, 1921, pp. 111–115, 19 figs. Methods of reaching and operating in power plants.

VENTILATION

Ventilators. Recent Tests on Automatic Ventilators, A. J. Mack. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 9, Dec. 1920, pp. 849–853, 3 figs. Tests conducted by Engineering Experiment Station of Kansas State Agricultural College upon different types of ventilators. Effectiveness of different types when operated under varying conditions was studied, and comparative tests were made on syphon ventilator and those types not intended to produce any syphoning action.

VIBRATIONS

Study. The Photo-Radiograph, A. C. Banfield. Sci. Am. Monthly, vol. 3, no. 1, Jan. 1921, pp. 44–45, 6 figs. Instrument for study of vibrations.

W

WAGES

High. The Cost of Labor and the Labor-Cost, Elmer W. Leach. Am. Mach., vol. 53, no. 26, Dec. 23, 1920, pp. 1188–1189. Suggests that wages be kept up by reducing labor cost, that is increasing production per man.

WARSHIPS

Towing Target. The Metal Arc Welded Battle Towing Target Built at the Norfolk Navy Yard, James W. Owens and H. G. Knox. Welding Engr., vol. 5, no. 12, Dec. 1920, pp. 23–28. Constructed for experimental purposes by Bur. of Construction and Repair of U. S. Navy.

WASTE HEAT

Utilization. The Utilization of Exhaust Heat in Modern Factories (Abfallwärmeverwertung in modernen Betrieben), Ernst Blau. Der praktische Maschinen-Konstrukteur, vol. 53, nos. 37–38 and 39, Sept. 16 and 30, 1920, pp. 321–328 and 343–352, 21 figs. Details and illustrations of a number of recent German patents and devices for the utilization of waste heat from furnace plants, gas and Diesel engines, and from steam engines.

WASTE RECLAMATION

Industry. Utilization of Waste in Trade and Industry (Abfallwirtschaft in Industrie und Gewerbe) Betrieb, vol. 3, no. 4, Nov. 25, 1920, pp. 29–31. Gives working program proposed by the Bureau for handling the waste problem which was organized by the Committee for Economic Production (AWF) in conjunction with official authorities.

WATER HAMMER

Penstock. Water Hammer in Penstocks of High Reaction Turbines (Sur le coup de bélier dans les conduites forcées alimentant des turbines à forte réaction), M. de Sparre. Comptes rendus des Séances de l'Académie des Sciences, vol. 171, no. 18, Nov. 2, 1920, pp. 833–835. Modifications to be made in general formula for maximum water hammer in a conduit to make it applicable to case of penstocks.

Pipe Lines. Water Hammer in Pipe Lines, W. F. Durand. Eng. News-Rec., vol. 85, no. 26, Dec. 23, 1920, pp. 1212–1216, 6 figs. Studies extended to include effects of imperfect reflection at discharge end, friction, non-uniform change of valve opening and imperfect action of discharge opening as nozzle.

WELDING

Autogenous. See AUTOGENOUS WELDING.

Electric, Arc. See ELECTRIC WELDING, ARC.

Oxy-Acetylene. See OXY-ACETYLENE WELDING.

WELDS

Testing. The Testing of Welds in Steel Plates, S. W. Miller. Ry. Elec. Engr., vol. 12, no. 1, Jan. 1921, pp. 49–52, 9 figs. Conditions which affect quality of welds; simple bend test and etching of sections recommended. Paper read before Chicago Section, Am. Welding Soc.

WIND TUNNELS

Göttingen. German Wind Tunnels and Apparatus, Edward P. Warner. Aeronautics, vol. 19, no. 376, Dec. 30, 1920, pp. 468–469, 2 figs. Description of Göttingen wind tunnels. (To be continued.)

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The Present Trend of Turbine Development

A Brief Survey of Past History and Recent Progress, Together with a Discussion of Theoretical Problems Involved in the Hydraulics of the Modern High-Speed Turbine

By LEWIS F. MOODY,[1] PHILADELPHIA, PA.

IN order to gain some idea of the direction in which the development of the hydraulic turbine is tending, it is useful to consider the path by which the turbine has reached its present condition. There are a few phases of the turbine's evolution which are worth noting, and these will be briefly mentioned.

The early turbines, during the first half of the last century, were most frequently of the single-runner, vertical-shaft type, usually set in open flumes, and having, at the choice of the builder, outward-flow, axial-flow, or inward-flow runners. After about 1850 the turbine began to develop along more theoretical lines, and much highly creative work was done on it by such engineers as Howd, Swain and Francis in America and Fourneyron and Jonval in Europe.

As an example of the early turbine forms, Fig. 1 is given, showing one of the Geyelin-Jonval turbines built by the I. P. Morris Co. and installed at the Fairmount Water Works, Philadelphia, in 1860. The regulation was furnished by a cylinder gate at the discharge from the draft tube.

Upon the advent of electrical power, the turbine began to experience rapid evolution. The requirements for driving electrical generators immediately called for great increases in the capacities of turbine units, and also demanded increases in speed. The simple form of single-runner, vertical-shaft turbine, such as that of Fig. 1, began to receive elaboration. At first two runners, and then still more runners were placed on a single shaft, and the vertical arrangement of shaft was abandoned in favor of horizontal-shaft units, as many as eight runners sometimes being placed in a single turbine.

The demands for close regulation of speed in the development of electrical power led to the improvement of gate mechanisms, and this also produced complication. Instead of the early cylinder and register gates, wicket-gate or movable-guide-vane regulation was introduced, requiring a material increase in the number of moving parts and the amount of mechanism.

The increasing demands for large amounts of electrical energy caused a corresponding increase in the size of units, and this phase of development of the turbine has continued practically without interruption; and there are no indications that the peak has yet been reached. With the growth of unit capacities, the importance of the turbine and its engineering problems increased correspondingly. When the turbine had reached a size such that any interruption of a single unit's service, due to a breakdown, or to such troubles as blocking by trash or ice, would involve a loss of 10,000 or 20,000 hp., it no longer became desirable to install a low grade of machinery nor to place many of the working parts within the water passages where they would be inaccessible for inspection, lubrication, adjustment or repair. The direction of evolution then took the form of a return to a simpler machine, and it no longer became the style to place four or six runners in a flume, each runner having twenty or more separate movable guide vanes, with a large number of the parts of the mechanism for operating them entirely submerged.

[1] Consulting Engineer, I. P. Morris Department, The William Cramp & Sons Ship and Engine Building Company. Mem.Am.Soc.M.E.

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One of the notable installations in which this direction of development was followed to its logical conclusion was that of the Appalachian Power Co., including two plants having turbines all of the same design, these turbines being of the vertical-shaft, single-runner type, installed in volute casings formed in the concrete substructure of the power house. The Appalachian turbines (Fig. 2) were completed in 1912, and were the forerunners of a large number of notable installations which have followed all of the principal features exemplified by the Appalachian turbines, including the use of a cast stay-vane ring or so-called "speed ring" set in the concrete to stay the upper and lower walls of the casing together and to support the superimposed structure, a thrust bearing located above the generator to carry the revolving weights, and operating mechanism of the outside type placed in an open turbine pit in an easily accessible position, actuated by a hydraulic cylinder placed just above the turbine head cover.

When turbines of this type are built in the enormous sizes which are being adopted today, there is little possibility of the turbine being subjected to enforced shutdowns due to any accidental cause, such as trash or ice lodging in the runner or guide vanes, and the ruggedness of the machine, due to its being composed of a small number of heavy parts, provides strong assurance of operation through many years of continuous service. All working parts are accessible for lubrication. The size of these turbines in itself makes them independent of most of the ordinary vicissitudes.

In most of the early turbines no draft tubes were provided, the outflow loss from the runner being limited to small values and no attempt being made to regain the energy of the discharge. Straight draft tubes were then introduced with the vertical single-runner turbines, but in the multiple-runner units the use of several draft tubes in a single tail-race chamber frequently interfered with the flow, often introducing a serious loss of head. In many units curved draft tubes were adopted, of quarter-turn or elbow form, and in horizontal-shaft units central discharge draft chests were used common to a pair of runners. The elbow type of draft tube, however, was inherently unsuited to handle a whirling discharge from the runner, such as exists in turbines of high specific speed at all gate openings, and at part gate in all turbines.

With the adoption of the single-runner, vertical-shaft turbine, it became possible to provide volute casings in which the velocity of flow could be definitely determined at every point and all sudden changes in direction or velocity avoided. With the recent introduction of draft tubes which are symmetrical about the turbine axis, and the elimination of the elbow form of passage, it is now possible to conduct the water from intake to discharge without disturbances or eddy formation at any point.

The same sort of progress has taken place in the design of the guide vanes and runner. From the simple radial- or axial-flow types of guides and runners, the effort toward increased speeds and capacities resulted in the adoption of so-called "mixed-flow" runners with complicated forms of wheel vanes, the water changing in direction from inward to axial or even to outward flow within the runner. A series of such runners of modern type is shown in Fig. 3, the largest being one of the runners for the Cedars Rapids Mfg. & Power Co., P. Q., Canada, and the largest ever built.

In turbines of extremely high specific speed, suited for use under very low heads and for small powers, where efficiencies can be sacrificed to some extent to secure a lower first cost, there has been a return to simpler runner types, including the purely diagonal-

and the axial-flow runner. Such types seemed the logical development of the process of cutting back more and more the vanes of the high-speed "mixed-flow" runner. The trend of development has thus been toward a turbine in which there is a more gradual change in the direction of flow within the runner, the runner being closely related to the simpler types which preceded the mixed-flow runners. This change has simplified both the lines of flow and the forms of the runner vanes.

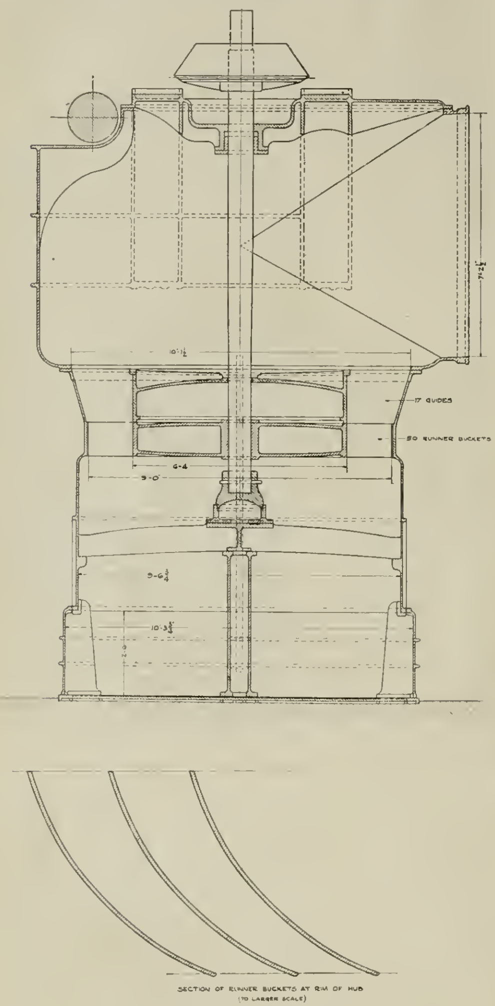


Fig. 1 I. P. Morris Company Turbine Installed at Fairmount Water Works, Philadelphia, in 1860

With the adoption of the mixed-flow type of turbine, academic methods of calculating the hydraulic elements of the design became less and less applicable, and for a number of years hydraulic engineers have been greatly handicapped by the lack of any satisfactory method of rational design due to the complicated form which the turbine has assumed, together with the natural difficulties inherent in practically every hydraulic problem. Little enough is known about the flow of water in simple forms of stationary conduits, and there are many uncertainties involved in the complex problems of hydraulic machines having rotating water passages such as the turbine and centrifugal pump. The theories given in the textbooks are not of much help in designing the turbines of today.

The writer believes that it will be worth while to give attention to some of the theoretical problems involved in the hydraulics of the modern turbine. Without attempting to develop a complete theory, a few considerations or "speculations" will be explained below which have a bearing on the further development of the turbine. In particular, it will be of interest to look into the possibilities of securing further increases in specific speed without undue sacrifice of efficiency.

Chief Elements of the Modern Turbine

The chief elements of the turbine of the present, and probably of the immediate future, are:

1 A casing in which the water can approach the runner symmetrically with respect to the axis on all sides, without any obstructions or enforced abrupt changes of flow which would introduce eddies or unsymmetrical distribution of velocity. The spiral or volute casing meets these conditions, and in most cases is the most satisfactory form of intake. On account of the increase in the velocity of the water from a low value in the intake to a high value where it passes through the runner, the water passage must contract radially as it approaches the runner, and must subsequently expand again. The approach of the water to the runner therefore involves a radial component of flow toward the axis;

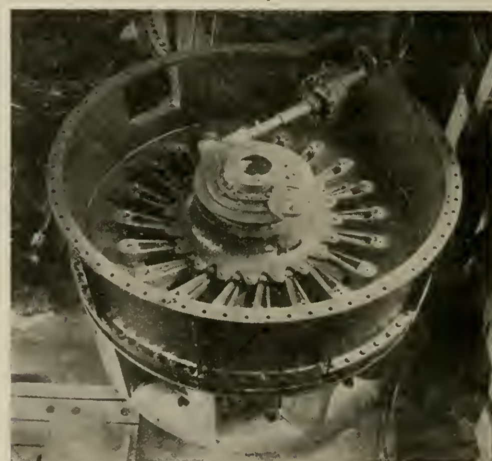


Fig. 2 Turbine for Appalachian Power Company, 1912, Erected in Shop

and by so-called "speed vanes" or stay vanes and by the movable guide vanes or gates the water is given increasing whirl or rotational components of motion about the axis as it nears the runner. After leaving the guide vanes the water continues to increase in velocity of whirl due to its closer approach to the axis, and at the same time it turns in the meridian plane and takes the axial direction either just before, during, or just after its passage through the runner.

2 A wide transition space is provided between guide vanes and wheel vanes, and in this space the water can come together in a continuous whirling mass before entering the runner. In a high-specific-speed turbine the water continues to contain whirl components of motion, but of somewhat reduced amount, after leaving the runner, even when the turbine is operating at its point of best efficiency.

3 After leaving the runner the water continues to flow as a whirling, axially advancing stream in a draft tube having a straight axis coincident with that of the turbine, and conical or flaring walls, this form of tube continuing, if what the writer believes to be the best practice is followed, until the velocity head has been reduced

by diverting the flow into other directions or by many discharging the water.

The turbine may be viewed as a water passage having walls which are surfaces of revolution and containing a continuous body of water which is both whirling and progressing with radial and axial velocity components, in which is placed a runner which develops torque by reducing, but not necessarily destroying, the whirl components of the flow. If a draft tube is used which is capable of regaining a considerable part of the energy due to the whirl components as well as that due to the axial components of the velocity of discharge from the runner, a result which can actually be secured, the "outflow loss" from the runner is reduced to a small fraction of that which enters into the usual textbook formulas.

The conditions of flow in the transition space in advance of the runner and in the draft tube, as well as the action of the water on the runner, can be usefully treated by means of the following method:

Consider the steady flow of water through a passage (Fig. 4) bounded by surfaces of revolution, and imagine the water to be given an initial whirl either by guide vanes or volute casing or equivalent means. Let us center our attention upon the annular space marked by double hatching. This ring is continually filled with water which is flowing in through its outer cylindrical surface of radius r_1 and out through its inner surface of radius r_2; and at any particular point in the space the velocity, pressure, etc., will be the same from instant to instant, since steady flow is being

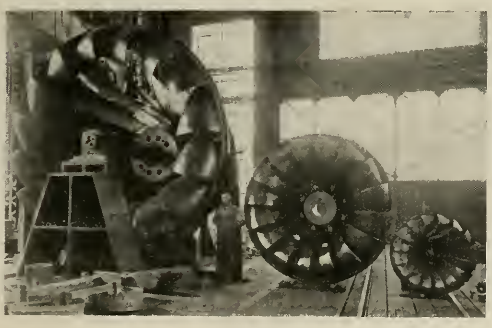


Fig. 3 Mixed-Flow Turbine Runners of Modern Type

considered. There will therefore be no change with respect to time in the conditions within the ring-shaped space; so that this ring of water is in equilibrium, and is acted on by balanced forces, with zero acceleration.

If the water enters the space with velocity c_1, having a circumferential component c_{u1}, and leaves with velocity c_2 having a circumferential component c_{u2}, then, applying the well-known principle that the "impulse" or force exerted by W lb. of water of velocity V is WV/g, we shall have the moment exerted upon the ring of water by the entering streams, about the axis, equal to $Wc_{u1}r_1/g$, in which W is the total weight of water entering the ring per second. In the same manner the moment due to the backward reaction of the leaving stream is $Wc_{u2}r_2/g$, the amount of water leaving being the same as that entering in accordance with continuity of flow. The two moments must be equal and opposite, since otherwise the ring of water would indefinitely increase in velocity; so that neglecting the frictional resistance of the walls, we have for steady flow

$$\frac{Wc_{u1}r_1}{g} = \frac{Wc_{u2}r_2}{g}, \text{ or } r_1 c_{u1} = r_2 c_{u2}$$

This relation will apply in any unobstructed space of revolution, whether the flow is inward, axial, or outward. The principle is not new. It was known in the case of a vortex to Leonardo da Vinci.[1]

[1] Forchheimer, Hydraulik, p. 285.

radius. We can illustrate the use of this law by applying it to the familiar case of a free vortex in an open basin. If we neglect the components of velocity in the meridian plane and assume for an approximation that the velocity is entirely in the circumferential direction we shall have, referring to Fig. 5, $v = k/r$, r being the radius to any point in the surface and k a constant; and if z is the

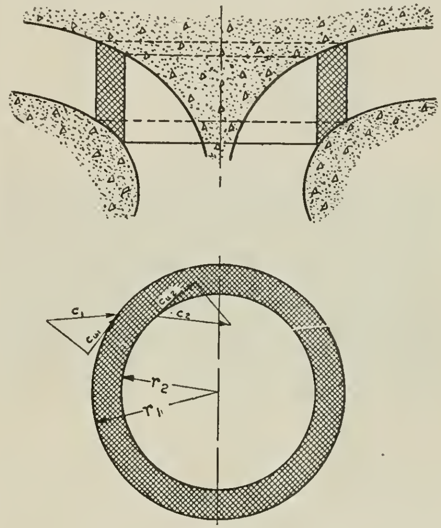


Fig. 4 Flow in Transition Space in Advance of Runner and in Draft Tube

ordinate of the same point, then since the pressure at every point of the surface is atmospheric, and since therefore the velocity head must increase by the same amount that the elevation head decreases, we shall have $z = v^2/2g$. Combining the above expressions we have $r^2 z =$ (a constant). This is the equation of a third-degree hyperbola, which agrees closely with the surface of a free vortex.

It is interesting to note that where there is a whirl component of velocity in the flow in such spaces of revolution there must be a surface of discontinuity bounding the flowing stream, similar to the surface of the above vortex, since if the flow should approach the axis more closely the velocity of whirl would be required by the above relation to approach infinite values. When the space within the surface of discontinuity is filled with water it is likely that this water is set into an eddying condition without partaking of the general flow of the surrounding stream.

The Spreading Type of Draft Tube

The principle just explained suggests a useful method of regaining the kinetic energy of the whirling component of flow in the water discharged from a turbine runner or pump impeller. For example, if the flow is turned into an outward direction, away from the axis, the velocity of whirl will diminish in inverse proportion to the increasing radius, and the corresponding velocity head will diminish inversely as the square of the radius, so that it is merely necessary to lead the water a moderate distance away from the axis to obtain the conversion of a large proportion of the velocity head of whirl into pressure head. This principle is used in the spreading type of draft tube.

The construction of this tube can be understood from Fig. 6, which shows a model of the draft tubes of the 30,000-hp. turbines for the United States Government Plant at Muscle Shoals, Alabama.

In utilizing this principle in the design of a turbine draft tube the meridian components of flow must not be lost sight of, and sufficiently gradual reduction in the meridian components must be provided, without sudden changes in direction. Both for the

avoidance of rapid changes in velocity and direction of the meridian components, and also to avoid a surface of discontinuity and the presence of a region of eddies, the value of including in the draft-tube design a central cone or core is clear. When a turbine draft tube is short, and when a long and awkward structure is not required to do it, it may be advisable to carry the central core up to the runner discharge, thus avoiding all flow close to the axis where the tendency to form a vortex or vortices is great. The writer also suggests the use of continuously curved inner and outer

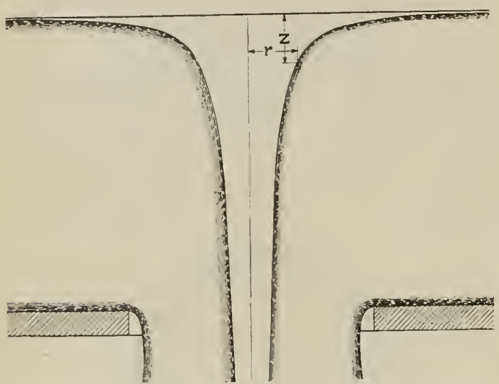


Fig. 5 Vortex Flow in Unobstructed Space of Revolution

surfaces of revolution for the turbine water passage, thus avoiding all sudden changes in curvature. Fig. 7 shows in outline a turbine which follows these principles.

A New Form of Turbine

In this new turbine form the entrance passage merges into the

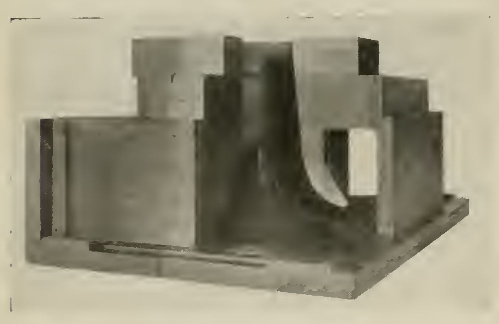


Fig. 6 Model of Spreading Draft Tube of 30,000-hp. Turbines at Muscle Shoals Plant

runner space and the latter merges into the draft tube, and the flow passes into the draft tube by a continuous gradation, with gradual changes in the whirl about the turbine axis and without sudden variations of the secondary whirl occurring in the meridian plane, i. e., the plane of the figure.

If a ring of vanes such as a runner is interposed in the revolving mass of water, the torque exerted on the vanes by the water is equal to

$$\frac{W}{g}(r_1 c_{u1} - r_2 c_{u2}).$$

New forms of runner suited to the new types of high-speed turbine here considered are shown in Fig. 8, which may be contrasted with the series of runners of the more usual type shown in Fig. 3.

Draft-Tube and Runner-Vane Friction Losses

Taking up some of the theoretical conditions presented by the modern forms of turbine, it will be recalled that in practically all of the time-honored turbine theories the design is based on the radial or axial direction of discharge from the runner; that is, for the conditions of best efficiency the absolute direction of outflow from the runner is assumed to be in a meridian plane, a plane containing the axis. That this is not actually the best direction of discharge for high-speed runners has been known for several years, as found from pitot-tube and direction-vane investigations in draft tubes.

With the use of the earlier forms of draft tube any direction of discharge having a whirl component introduced uncertainties and complications in the formulas, and the problem was not attractive. With the use of a draft tube capable of efficiently regaining the energy of whirl components as well as of meridian components of flow, however, it becomes possible to formulate some simple relations which it will be interesting to investigate. For one thing we shall no longer have to make the outflow loss from the runner dependent upon the direction of discharge, since we can use a draft tube which will handle the whirl components just as efficiently as the meridian components; the outflow loss from the runner can therefore be expressed as a function merely of the amount of the discharge velocity regardless of its direction. If the draft-tube efficiency is e_d and the coefficient of loss in the draft tube f_3, the portion of the velocity head of the water discharged from the runner which is lost or dissipated will be $f_3c_2^2/2g$; c_2 being the absolute velocity of discharge from the runner and $f_3 = 1 - e_d$.

In runners of high specific speed another important loss is that due to the frictional resistance of the runner vanes, since very high relative velocities between the vanes and water are employed. In recent forms of high-speed turbines, such as just shown in Fig. 8, the rotational speed is high and the torque correspondingly low, so that the runner vanes have but little curvature and deflect the water only in small amounts. The loss of head due to the frictional resistance of the runner vanes can be expressed as $f_2w_2^2/2g$, in which w_2 is the relative velocity with which the vanes move through the water, measured at their outflow edges. (For the reason just

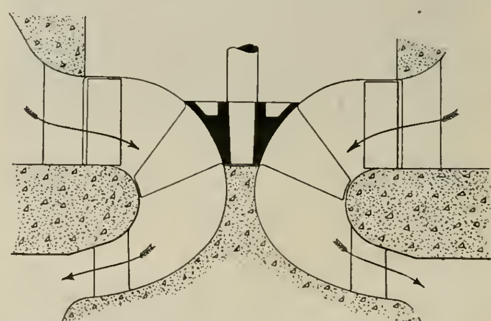


Fig. 7 A New Form of Turbine

mentioned, however, the relative velocity is nearly the same over the whole vane.)

Instead of making any arbitrary assumption regarding the direction of discharge upon which to base our turbine design, it will be useful to find the conditions which will give the minimum value for the sum of the above two losses—the outflow loss from the runner and the resistance loss in the runner. The problem may be stated as the determination of the conditions for maximum efficiency for a given specific speed or of maximum specific speed for a given efficiency.

Before proceeding with the problem itself, a distinction between two expressions for specific speed now in use should be explained. The usual formulation for specific speed used in turbine work is $N_s = N\sqrt{\text{hp.}}/H^{5/4}$. This form of specific speed is useful in turbine work because we most frequently have to fix the turbine

the specific speed as $N_s = N\sqrt{Q}/H^{3/4}$, since the discharge and head are usually the known quantities. The two expressions are derived from the same dimensional relations and the second is just as applicable to turbines as to pumps, and the first as applicable to pumps as to turbines. Let us distinguish by calling the specific speed based on quantity $N_{sQ} = N\sqrt{Q}/H^{3/4}$. Although in adapting turbines of types already developed to new requirements of head and power the first expression is more convenient, the second has advantages when the problem is the development of a new design or type, since by its use we may design for a desired discharge under a definite head without introducing unnecessary uncertainty by having to assume an efficiency in advance. Moreover, if the efficiency should turn out to be materially different from that expected, the discharge and velocities will not be thrown so far out of agreement with the designed values if taken for a given N_{sQ} as they would be if taken for a given N_s. In stepping a small turbine up to a larger size the N_{sQ} will remain more nearly constant than the N_s.

In the problem in hand we will gain simplicity by employing N_{sQ}, and if we determine the conditions for maximum N_{sQ} for a given efficiency we shall at the same time have found those for the maximum N_s, since

$$N_s = \sqrt{\frac{62.4}{550}} \times N_{sQ}\sqrt{e}$$

and the conditions which will give the best efficiency for a given N_{sQ} will also give the best efficiency for a given N_s.

The writer might mention, in passing, his belief that the knowledge of hydraulics has gained more from the study of dimensional relations such as the principles of similarity and specific speed than from any other method; and it may not be altogether fanciful to think of these relations as corresponding in a minor degree with the "relativity" movement in abstract philosophy.

To resume the problem of finding the conditions for the maximum value of the sum of the two losses mentioned, the "outflow triangle" of velocities is drawn as in Fig. 9(a) with the velocities marked to show the notation which is here used (the system which has now become standard in Europe).[1]

The form of the triangle can easily be related to the specific speed by putting $U_2 = \pi D_2 N/60\sqrt{2gH}$ and $C_{m2} = Q/A\sqrt{2gH}$, in which A is the area of the turbine passage at the runner discharge measured normally to C_{m2}.

Then

$$N_{sQ} = \frac{60\sqrt{2gH}}{\pi D_2} U_2 \frac{\sqrt{AC_{m2}\sqrt{2gH}}}{H^{3/4}} = \frac{60(2g)^{3/4}\sqrt{A}}{\pi D_2} U_2\sqrt{C_{m2}}$$

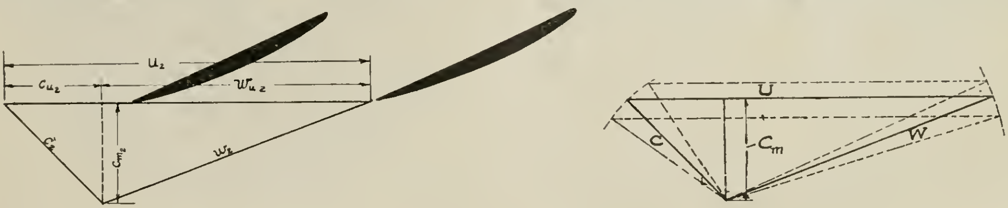
or, dropping subscript ($_2$), $k_{sQ}\,N_{sQ} = U\sqrt{C_m}$, in which

$$k_{sQ} = \text{a constant} = \frac{\pi D_2}{60\,(2g)^{3/4}\sqrt{A}}$$

Before considering the problem with reference to the amounts of the vane loss and outflow loss, we can reach an interesting con-

Fig. 8 New Forms of Runner Suited to New Types of High-Speed Turbine

clusion simply by supposing that the magnitude of the absolute and relative velocities C and W are kept constant while their directions are changed until the most advantageous shape of outflow triangle is attained. As shown in Fig. 9(b) various shapes of outflow triangle can be drawn with the same values of C and W, and therefore with the same losses of head. There will be one of these triangles which will give the highest specific speed, which we have



(a) (b)

Fig. 9 Outflow Triangle of Velocities

Velocity of runner vanes = $u_2 = (\pi D_2/60)N$. Meridian velocity component of water = $c_{m2} = Q/A$. Specific speed based on quantity = $N_{sQ} = N\sqrt{Q}/H^{3/4} = (60\sqrt{A}/\pi D_2 H^{3/4})u_2\sqrt{c_{m2}}$

Here c_2 = absolute discharge velocity from runner
w_2 = relative discharge velocity from runner
u_2 = velocity of runner
c_{m2} = meridian component of velocity of discharge
c_{u2} = whirl component of absolute velocity of discharge, which may we call the "absolute whirl," and
w_{u2} = whirl component of relative velocity of discharge which we may call the "relative whirl."

Since we are not concerned with any particular value of the head, we can adopt a "specific" value for each velocity, using the device of Thomann,[2] which is convenient in problems of this kind, and call

$$C_2 = \frac{c_2}{\sqrt{2gH}};\ W_2 = \frac{w_2}{\sqrt{2gH}};\ U_2 = \frac{u_2}{\sqrt{2gH}},\ \text{etc.}$$

[1] See Camerer, Wasserkraftmaschinen, 1914, pp. iv, vii and viii.
[2] R. Thomann, Die Wasserturbinen, 1908, pp. 11–12.

just seen is proportional to $U\sqrt{C_m}$. To find the relation which will thus give the maximum N_{sQ} for a given loss, we can put

$$k_{sQ}\,N_{sQ} = U\sqrt{C_m} = (\sqrt{C^2 - C^2_m} + \sqrt{W^2 - C^2_m})\sqrt{C_m}$$

and considering C and W to be constant, we can differentiate $(k_{sQ}\,N_{sQ})$ with respect to C_m and equate to zero:

$$\frac{k_{sQ}\,dN_{sQ}}{dC_m} = (\sqrt{C^2 - C^2_m} + \sqrt{W^2 - C^2_m})\frac{1}{2\sqrt{C_m}} - \sqrt{C_m}\left(\frac{C_m}{\sqrt{C^2 - C^2_m}} + \frac{C_m}{\sqrt{W^2 - C^2_m}}\right) = 0$$

From this we have, simplifying,

$$\sqrt{C^2 - C^2_m} + \sqrt{W^2 - C^2_m} = 2C^2_m\left(\frac{1}{\sqrt{C^2 - C^2_m}} + \frac{1}{\sqrt{W^2 - C^2_m}}\right)$$

and substituting C_u for $\sqrt{C^2 - C^2_m}$ and W_u for $\sqrt{W^2 - C^2_m}$,

$$C_u + W_u = 2C^2_m\left(\frac{1}{C_u} + \frac{1}{W_u}\right); \text{ or } U = 2C^2_m\left(\frac{W_u + C_u}{C_uW_u}\right) = \frac{2C^2_mU}{C_uW_u}$$

which gives $C_m = \sqrt{C_uW_u/2}$ as the most advantageous proportion. That is, the meridian velocity should be chosen as 0.707 multiplied by the mean proportional of the absolute whirl and relative whirl. In calculations applying to the runner as a whole, the velocities corresponding to an average point in the runner may be used, such as the center of area of a sector of the discharge space.

Fig. 10 enables us to visualize the meaning of this relation.

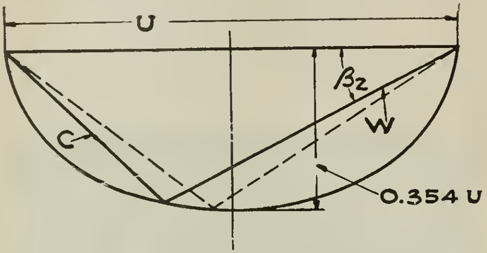


FIG. 10 DIAGRAM SHOWING PROBABLE POINT OF BEST OPERATION FOR RUNNER WITH VANE INCLINATION β_2

The vertex of the outflow triangle should fall somewhere on the ellipse of major axis U and semi-minor axis =

$$0.707\sqrt{\frac{U}{2} \times \frac{U}{2}} = 0.354\ U$$

For example, if a runner has a vane inclination β_2 its probable

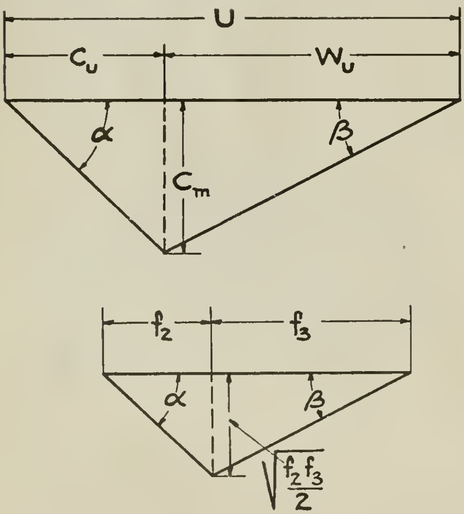


FIG. 11 RELATIONS OF VARIOUS OUTFLOW VELOCITIES FROM THE RUNNER TO EACH OTHER

point of best operation can be found by drawing W at this angle with the base line and completing the triangle with the vertex at the point where the W line intersects the ellipse. According to this diagram, it would evidently never pay, from the standpoint of efficiency alone, to use a meridian velocity greater than 35.4 per cent of the circumferential velocity of the runner. Since the meridian velocity may be somewhat increased, however, before the efficiency is seriously impaired, it will probably be economical to use slightly higher values of C_m than are called for by this relation, in order to reduce the turbine dimensions and cost.

Now proceeding with the problem, and considering the amounts of the losses of head, we can derive some useful relations, as follows:

From the above expression for specific speed, we see that we can keep the length of base U of the outflow triangle and its altitude C_m constant, and can change its shape without changing the specific speed. By shifting the vertex parallel to the base, there must be some position which will make the sum of the outflow loss and vane resistance loss a minimum.

Calling the sum of these losses H_L, the loss of head expressed as a fraction of the effective head is

$$h_L = \frac{H_L}{H} = f_2\frac{w_2^2}{2gH} + f_3\frac{c_2^2}{2gH} = f_2W^2 + f_3C^2$$

Expressing h_L in terms of U, C_m and C_u,

$$\begin{aligned} h_L &= f_2W^2_u + f_3C^2_u + (f_2 + f_3)C^2_m \\ &= f_2U^2 + f_2C^2_u - 2f_2\,UC_u + f_3C^2_u + (f_2 + f_3)C^2_m \\ &= f_2U^2 + (f_2 + f_3)C^2_u - 2f_2UC_u + (f_2 + f_3)C^2_m \end{aligned}$$

For a given U and C_m we can find the value of C_u which will make h_L a minimum, neglecting the effect of any small variation of f_2 due to a change in direction of W as being of a higher order of small quantities than differences in the losses themselves. Then

$$\frac{dh_L}{dC_u} = 2(f_2 + f_3)C_u - 2f_2U = 0$$

That is,

$$C_u = \frac{f_2}{f_2 + f_3}\,U, \text{ or } f_2(U - C_u) = f_3C_u$$

from which

$$f_2W_u = f_3C_u, \text{ or } \frac{C_u}{W_u} = \frac{f_2}{f_3}$$

This means that for the best efficiency the absolute whirl should

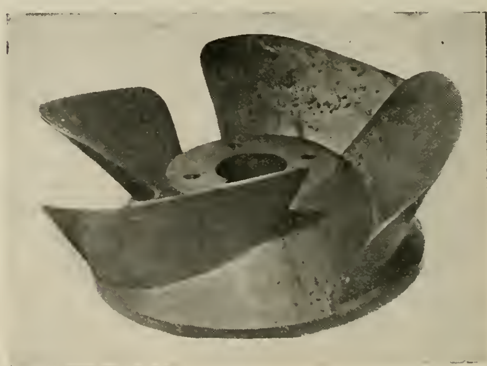


FIG. 12 NEW TYPE OF HIGH-SPEED PUMP IMPELLER

be to the relative whirl as the coefficient of frictional loss is to the coefficient of outflow loss.

The above result shows for one thing that in a runner for which f_2 is large, as is the case in runners having a large amount of vane surface—particularly when this surface is increased by an outer band—the best condition of operation will be with comparatively low relative whirl and high absolute whirl, so that such runners will discharge the water at a greater angle of inclination to the meridian plane than runners having less vane surface and correspondingly lower f_2. The numerical value of f_2 can be calculated by figuring the loss of head in the runner buckets considered as rectangular channels. The purpose of this investigation is not so much to take up questions of design and calculation, however, as to establish some of the controlling relations, and we will give less attention to the numerical values of the coefficients than to the general conclusions which may result.

Having established the above relation between the relative whirl and absolute whirl at the runner discharge, we can now proceed, assuming that the said relation is to be complied with,

$$h_L = f_2U^2 + (f_2 + f_3)C^2{}_u - 2f_2UC_u + (f_2 + f_3)C^2{}_m$$

by expressing C_u in terms of U according to the result just obtained above, namely, $C_u = [f_2/(f_2 + f_3)]\,U$, we have

$$h_L = \frac{f_2f_3}{f_2 + f_3}\,U^2 + (f_2 + f_3)C^2{}_m.$$

Substituting in this

$$U = k_{sQ}N_{sQ}/\sqrt{C_m}$$

we have

$$h_L = \frac{f_2f_3}{f_2 + f_3} \times \frac{k^2{}_{sQ}N^2{}_{sQ}}{C_m} + (f_2 + f_3)C^2{}_m$$

To obtain the conditions for minimum h_L for a given N_{sQ} we will differentiate the last expression with respect to C_m, considering N_{sQ} a constant, and will equate the derivative to zero:

$$\frac{dh_L}{dC_m} = -\frac{f_2f_3}{f_2 + f_3} \times \frac{k^2{}_{sQ}N^2{}_{sQ}}{C^2{}_m} + 2(f_2 + f_3)C_m = 0$$

outflow velocities from the runner should therefore be related to each other in the proportions shown at the top in Fig. 11, which is geometrically similar to the outflow diagram as indicated in the lower part of the same figure. That is, C_u, W_u, C_m and U should be to each other respectively as f_2, f_3, $\sqrt{\frac{f_2f_3}{2}}$ and $(f_2 + f_3)$.

From the last-mentioned figure it is seen that

$$\tan\beta_2 = \sqrt{\tfrac{1}{2}\frac{f_2}{f_3}} \text{ and } \tan\alpha_2 = \sqrt{\tfrac{1}{2}\frac{f_3}{f_2}}$$

In order to use advantageously small values of β_2, to secure runners of very high specific speed, it therefore becomes necessary to obtain low values of f_2, and thereby to avoid the necessity for high angles of whirl at the runner discharge. These small values of f_2 can be secured by reducing the exposed runner surface to a minimum. If this reduction of vane area is carried too far, how-

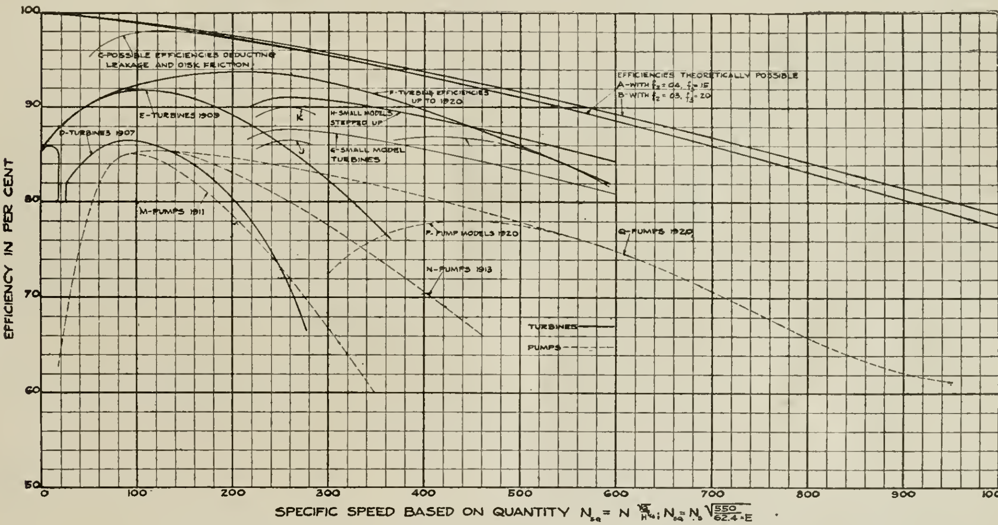


Fig. 13 Curves of Turbine and Pump Efficiencies Plotted Against Specific Speed Based upon Quantity N_{sQ}

A—Calculated efficiencies based on loss in runner $= f_2w_2^2/2g$ and discharge loss from runner $= f_3c_2^2/2g$ with $f_2 = 0.04$, $f_3 = 0.15$, and neglecting other losses

B—Calculated efficiencies with $f_2 = 0.03$ and $f_3 = 0.20$

C—Calculated efficiencies deducting leakage loss ($= 50/N^2{}_{sQ}$) and disk-friction loss ($= 6/N_s^2$)

D—Turbine efficiencies attained in Europe up to 1907 (from paper by Graf and Thoma, *Zeit. Ver. Deutsch. Ing.*, June 29, 1907)

E—Turbine efficiencies attained in America and Europe up to 1909 [from discussion by L. F. Moody of paper by C. W. Larner in Trans. Am.Soc.C.E., vol. lxvi, p. 306 (1910)]

F—Turbine efficiencies attained up to 1920 from tests so far reported

G—Efficiencies of small model turbines (16-in. diam.) in I. P. Morris Hydraulic Laboratory of Cramp Shipbuilding Co.

H—Efficiencies of Curve G stepped up to Holyoke size, based on comparison of Holyoke test (Curve K) and geometrically similar model (Curve J) of 16-in. diam. at I. P. Morris Laboratory

J—Test of small model of Cedars Rapids type turbine at I. P. Morris laboratory

K—Holyoke test of larger model of Cedars Rapids type turbine

L—Efficiencies from paper by Forrest Nagler, Trans. Am.Soc.M.E., vol. 41, p. 829 (1919)

M—Efficiencies of centrifugal pumps from Greene's Pumping Machinery, 1911

N—Efficiencies of centrifugal pumps up to 1913

P—Tests of 12-in. pump models of author's spiral type at I. P. Morris Laboratory up to 1920

Q—Pump efficiencies attained up to 1920

from which, replacing $k_{sQ}N_{sQ}/\sqrt{C_m}$ by U, we have

$$2(f_2 + f_3)C_m = \frac{f_2f_3}{f_2 + f_3} \times \frac{k^2{}_{sQ}N^2{}_{sQ}}{C^2{}_m} = \frac{f_2f_3}{f_2 + f_3}\,\frac{U^2}{C_m}$$

From this we obtain

$$\frac{C_m}{U} = \frac{\sqrt{{}^1/_2(f_2f_3)}}{(f_2 + f_3)}$$

The same result is called for by the relation $C_m = \sqrt{C_uW_u/2}$, already given, if we insert

ever, another source of loss will be introduced due to permitting the passage of a considerable portion of the flow between the vanes without its acting effectively upon them.

The foregoing relations are as applicable to pumps as to turbines, and furnish a helpful guide in proportioning the absolute whirl, the relative whirl and the meridian velocity component in designing both turbines and pumps of high specific speed. Fig. 12 shows a new type of high-speed pump impeller.

In looking forward to the future development of the turbine, it can be seen from the foregoing that theoretic considerations

call for a conservative proportioning of the various velocities and angles of the turbine, and that there is no apparent means of greatly increasing specific speeds merely by using some new and radical proportion between the velocities. Efficiencies are already so high that no startling increase is possible. The prospect of further increases in specific speed therefore lies entirely in the use of higher velocity heads in comparison with the head on the plant, and an avoidance of serious impairment of the efficiency, by giving attention to the securing of low coefficients of loss in the runner and draft tube, and by observing the relations between the velocities deduced above.

Possibilities of Further Increase in Specific Speed

To get some idea of the possibilities of further increases of specific speed, it may be pointed out that if the best relation between the velocities is adhered to the losses here considered will vary as the four-thirds power of the specific speed N_{sQ}, the functional relation between efficiency and N_{sQ} being derived in the following manner:

$$h_L = \frac{f_2 f_3}{f_2 + f_3} U^2 + (f_2 + f_3) C^2_m; \text{ and from } \frac{C_m}{U} = \sqrt{\frac{\frac{f_2 f_3}{2}}{f_2 + f_3}}.$$

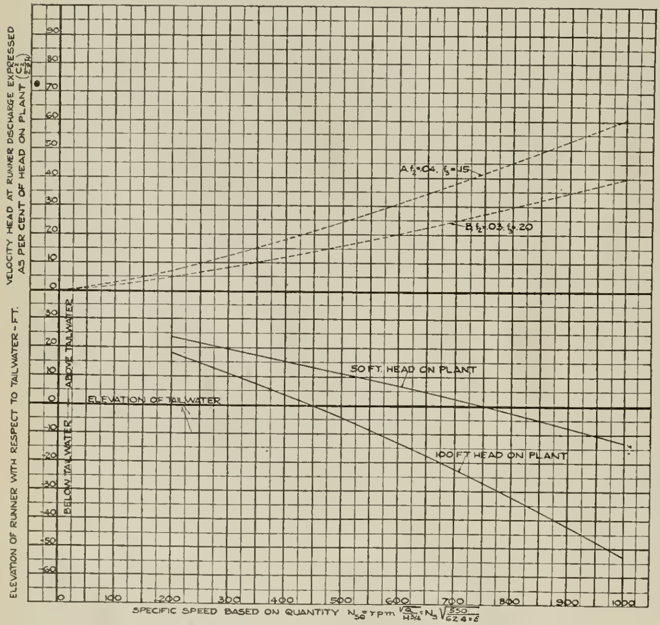


Fig. 14 Curve Showing Restriction Placed upon Specific Speed by Location of Turbine with Respect to Tailwater

$$h_L = 3(f_2 + f_3)C^2_m; \text{ and also, from } k_{sQ}N_{sQ} = U\sqrt{C_m} = \sqrt{\frac{f_2 + f_3}{\frac{f_2 f_3}{2}}}\, C_m^{3/2}$$

$$h_L = \frac{3}{2^{2/3}} \times \frac{(f_2 f_3)^{2/3}}{(f_2 + f_3)^{1/3}} k^{4/3}_{sQ} N^{4/3}_{sQ}, \text{ and}$$

$$\text{efficiency} = 1 - \frac{3}{2^{2/3}} \times \frac{(f_2 f_3)^{2/3}}{(f_2 + f_3)^{1/3}} k^{4/3}_{sQ} N^{4/3}_{sQ}$$

This considers the effect of only the two losses here treated of, and neglects certain other losses. These values of efficiency are therefore merely indications of the limiting values attainable.

The two losses mentioned account for nearly the whole loss in turbines of high specific speed. In low-speed machines two other losses assume importance—those due to leakage and disk friction. These losses can be shown to be given approximately by the following formulas:[1]

[1] For derivation see paper on The Specific Speed of Hydraulic Turbines by the writer, presented at December 28–30, 1908, meeting of Am. Assn. for Advancement of Science, and printed in *The Polytechnic* of Rensselaer Poly. Inst., 1913.

Leakage loss, expressed as a fraction of the total quantity, is equal to

$$L_L = \frac{q_L}{Q} = \frac{201\,\phi^2}{N^2_{sQ}}$$

where ϕ has the usual significance; i. e.,

$$\phi = \frac{\pi D N}{60\sqrt{2gH}}$$

and disk-friction loss, expressed as a fraction of the total power, is equal to

$$L_D = \frac{l_d}{\text{hp.}} = \frac{35\,\phi^5}{N^2_s}$$

and for present purposes a still rougher approximation will be sufficient, giving

$$L_L = \frac{100}{N^2_{sQ}} \text{ and } L_D = \frac{6}{N^2_s}$$

When labyrinth seals are used for the runner, the above leakage loss, which is for ordinary seals, may be as roughly equal to $L_L = 50/N^2_{sQ}$ or even less. We shall find that these losses become negligible at moderate values of N_s and N_{sQ} and are of no importance in the high-speed field which we are particularly investigating.

Turbine and Pump Efficiencies as Related to Specific Speed

In Fig. 13 are shown a series of curves of efficiency plotted against N_{sQ}. Curve A is the attainable efficiency computed from the theoretic relation derived above, using as values of the coefficients $f_2 = 0.04$ and $f_3 = 0.15$. To show the effect of altering the coefficients, Curve B has been plotted with $f_2 = 0.03$; $f_3 = 0.20$. The effect of leakage and disk friction has been shown by deducting these losses from the efficiencies given by Curve A, and Curve C shows the result (the leakage loss being figured for turbines having labyrinth seals).

To show the general progress which has been made in recent years, and the continuing trend toward higher specific speeds, a number of other curves have been plotted in the same figure, four of them being for pumps.

It is interesting to note the similarity in the form of Curves G and H with A and B. As more development work is carried out in the high-specific-speed field, it may be expected that the efficiencies shown by Curves F and Q, for both turbines and pumps, will be materially exceeded and brought in closer relation to the theoretic values of Curves A and B, assuming that the coefficients used in computing these curves can be more closely approached.

The generally lower range of values of pumps as compared to turbines at all specific speeds is not entirely due to essential differences in action, but much of the difference the writer believes to be attributable to the generally smaller dimensions of pumps; although the pump suffers a definite disadvantage in its action from the fact that in the pump the impeller imparts velocity head to the fluid and depends upon a stationary diffuser for the reconversion of this velocity head into pressure head; while in the turbine pressure head is converted into velocity head in the stationary casing and guides, and is absorbed in the runner, leaving only a small portion for reconversion in the draft tube.

Going back to the theoretic conditions for best efficiency or higher specific speed, let us see what is involved in the increases in specific speed shown by Curves A and B. These high specific speeds are imagined to be attained without changing the proportioning of the velocities relatively to each other, but by increasing the magnitudes of all of them, and thus requiring the use of higher velocity heads in comparison with the head on the plant. To see what this means in actual values, we can determine the manner in which the absolute velocity of discharge from the runner

$$\frac{C_m}{C} = \frac{\sqrt{\frac{f_2 f_3}{2}}}{\sqrt{f_2^2 + \frac{f_2 f_3}{2}}}; \quad \frac{U}{C} = \frac{f_2 + f_3}{\sqrt{f_2^2 + \frac{f_2 f_3}{2}}}$$

We also have

$$k_{sQ} N_{sQ} = U\sqrt{C_m} = \frac{(f_2 + f_3)\left(\frac{f_2 f_3}{2}\right)^{1/4}}{\left(f_2^2 + \frac{f_2 f_3}{2}\right)^{3/4}} C^{3/2}$$

and hence

$$C^2 = \frac{f_2^2 + \frac{f_2 + f_3}{2}}{(f_2 + f_3)^{4/3}\left(\frac{f_2 f_3}{2}\right)^{1/3}} k_{sQ}^{4/3} N_{sQ}^{4/3}$$

or

$$C^2 = \frac{c_2^2}{2gH} = \frac{1 + \frac{f_3}{2f_2}}{\left(1 + \frac{f_3}{f_2}\right)^{4/3}\left(\frac{f_3}{2f_2}\right)^{1/3}} k_{sQ}^{4/3} N_{sQ}^{4/3}$$

From the last equation values of C^2, which represents the ratio of the velocity head of the water at discharge from the runner to the head on the turbine, can be computed for various values of the specific speed. As previously noted, the term k_{sQ} in the formula for C^2 is a coefficient having the value

$$k_{sQ} = \frac{\pi D_2}{60\,(2g)^{3/4}\sqrt{A}}$$

In this expression D_2 should be taken as the mean diameter of discharge of the runner and A the cross-sectional area of the space into which the runner discharges, measured in a section perpendicular to the turbine axis. In a runner in which the direction of the meridian velocity of discharge is at a moderate inclination to the axis and having vanes extending nearly to the axis, D_2 may be taken as approximately equal to $^2/_3\, D$, where D is the diameter of the outflow space. This gives us

The computation has been carried out for the two sets of values of f_2 and f_3 which were used in plotting Curves A and B in Fig. 13. Fig. 14 (upper diagram) shows the corresponding values of C^2, the curves in this figure being marked A and B to correspond to Fig. 13.

The ordinates of these curves represent the velocity head corresponding to the absolute velocity of discharge from the runner, expressed as a percentage of the head on the turbine. With the low values of the coefficients f_2 and f_3 which have been used in computing these curves, the possibility is shown of developing

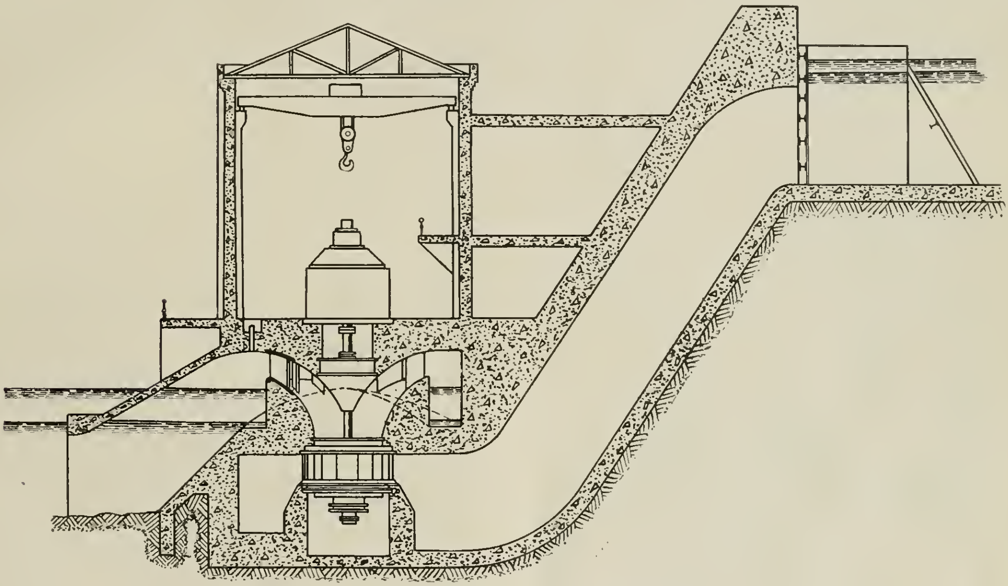


Fig. 15 New Type of Power Plant

much higher specific speeds than have yet been attained, and it is also seen that this can be done without the necessity of employing extremely high velocity heads. It may be found from later experience that somewhat higher velocity heads may be employed without serious loss in efficiency, in order to reduce the turbine dimensions. The exact numerical values of coefficients f_2 and f_3 which can be secured in the future remain for further investigation to show.

Whatever the values of the coefficients secured by a particular turbine design the relation indicated by the general form of the curves of the last figure will always apply, i. e., increases in specific speed to extremely high values will inevitably involve, sooner or later, the use of higher velocity heads at the runner discharge. In turbines arranged according to present practice the extent to which the increase in specific speed can be carried will be limited by the height of the turbine runner above the surface of the tailwater.

In order that the absolute pressure at the runner discharge should be kept at a sufficient margin above the point at which the water will vaporize, and to provide the necessary head for the retardation of flow during quick gate closures, the sum of the static elevation of the runner above the tailwater surface and the regained velocity head should not approach unduly close to the barometric limit of 34 ft., and in the following examples the limit will be set at 27 ft. With such a limiting value, if a runner should be placed, say, 17 ft. above tailwater, there would remain only 10 ft. as the limit of the velocity head which can be employed, making the necessary allowance, however, for draft-tube losses,

distribution of velocity, and increase in velocity during full-gate operation.

In order to show in a general way the restriction placed upon specific speed by the location of the turbine with respect to tailwater, the curves shown in the lower part of Fig. 14 have been drawn, using Curve A in the upper portion of this figure as a basis, but adding 30 per cent to the velocity heads called for by this curve in order to provide a margin to cover certain factors, including the unequal distribution of velocities at the runner discharge and the variation in the absolute velocity from the normal point of operation up to full gate, the necessary margin being reduced, however, by the fact that velocity head is not completely regained by the draft tube. Two curves are shown in the figure, for plants operating respectively under heads of 50 ft. and 100 ft.

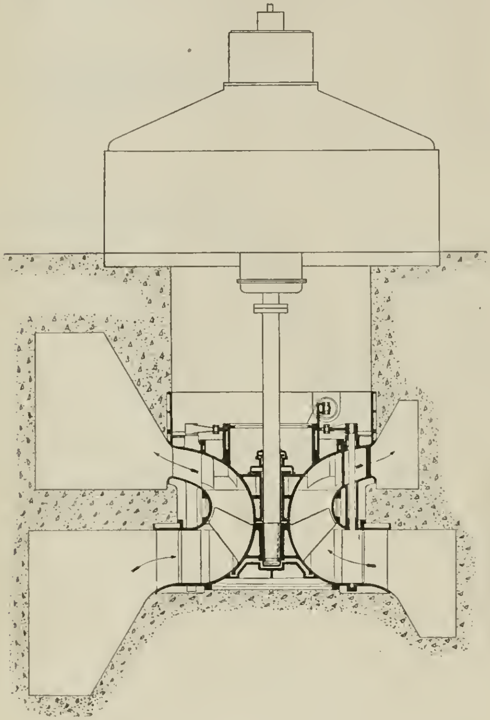


Fig. 16 Inverted Turbine of the Wicket-Gate Type

It will be noted that even with the low outflow losses called for by the types of turbine considered, a point is soon reached where the turbine must be set at the tailwater elevation or below it. If the turbine should be applied to heads higher than 100 ft., this point would occur at still lower specific speeds.

Power Plants with Inverted Turbines and Draft Tubes Directed Upward from Runners

If we should adhere to the usual practice in the design of power plants, the future extension of the available range of specific speeds for turbines would be narrowly restricted. The following procedure has, however, been proposed by Mr. H. Birchard Taylor, namely, that we remove this restriction on future progress and abandon the universal practice of placing the turbine runner at a considerable height above tailwater. Mr. Taylor proposes, if necessary, to locate the runner considerably below the normal tailwater elevation. The objection immediately presents itself that even if the runner is placed above normal tailwater it will be submerged and inaccessible during times of high water. This difficulty is overcome by the very simple but somewhat radical procedure of turning the turbine upside down and directing the draft tube upward from the runner, so that it will discharge over a crest located slightly above the highest tailwater elevation to be encountered in a particular installation. Fig. 15 shows a power plant built in accordance with this idea, and Figs. 16 and 17 two new forms of inverted-type turbine which could be used in such a plant.

In Fig. 15 the turbine is arranged with wicket gates or movable guide vanes, operating from below in a pit provided for the purpose. The draft tube is of the spreading type, the outer barrel of the tube being used to form a circular crest to exclude the tailwater when access is desired to the interior of the turbine. The procedure to follow would be to close the head gates and to pump out the water contained by the draft tube and turbine passages by the use of low-head centrifugal pumps or hydraulic ejectors.

Without going into all of the new features opened by this arrangement, it may be mentioned that the turbine casing, which is under a considerable amount of pressure, is located at a low point in the power-house substructure where there is a large mass of concrete above it to counteract the upward pressure of the water. An excellent design of draft tube can be used without requiring any increased depth of excavation, and the runner is naturally located at a low point in the substructure.

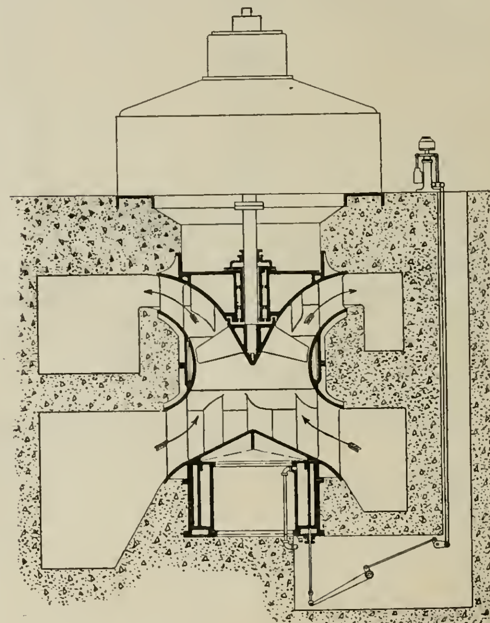


Fig. 17 Inverted Turbine of the Plunger-Gate Type

The arrangements shown in Figs. 16 and 17 can be readily understood from the drawings. In the turbine in Fig. 16 wicket gates are used with the guide-vane stems carried up through, or in line with, the draft-tube stay vanes which are used to support the superimposed structure, and "outside" operating mechanism is used, arranged in the usual manner in the turbine pit. In Fig. 17 a plunger gate is used instead of the usual wicket gates, this plunger being operated by hydraulic pressure.

In conclusion, the writer hopes that in pointing out some of the possibilities for the future development of the turbine, and some of the factors affecting its evolution, the suggestions presented in the foregoing pages may prove helpful to other engineers working in this field.

Speed Regulation of the Hydraulic Turbine

By RAYMOND D. JOHNSON,[1] NEW YORK, N. Y.

THERE is a more or less prevalent idea that the water-wheel governor, of itself, directly controls the speed of the units. The only direct function of a governor, however, is to alter the wheel-gate opening when impelled to do so by a slight change in the speed. It is also endued with more or less independent or secondary functions which check its natural motion and which introduce delay after the first impulse has become effectual.

These secondary adjustments may succeed in producing good speed regulation or they may not, regardless of the perfection of the governor itself and dependent entirely upon the thought which has been put into the general layout of the plant.

For example, consider a case of a long pipe line where the velocities are allowed to run too high in proportion to the head on the plant; any additional draft or water will of course lower the pressure at the power house, due to friction, and will therefore produce less power so far as the head is concerned, while at the same time it is producing more power from the additional amount of water. It may seem a fanciful thing that a condition could ever arise where the proportionate drop in head ould offset, in power, the extra amount of water supplied, but it is so far from being fanciful that it has actually occurred in plants, in the region of gate openings between three-quarters and full. In fact, it occurs more often than is commonly supposed and it is a condition which is not always discovered by the operators. It is clear that the governor would have absolutely no control of the speed of the turbine under this extreme condition. A slight increment of load would drop the speed and impel the governor to open the gates wider without recovering any of the loss of speed but, nevertheless, causing a great waste of water to no purpose.

It may appear that such a condition is the result of such gross incompetence in design as to make it of little interest to real engineers, but this is not the case, because coöperation of the water-wheel characteristics and surges in pressure, due to increments of load, with insufficient area of the feeder pipe, may easily produce such results, even when the general features of the plant are arranged in more or less standard fashion. or example, suppose that the pipe line is more or less adequate, not nearly approaching the extreme condition as above mentioned, so that when additional water is called for there is a very decided increase in the power, in spite of the drop in hydraulic gradient; but, at the same time let us assume that the water wheel has been opened beyond its point of best efficiency, toward full gate, and that in so doing it has suffered a material loss in efficiency due to its drooping characteristic. In such a case the further opening of the wheel gates may cause to be delivered to the generator no more power than it received prior to the action of the governor. This may strike some as a hair-splitting contention, but it will be found, upon a brief investigation with actual figures, that the atter is a very important one.

Now let us suppose that both of these terms have been adequately considered and properly taken care of and that, nevertheless, the same trouble arises. This may be due to a drop in pressure caused by surging. In other words, even though the drop in pressure, due to the change of hydraulic gradient, is not sufficient to produce a permanent condition of impossible governing, yet the short duration drop in pressure, due to inertia of the water column as modified by a surge tank, may add to the trouble sufficiently to bring about the same difficulty.

It is also well to remember that these conditions do not have to exist in an extreme degree to render the speed regulation very unsatisfactory, but an approach to them may almost discount the efforts of the governor.

[1] Consulting Engineer, Mem.Am.Soc. M.E.

Abstract of a paper presented at the Symposium on Hydroelectric Development and Distribution, held at Philadelphia, January 21, 1921, under the auspices of the Engineers' Club of Philadelphia and the Philadelphia Sections of the American Society of Civil Engineers, the American Institute of Electrical Engineers and The American Society of Mechanical Engineers.

It is well known that the ordinary characteristic of the Francis turbine is such as to give a maximum efficiency at part gate and the manufacturers all show drooping curves beyond this point, up to full gate. The water wheel is ordinarily rated at its full-gate power.

Now, unless one has carefully studied the relation of the additional power to the additional water on the drooping part of this curve, it is fairly safe to say that he has little realization of exactly what this means.

A good way to study it is to plot a first differential curve showing the relation of added water to added power and to express the efficiency as such. In this way it will often appear that whereas the full-gate efficiency may be given as perhaps 88 per cent, the actual efficiency of small increments of water, compared to the corresponding increments of power, may go as low as 25 or 30 per cent near full gate.

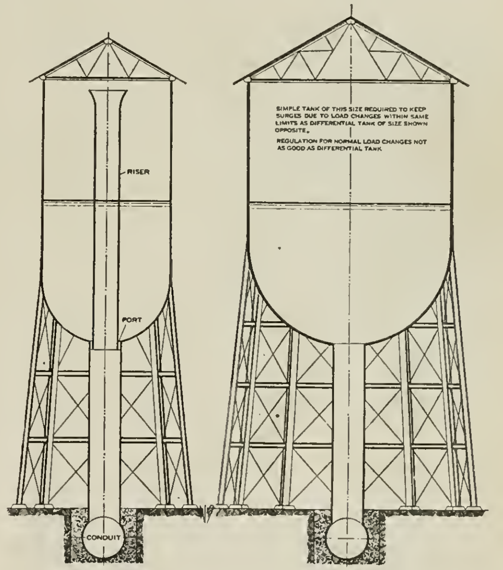


FIG. 1 RELATIVE PROPORTIONS OF SIMPLE AND DIFFERENTIAL SURGE TANKS

his stealing of additional water might not be of any great importance in an open-flume setting, but at the end of a long pipe line this additional water causes more surging, more friction drop, with little or no increase of actual power; and it is the writer's firm belief that in all such cases the turbines should be rated as at their full power output where the efficiency is only slightly less than the maximum and the motion of the water-wheel gates should be limited in an unchangeable way so that they cannot be opened beyond this point. This conclusion has been reached as the result of the study of many designs where long pipe lines and surge tanks have been used.

The flywheel effect of the rotating parts is an important factor in regulation, and the ability to store energy in this way as the speed slightly rises and to release energy as the speed falls off, furnishes a time element in which the flow of water in the penstock may be partially or completely readjusted to the new demand of the load. It is the writer's belief that even this well-known feature has not always received sufficient attention and that the regulation of many plants could be materially improved by the addition of heavy steel flywheels.

It is the present purpose, however, to dwell more particularly

upon the function of the surge tank, the correct design of which is probably the most potent factor in promoting proper regulation.

The function of a properly designed surge tank is complex. It may be said to have six distinct duties:

1 To regulate the pressure, preventing undue rise or fall following sudden motion of the water-wheel gates
2 To act as a reservoir furnishing water promptly to the wheel when a sudden demand is made for more, thus taking care of the time element in which the water in the long conduit may be accelerated
3 To lengthen the period of oscillation of a surge so that the governor may prove fast enough to follow it with the gate motion in order to keep the power output of the unit at constant value
4 To damp out this surge vibration in spite of the augmenting effect of the governor action, so that the variation of pressure will not continue to increase after having once been started in oscillation

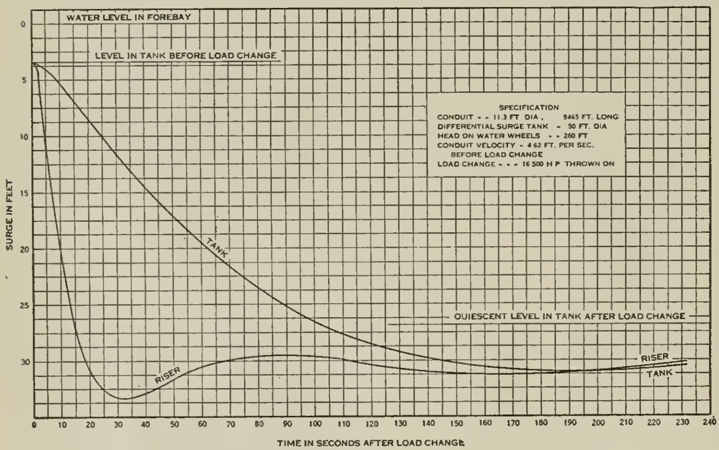


FIG. 2 TYPICAL VARIATION OF WATER LEVEL IN BOTH TANK AND STANDPIPE OF A DIFFERENTIAL REGULATOR

5 To furnish sufficient internal resistance to accomplish this damping effect without depending upon excessive friction in the water system itself which would also assist in this duty
6 To conserve water which would otherwise be wasted in overflow or through a by-pass.

An ordinary standpipe of somewhat large dimensions is frequently designated as a simple surge tank. Its action may be likened to one leg of a U-tube filled with fluid; that is to say, the forebay and pipe-line system, together with the surge tank, form a hydraulic pendulum in which an oscillation when once started by a change of load tends to maintain itself indefinitely, as a pendulum, until the action of friction stops it.

It is plain to be seen that the worse the design of the plant and the more the power which is thrown away in friction, the less likelihood there is of troublesome conditions due to oscillation.

When the waterways are comparatively free from friction, a simple surge tank, such as above described, designed to operate properly, will have to be very large and expensive. This is due principally to the fact that the operation of the governor is such as to keep alive any oscillation which is once initiated.

That is to say, as the water level is dropping due to a load demand, the head is also falling off and the wheel gates must continue to open wider and wider in order to maintain a constant power output of the unit. This calls for more and more water as the level drops and very materially increases the magnitude of the surge; and conversely, as the water rises, the wheel gates must continually decrease their opening for the same reason, and thus fan the surge wave into lively activity.

In other words, the simple surge tank is not, properly speaking, a regulator at all, because it depends upon an undesirable and unnecessary amount of friction to make it work right.

It is of course, a fact that some plants are operating under such conditions and oftentimes without a suspicion on the part of those associated with them that any material improvement would be possible; but a close scrutiny of many of them shows that were it not for almost inexcusably large losses of head, the surge tank, as installed, would not only *not* be a benefit, but would even prove to be a source of danger.

To obviate this difficulty and to provide a regulator which will permit the utmost smoothness of all the waterways, the differential surge tank (see Fig. 1) has been devised. This is really a double tank—the smaller one in the nature of a standpipe freely connected to the conduit and surrounded by another tank which is connected to the conduit by means of a restricted passage. The action of the internal standpipe is very much the same as that of the ordinary standpipe, except that as the water tends to rise or fall its motion is checked by secondary escape of water through the restricted passage into or out of the larger tank. This produces a differential, nonperiodic action which is absolutely effective in steadying down any tendency toward instability of the surge wave; and furthermore, inasmuch as the motion of the water within the smaller pipe is relatively rapid as compared to what it would be in a larger simple surge tank, an accelerating head is rapidly applied to the conduit and less water has to be supplied or received than in the case of a simple tank of corresponding dimensions.

Fig. 1 illustrates the relative sizes of simple and differential surge tanks for a given case. In general it may be said that the ratio of the two sectional areas will vary from about two to nearly four, depending upon the physical conditions to be met.

Fig. 2 illustrates the typical variation of water level in both the tank and standpipe (or riser) of a differential regulator. The comparatively sudden drop in the riser level starts immediately an active acceleration of the water column leading from the forebay and, meantime, the lack of water which is only gradually provided through the conduit, is supplied by the tank, thus producing the upper curve.

In about 190 seconds, as shown by the diagram, these two levels come together, which indicates that at that time the conduit velocity has received sufficient acceleration to supply the new demand for water and no further depression of level takes place.

The water level will eventually become quiescent with no further load change, at the elevation shown on the diagram, and if one considers the small distance between this level and the point where the curves cross as compared to the distance up to the level before the load change, it will become apparent how little life is left in this wave.

In other words, the level in this case has not dropped a great deal below the point where the end of the new hydraulic gradient would, in any event, require it to go.

If it should seem desirable to have these two curves cross exactly at the final quiescent level, this could easily be done by making the regulator slightly larger, in which case there would be no surging whatever. That is to say, there would be no motion in the water greater than that which is inevitable on account of the fact that the larger draft of water requires a greater drop in the hydraulic gradient.

This absolute damping of deadbeat effect can also be obtained by means of a simple surge tank, but in that case the area has to be nearly four times as great.

(*Continued on page 248*)

Measuring Water Flow for Power Purposes

Description of a New Method and Its Application in the Efficiency Tests of the 37,500-Hp. Turbines of the Niagara Falls Power Company

By N. R. Gibson,[1] Niagara Falls, N. Y.

The necessity of measuring the flow of water used for power purposes at Niagara Falls is known to all who are familiar with conditions there, but many others would imagine that with the whole Niagara River to draw from the consumption of water would be the last thing to consider. On account of the restrictions placed by law upon the diversion of water for power purposes from the Niagara River, however, the measurement of the quantity of water used in the various power plants is a matter of extreme importance. According to the terms of a treaty between the United States and Great Britain, each country is permitted to divert for power purposes a certain quantity of water. In the United States this quantity is 20,000 cu. ft. per sec. and the Niagara Falls Power Company's allotment is 19,500 cu. ft. per sec. The terms of this treaty are being rigorously observed, and in the observance the output in kilowatts of the power company's plants must not at any time exceed the capacity which will utilize its allotted quantity of water.

To determine the relation between power and discharge of a unit it becomes necessary, therefore, to measure the quantity of water used and incidentally to determine the efficiency of the turbine. The importance of this measurement and the accuracy desired will be appreciated if the annual value of the power that can be produced from one per cent of the water allotment is computed. One per cent of 19,500 cu. ft. per sec. would generate in the existing plants at least 4000 hp., the income from which may be placed at about $80,000 per year. On the one hand, therefore, if the allowed capacity were one per cent less than the correct value, the company would be deprived of the possibility of earning about $80,000 per year, and on the other hand if the allowed capacity were one per cent greater than the correct value, it would be able to receive revenue in the same amount in excess of that to which it was legally entitled. The burden of proof, of course, is placed on the power company, and rightly so.

When the three new 37,500-hp. turbines were installed and ready for operation the company was then in a position to use all the water to which it was entitled and the regulating authorities fixed the efficiencies of the new units at a point which it was believed would not be greater than the actual efficiencies. Possibly the efficiency was fixed low enough to make it worth while for the company to go to the expense of proving the exact e ciency. In any event the results were not disappointing because after making the official tests, which received the approval of the division engineer, the allowable output from the three units when charged with the same quantity of water as formerly was increased by nearly 5000 hp.

Shortly before these units were installed the writer had invented a new method of flow measurement which seemed to offer many advantages, particularly in the case of very large units supplied with water through closed conduits. This method was the outcome of studies of the c anges of pressure in penstocks caused by the gradual closing of turbine gates which appeared in the form of a paper in the Proceedings of the American Society of Civil Engineers in April 1919. The company is fortunate in having in Mr. John L. Harper a chief engineer of broad vision and unlimited courage, so when the new method of measurement was proposed to him it received at once his full support, and the writer was given an opportunity to develop the method and apparatus for its application.

The method makes use of two well-known principles, the first being Newton's second law of motion, sometimes referred to as the equation of impulse momentum, and the second being a corollary of the first, namely, the relation between change of pressure and change of velocity of a column of water expressed in terms of the velocity of the pressure wave. The application of these two principles makes it possible to determine the mean velocity of a column of water in a penstock by recording the changes of pressure at a point in the pipe line when the flow of water therein is gradually brought to rest by closing a valve or the turbine gates. The mean change of pressure so recorded is a precise measure of the velocity destroyed.

In practical work it is not always possible to stop the flow entirely, because leakage nearly always occurs through the turbine

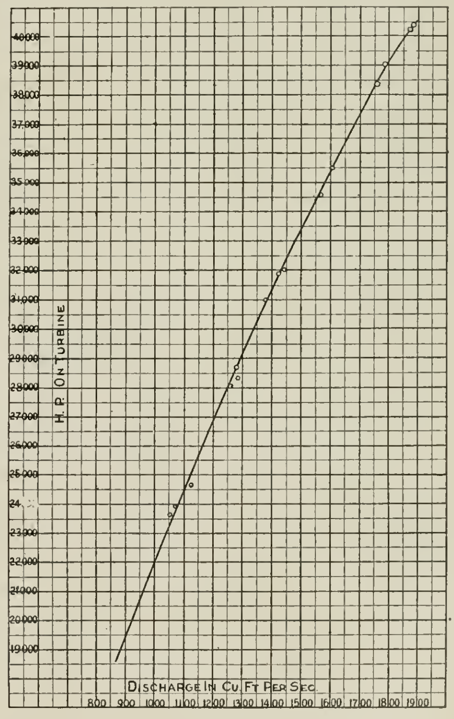


Fig. 1 Power-Discharge Curve for Unit No. 18 of the Niagara Falls Power Company

gates, and in such cases the velocity determined is the difference between the initial and final velocities. The remainder is readily determined in one of several ways.

The apparatus employed comprises a new combination of simple elemental parts in which the pressure element is a U-tube containing mercury, the motion of which can be made to correspond in any desired ratio to the change of pressure in the penstock. The apparatus provides illumination and records photographically to exact full scale the motion of the top surface of the mercury in the tube and combines in the record the oscillations of a seconds pendulum. The resulting diagram shows to exact scale a complete record of pressure changes and time.

After completing the theoretical studies and after building the

[1] Hydraulic Engineer, Niagara Falls Power Company.

Abstract of a paper presented at the Symposium on Hydroelectric Development and Distribution, held at Philadelphia, January 21, 1921, under the auspices of the Engineers' Club of Philadelphia and the Philadelphia Sections of the American Society of Civil Engineers, the American Institute of Electrical Engineers, and The American Society of Mechanical Engineers.

first apparatus, which has subsequently been much improved, both theory and apparatus were tested by experiments.

One of the most important reasons why it was desired to use the new method rather than one of the older and well-known methods, was that tests could be carried out without serious or prolonged interruption of the supply of power from the unit being tested. It requires a two-minute shutdown for each measurement, and the measurements may be repeated about once every ten or fifteen minutes. A complete set of measurements at each tenth gate opening from half to full gate may be made in less than two hours, and during that time the unit would be out of commercial service only about fifteen minutes.

There were two other reasons that may be mentioned, one being that the trouble and expense of the tests would be much less than by any other method, and the other that it was believed the new method was very accurate.

Without going too deeply into theory, the reason for the accuracy of the new method will be appreciated by a reference to the fact that a small change in velocity can be made to produce a relatively large change of pressure. The mean change of pressure corresponding to a change of velocity can be made from five to twenty times the velocity head or even greater if there were any advantage in doing so. In the pitot tube the velocity head only is observed, or, at best, by differential methods only some small multiple of it. In the new method a record is made with great precision of a quantity that is many times greater than the velocity head. In other words, the quantity observed and recorded is many times greater than, but is proportional to, the quantity it is desired to know. It is true, of course, that this change of pressure takes place in a comparatively short time, and the element of time must be considered. It is comparatively easy, however, to measure time very accurately. If an interval of ten seconds is measured within one-tenth of a second, the error is only one per cent, but time may be quite readily measured within one one-hundredth of a second, in which case the error is only one-tenth of one per cent. It so happens, however, that in the new method it is not necessary to measure time directly at all, but only the product of pressure and time, which may be done very accurately indeed.

In order to obtain satisfactory proof of the accuracy of the new method of measurement, as required by the authorities in charge of the regulation of the use of the water, arrangements were made with Dean E. E. Haskell, of the College of Civil Engineering at Cornell University, to have a thorough test made by comparison with volumetric measurement at the laboratory of the university. Six series of tests were made under conditions approximating as nearly as could be had at the laboratory, the conditions prevailing for efficiency tests at Niagara Falls. Table 1 shows the results of the nineteen tests made, from which it is seen that the average of all measurements made by the Gibson method agrees within less than two-tenths of one per cent with the average of all the volumetric measurements. The maximum variation of any one series is eight-tenths of one per cent.

A very careful analysis of these results has been made, which indicates that part of even the slight variations between the volumetric measurements and measurements by the new method may be explained by a very slight unsteadiness of flow, which is sufficient to account for some of the difference between the two measurements. This unsteadiness seems to be characteristic of all water flowing above the critical velocity, and while difficult to account for, it was manifest in this case by the variations in the level of the water passing over the weir before it entered the measuring tank. The magnitude of the variations in gage height was an index of the magnitude of the variations in flow. It would be natural of course that variations in the measurements due to this cause would be both positive and negative, and the mean of a series of results would not show differences of the same magnitude as might occasionally be found in any single measurement. The fact that the mean variation between the volumetric measurements and the measurements by the new method is only two-tenths of one per cent would indicate that, while there might be a difference between the two methods of measurement for any one observation, each method might be as near perfect as the other, because the quantity measured is slightly different in each case.

Having thus established, by careful experiments, the accuracy of the new method, the official efficiency tests of the before-mentioned three new units in Station No. 3 Extension were made on June 29, August 8, and August 17, respectively. On account of the ease with which diagrams can be made, several were taken at each gate opening so as to obtain an average result, and in all from sixteen to eighteen diagrams were made for each unit.

After velocities had been calculated from the diagrams and discharges, and effective heads computed, the usual power-discharge and efficiency curves were prepared. Fig. 1, which is representative, shows the remarkable uniformity in the determination of the points along the power-discharge curves, from which it may be concluded that the errors of observation, or so-called variable errors, are extremely small. The absence of any inherent or consistent error was demonstrated by the tests made at Cornell University.

TABLE 1 COMPARISON OF VOLUMETRIC MEASUREMENTS WITH THOSE MADE BY AUTHOR'S METHOD

Date 1920	—Discharge— (cu. ft. per sec.) Volumetric	Gibson	Per cent variation	Remarks
June 11	20.27	20.31	+0.2	Tube R = 1.335.
June 11	20.42	20.52	+0.5	
June 11	20.45	20.65	+0.9	
	20.38	20.48	+0.5	Mean of series.
May 24	30.38	30.51	+0.4	
May 25	30.63	....	...	Poor diagram (not completed)
May 25	30.69	31.15	+1.5	
	30.57	30.82	+0.8	Mean of series.
May 25	42.24	42.17	−0.2	
May 25	41.94	42.28	+0.8	
May 25	42.22	42.09	−0.3	
May 25	....	41.96	...	Volumetric not taken.
	42.13	42.12	0.0	Mean of series.
June 4	40.36	40.41	+0.1	
June 4	40.36	40.90	+1.3	
June 5	40.98	40.88	−0.2	
	40.57	40.73	+0.4	Mean of series.
May 29	46.82	....	...	Film fogged, diagram invisible
May 29	46.95	46.60	−0.7	
May 29	46.98	46.60	−0.8	
	46.92	46.60	−0.7	Mean of series.
June 7	50.30	49.95	−0.7	
June 9	50.66	51.47	+1.6	
June 10	50.93	51.15	+0.4	
	50.63	50.85	+0.4	Mean of series.
Total of Means	231.20	231.60	+0.2	Mean variation of all tests.

In conclusion, attention may be drawn to some of the advantages of the new method of measurement where it may be applied:

1 Remarkable accuracy in the determination of the velocity of flow because small changes of velocity result in comparatively large changes in the pressure to be recorded.

2 Determination of velocity may be made without serious or prolonged interruption of the commercial supply of power from the unit being tested.

3 Each determination of the velocity of flow may be made quickly in one operation, tedious methods involving tabulation of observed results being avoided.

4 The process is essentially simple and inexpensive. Special appurtenances in the pipe line are not required.

SPEED REGULATION OF TURBINES

(Continued from page 246)

Where large tanks have to be supported on towers, if the differential action is not resorted to, the dimensions of a simple tank will be such as to make its construction impossible on account of exceeding the limits of the boilermaker's art in respect to thickness of plate, size of rivets, etc., where most of the assembling must be done in the field.

Merely because a water-power plant is in successful commercial operation, is by no means an indication that it is doing nearly its best. It seems rather remarkable that while great attention is usually paid to the question of high efficiency of the water wheels and generators and much effort is expended to gain the last one-half of one per cent, enormously larger losses are sometimes permitted to accumulate in the water system, which, by reason of their not having been definitely located or computed, never cause the slightest concern to the financial interests.

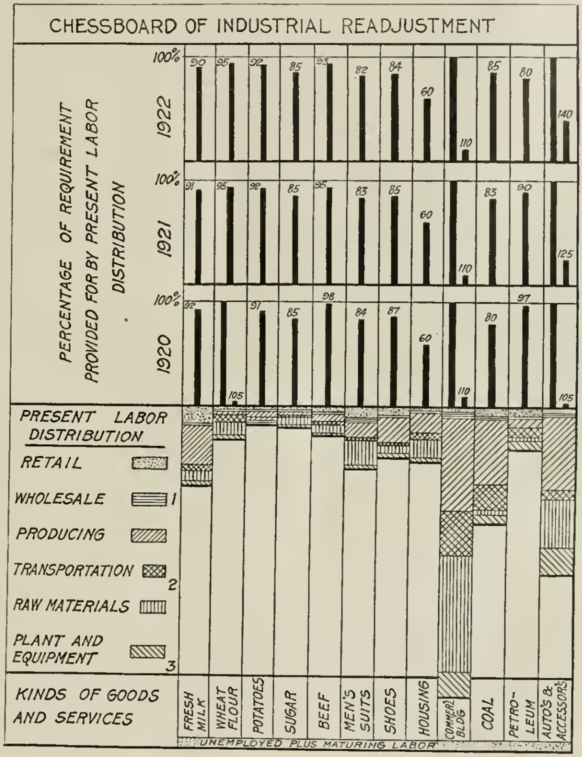
the past and upon *beliefs* formed by frequent repetition of dogmas; and inasmuch as conservatism is an element of dogmatism, it is therefore of necessity arrogant. Its method of self-preservation is to prevent the verification of truth by experiment with facts. Wars and revolutions do not happen—they are caused by arrogance of conservatism based on insufficient knowledge of the laws governing human development.

Self-assumed authority and unanimity, upon which human relations are formulated (commonly known as autocracy and democracy) are conservative in so far as they are based upon beliefs accepted in the past. Their preservation depends upon legal opinion and police force. Opinion derived from an accepted dogma (through scholastic speculation) is impotent to discover new truths, while the power of police force is exercised to suppress their manifestations.

As opposed to this *static* character of social relations, there is produced the *dynamic* force of the economic, intellectual, and spiritual relation through the accumulation of a mass of positive knowledge which gains momentum through a period of time. The gap between the two has been increasing at an accelerated rate until now the old social relations are collapsing and new dogmas are being formulated corresponding more closely with the existing state of technique. Thus in social relations we observe revolution, while in economic and spiritual we have evolution.

The conflict of static control and dynamic process is peculiar only to human life. Prehistoric bees and ants performed their work in a manner identical with ants and bees of today. No expert bee taught posterity how to produce more honey in less time; no expert ant trained the rest of them how to build hills quicker and with less exertion.

On the other hand, the "binding time capacity of the human class of life" has been an unconscious force working toward progress and improvement. Its impulse has been to seek, to learn and to teach how to produce greater results in less time, thus saving the time allotted us to live. The fundamental law of the human class of life is binding time, the natural expression of which



Example of Use of Gantt's Method in Analyzing Industrial Readjustment

[1] Consulting Engineer, Walter N. Polakov & Co., Inc., Mem. Am.Soc.M.E. Paper presented at the Annual Meeting, New York, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

as an expression of the human law of "binding time." This capacity of humans to "bind time" and thereby to accumulate a wealth of knowledge, like any natural organic capacity is insuppressible, as has been demonstrated for the first time by A. Korzybski in his forthcoming book Human Engineering. The suppression or interference with the exercise of this potential power creates counteraction, with consequences as disastrous as an interference with any other known law of nature.

The Philosophy of H. L. Gantt

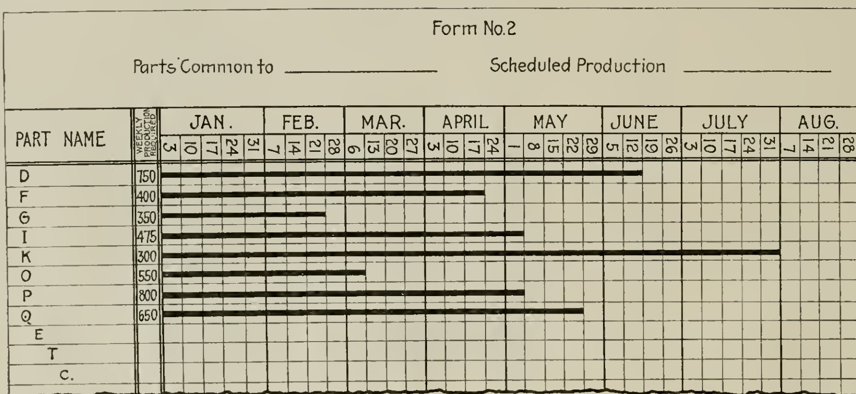
Gantt's philosophy was formulated with an understanding of this first law of human life and can neither be disputed nor ignored. Its application to human relations, and more specifically to industrial problems, is as inevitable as the application of the law of gravitation to astronomy with certainty in foreseeing the results. The method of application of this philosophic concept to the solution of practical problems determines what these results are to be in the same manner as in the solution of a mathematical problem, where an error in the answer is not due to any fallacy in the principles themselves but rather to the method of application of the principles. As formulated by Gantt, the "business system had its foundation in service, and as far as the community is concerned, has no reason for existence except the service it can render."

The foundation of our economic, industrial, and business system lies in the service rendered by all the preceding generations of humanity. A sewing machine is capable of increasing the productivity of its operator not only by the amount of labor worked into it by the mechanic who made it, but by the integrated services of all the scientists, philosophers, artisans, etc., and of all those who since the ages of primitive men have served indirectly to make their lives and works possible. If this were not so, the increased productivity of an operator using a machine would be equal only to the productive efforts expended in its construction. The law of Mayer and Lavoisier, that energy and matter cannot be created or annihilated, would receive its death blow by the first yard of stitches made on the machine in excess of the energy expended by all the living coöperating workers.

The law of nature remains inviolated, however, for the "time-saving" capacity of machines is the manifestation of the service of dead men, who passed to us their ideas and knowledge. This ever-increasing accumulation of our material and spiritual wealth

is therefore not so much the fruit of our toil as that of preceding humanity. Wealth, therefore, like knowledge, if treated as personal property, loses its human value, for possession is an animal standard which is based on "binding space"—brute force of dogmatism—and not on the human capacity of "binding time."

The neglect to abide by and to live up to this natural law of humanity was in Gantt's mind when he said: "The production of goods was always secondary to the securing of dollars." This is evident from a study of our economic development which is characterized by periodic crises, that is, business depressions, financial panics, and overproduction for profit, not for use. To use Gantt's analysis: "If we could harvest more dollars by producing fewer goods, we produced fewer goods. If it happened that we could harvest more dollars by producing more goods, we made an attempt to produce more goods. To be sure, the relation between the demand for, and supply of, the product, directed by a desire to get the greatest possible profit, has resulted in a sort of control which has usually been based more on opinion than on facts, and generally exercised to secure the greatest possible profits rather than to render the greatest service." This violation of the natural law of humanity, that is, the substitution of an *animal* aim of selfish profit for the *human* aim of "binding time" by means of rendering service, brings ultimate and unescapable punishment, as does any act contrary to the laws of nature.



In "The Americas," Mr. Ellery A. Baker, of the National City Bank of New York, Adopts Gantt's Charting Mechanism, Urging Increase of Production (April 1920)

The analysis of law and fallacies brings about a realization of the consequences of violations of this law and introduces a motive into our actions. In Gantt's formulation, "The business system must accept its social responsibility and devote itself primarily to service, or the community will ultimately make the attempt to take it over to operate in its own interest." The social experiments conducted in Russia, Italy, and less systematically in Germany, England, and Austria, are ample proof that the operation of this law is as infallible, unavoidable, positive, unalterable, and universal as that of any natural law.

The conflict between the animal standards of business and the human standards of science and technology has recently culminated in the World War and subsequent revolutionary movements. The enormous power which the application of technology gives to the conservative, dogmatic rule of static animal instincts, brought about a realization of the necessity for wise direction of the dynamic forces of society. The direction of any force presupposes an understanding of laws which it follows. Until Gantt postulated the fundamental law and showed its application to be technology, this accumulated wealth of all preceding human generations remained a blind, unconscious, aimless force, beneficial or destructive as the whim of dogmatic speculation decreed.

Engineering has been variously defined according to the private opinion of scholastic minds: from the *moral* viewpoint as the "mastering of natural forces and materials for the benefit of mankind;" from the *economic* viewpoint as "engineering aims at maximum production with minimum outlay of time, efforts and resources;" or from the *utilitarian* viewpoint as "knowledge of what to do, when to do it and how to do it." Such statements demonstrate vague and arbitrary selection of aims. Now, technology, and more specifically engineering, can be defined as "a method of rendering rigorous service."

The direction of the enormous forces of technology of modern society according to static dogmas which violate the natural law of human developments, can result only in the destruction of society. Until this fundamental truth was conceived, the privilege of violating this law of humanity had its origin in ignorance. The forbidden fruit of the Tree of Knowledge was eaten before it was ripe and mankind suffered from mental indigestion until the Nazarene brought His gospel of a "chief that doth serve." For two thousand years this revelation has been dogmatized and kept out of practical application by those more willing to receive than to give service.

Using the Baconian method of induction and the Cartesian method of doubt in his confutations of economic and industrial fallacies, Gantt began with expositions of errors, proceeded with producing evidence of the causes of error, and concluded with the establishment of verified truth.

With the projection of service through time established as the natural law of humanity, the criterion for human activities suggests itself as a necessary and sufficient corollary: "In an economic or a moral sense an action is right when it will advance the cause of humanity, and wrong when it will not."[1]

Following up the mathematical method of reasoning, human relations, periodically clashing in disastrous catastrophes, present a problem consisting "in a readjustment of our economic conditions with the object of averting another such catastrophe." Such a readjustment obviously must be in compliance with the fundamental principle of human progress. The first practical task, therefore, is the exposition of error.

Gantt produced the evidence of the causes of errors from the analysis of social evils which lead the so-called civilized world periodically to such catastrophes as overproduction coincident with unemployment, epidemics, high infantile mortality, underfed school children, etc., or revolutions and wars for new markets after internal markets have been overtaxed, or competition which withholds from competitors information which would make for advancement in art. According to Gantt, industry cannot begin to fulfil its function of serving humanity until we

1 "Eliminate special privileges of whatever kind, and make industry and business serve the community;
2 Base the conduct of industry and business on facts, instead of opinions, as has been common in the past;

[1] Influence of Executives, in Annals of the American Academy of Political and Social Science, publication No. 1319.

industrial services is very close to that laid out by Francis Bacon, Lord Verulam, in his Novum Organum (1620), although his philosophy is nearer that of Descartes. He follows a well-beaten path of scientific analysis in order to eliminate and exclude all elements of doubt and to establish each fact from a sufficiently large number of observations with reasonable certainty. Gantt divides such an investigation into three parts, as follows: "An analysis of the operation into its elements; a study of these elements separately; a synthesis, or putting together the results of our study." Practice of this method leaves no room for opinions, frequently dignified by the name "theories."

Heretofore this method has been employed by every positive science and has transformed witchcraft into medicine, alchemy into chemistry, astrology into astronomy, and craftsmanship into engineering. Those lines of human endeavor that failed to adopt this scientific method remained in the medieval state of dogmatic sophistry like jurisprudence, which even in the twentieth century renders such decisions as the acquittal of a man charged with bigamy on the ground that his first wife is under legal age, hence he is not legally married to her.

This method of scientific research while in itself not new, was extended and applied by Gantt to decidedly novel purposes. It was applied to engineering rendering rigorous service to society and to the measurement of the service rendered. Heretofore profit-making managements, which aimed at converting industry into a dividend-grinding mechanism, have attempted to use scientific methods. From now on the achievement of Gantt offers a means of measuring the human or social efficiency of industry. Special privileges and incompetency are no longer a matter of private or prejudiced opinion, for by means of quantitative analysis they can be ascertained and measured with precision like any other physical phenomena. Gantt's method has made it possible to ascertain the cause of the diseased industry just as blood analysis established the cause of malaria. While the latter made the completion of the Panama Canal possible, the former will transform industry from servitude into creative service and its pensioners into respectable members of the community.

A criticism is sterile unless it carries the constructive element. The mechanism for demonstrating the results of the analysis is at once the mechanism for directing the service. The mechanism of Gantt for the analysis of service exposes error in a manner clearly indicating its cause. He who knows the cause of his failure can readily avoid failure unless he is mentally defective or criminally inclined. Graphic presentation of failures in production, distribution, etc., is as immediate in effect as it is obvious. Unlike statistical diagrams, curve records, and similar *static* forms of presenting facts of the past, charts logically evolved from the concept of "binding time" by rendering service are *kinetic*, moving, and project through time the integral elements of service rendered in the past toward the goal in the future.

Three cardinal questions asked of industry, agriculture, transportation or any other productive endeavor, are:

formity with the fundamental law of rendering service for the benefit of humanity, inasmuch as:

1 Facts being established leave no room for opinions, traditions, or fallacies
2 Facts being openly established, privilege supported by secrecy fall,
3 Facts being public, drive into disrepute incompetence, bluffs nepotism and favoritism

Mines of Central Competitive Field 1917

STATE	MONTH	PERCENT OF CAPACITY USED ON SECOND HALF YEAR 10 20 30 40 50 60 70 80 90	DETAILS OF IDLENESS DUE TO: LACK OF WORK (CARS)	LACK OF HELP	LACK OF AND POOR MATERIAL	REPAIRS	POOR PLANNING	REMARKS
ILLINOIS	June		15 %	2 %		3 %	7 %	"THE DAYS A MINE IS IDLE NOT ONLY MEANS NO REVENUE BUT AN INCREASE
	July		16 %	4 %		2 %	6 %	IN AVERAGE COST OF PRODUCTION" FROM US GEOL SURVEY II 4, PAGE 19.
	Aug		5 %	22 %		4 %	5 %	
	Sept		9 %	5 %		6 %	7 %	
	Oct.		8 %	13 %		5 %	7 %	NEARLY 40,000,000 TONS PRODUCT WERE LOST DUE TO ALL CAUSES AND
	Nov		12 %	3 %		7 %	2 %	13,300,000 DUE TO ALL TRANSPORT ALONE
	Dec.		11 %	4 %		9 %	2 %	31 PERCENT OF ILLINOIS COAL PRODUCTION LOST
	Aver. Illinois		10 %					
INDIANA	June		18 %	3 %			7 %	
	July		19.5 %	3.5 %			9.5 %	
	Aug		20 %	3 %			8 %	
	Sept.		19 %	2 %			9 %	ALMOST 10,000,000 TONS PRODUCTION LOST IN INDIANA DUE
	Oct.		15 %	4 %			10 %	TO ALL CAUSES AND 6,600,000 TONS DUE TO TRANSPORTATION
	Nov.		11 %	2 %			10 %	ALONE
	Dec.		18 %	2 %			11 %	
	Aver. Indiana		18 %					
OHIO	July		20 %	2 %			5 %	
	Aug.		19 %	3 %			6 %	MINE MISMANAGEMENT AND DISABILITY CAUSED PRODUCTION LOSS OF
	Sept.		18 %	5 %			5 %	ABOUT 3,600,000 TONS TRANSPORTATION CAUSED 20
	Oct.		22 %	4 %			5 %	PERCENT LOSS, EQUIVALENT TO 12,000,000 TONS LOST
	Nov.		25 %	4 %			6 %	PRODUCTION.
	Dec.		27 %	5.5 %			4.5 %	
	Aver. Ohio		20 %	4 %			6 %	
	All Bituminous							

IDLENESS CHART

IN *The Dial* (NOV. 1, 1919) DATA OF U. S. GEOLOGICAL SURVEY, BUREAU OF MINES,, FEDERAL TRADE COMMISSION, ETC., ARE STUDIED AND REPRESENTED BY MEANS OF MR. GANTT'S METHOD

4 Results being compared, point out where most service and help is needed
5 Results attained being known, create interest in the work and bring commensurate reward
6 Attainment of the aim being recorded, stimulates rendering service.

Moreover the proper use of such mechanism points out three integral elements of the organization for rendering rigorous service, namely,

1 Reward commensurate with service rendered
2 Elimination of idleness before securing additional means of production
3 Utilization of available knowledge without awaiting the new discoveries.

The strict conformity of the above aphorisms with the fundamental postulate renders them an organic whole as irrefutable as the natural law of binding time for the human class of life.

Application and Influence of the Principles Enunciated by Gantt

The sphere of application of the principles of Gantt is limited only by the boundaries of human activities. Not every act that is performed within *time* at an expense of *energy* (whether mental or physical) falls into the class of "binding time." The applica-

tion of the criterion of projection of service through time or real "binding time" defines whether or not the act is of human dimension. An act possessing zero or negative value from the point of projecting service into future time has no human value. The inexpert waste of natural resources which is present in the consuming of time and destroying of energy through misdirected effort is contrary to the "natural law of the human class of life" because it renders a negative service to future mankind.

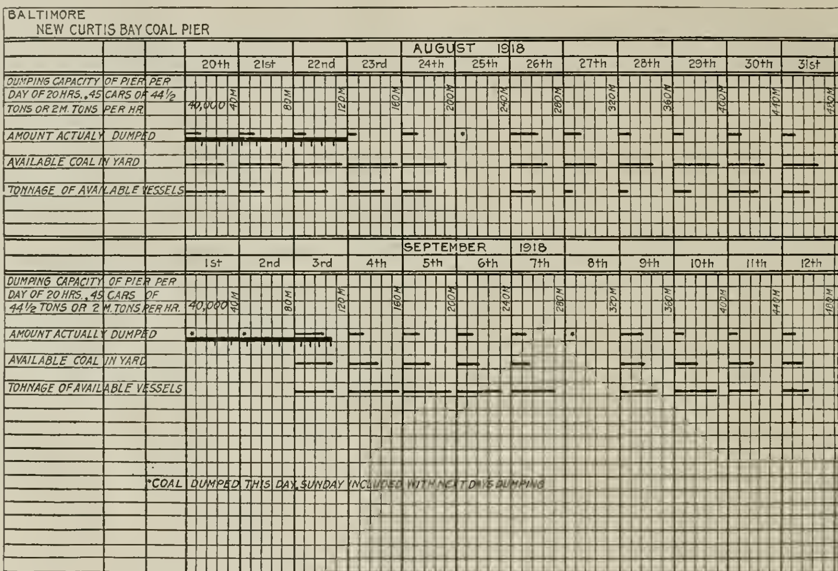
Similarly a war or other form of securing profit at the expense of destruction is a violation of the law of humanity. Again, activities that merely keep things in balance, consuming what is produced without serving futurity, as for instance those of mere maintaining animal existence, are of no human value. On the other hand, service which tends to accumulate and augment the time value, like that of increasing knowledge which will be of service in the time to come, is human and positive. A few illustrative examples of the influence of this philosophic concept and recent applications of Gantt's method to various problems are given in the five accompanying charts.

The influence of this philosophy is clearly shown in the recent conception of credit as a measure of the ability to render service (human standard) as opposed to the earlier practice of extending credit commensurate with the possession of things (animal standard), as well as in the still more recent recognition of the accountability of public utilities for their waste of natural resources.

The acceptance of the new concept is evolved in the change of our social and industrial relations from the régime of ignorant violation of the natural law of humanity for the projection of service into the future, to that of compliance with this law. Heretofore the success of an undertaking was measured in dollars. Improvements were reckoned in dollars saved. The stability of the enterprise was dependent on the steady flow of dollars. Quality of the product had value in so far as it permitted a larger margin between the price and production cost. Wages were fixed at the lowest acceptable minimum. Working hours were limited only by need for recuperation. Hygiene and safety were judged from their effect on dividends. Human relations were considered only when dollars were in danger. Natural resources were sacked, for it paid better to waste than to conserve. Outputs were determined only by the ability of the customer to buy, and not by his need. Idleness was respectable—it gave leisure to a few who could enjoy it.

The control of resources, of means of production or even of political power is of no avail whatsoever unless the productive forces are so directed and organized that the new industrial relations shall better serve large masses of people. The knowledge and the ability to do things assumes the natural, intrinsic authority and leadership. It is inevitable, therefore, that the industrial administrators, preeminently the engineers, are alone capable of mastering the complex mechanism of modern life in motion. The old masters of static things have no function in the modern dynamic society. The new leadership cannot be either autocratic or arbitrary, for dealing as it does with the laws of nature, with intrinsic laws of life, not with man-made laws of barristers, it can neither alter nor misinterpret them. Where errors spell annihilation, there is no room for opinions, whims or desires. Action must be taken on the basis of the knowledge of facts; hence those who know what to do and how to do it must assume the leadership. Their authority, being based upon the knowledge of facts, cannot be questioned, disputed or denied any more than the facts themselves. This authority is not conferred on them by vote, nor is it taken by force—it is theirs so long as it serves humanity in its quest for life and happiness. The problem therefore resolves itself into the mastering of time, or, in other words, the extension of human life and happiness into the future.

Yet even this aim alone is narrow and unsatisfactory. Mere "avoidance of starvation" appears today, in view of the advancement of science and technology, as an uninspiring daily toil. A higher ideal, a more inspiring aim of self-expression is instilled into the masses of even the most downtrodden people by the retrospect of the past struggle for mere animal existence. The desire to create can no longer be suppressed in the human masses. In factories as in politics it is no longer a full dinner pail that is the goal, but an indispensable means for self-expressive creation, for self-projection into the time to come. This philosophy, as established by Gantt, thus provides means and motives for accomplishing the natural aim of human development, and is bound to play the role of intrinsic leadership, pointing the way out of the welter into which the disregard of the fundamental law of humanity has brought us.



During the War the Critical Coal Situation was Similarly Studied by Government Agencies by Following the Path Blazed by Mr. Gantt. This Chart Shows Neglect to Use our Coal-Loading Capacity

At the solicitation of Mr. Polakov a number of discussions of his paper have been presented. It is not possible to publish these in their entirety, but the following selections from certain of them cover the main points which have been brought out.

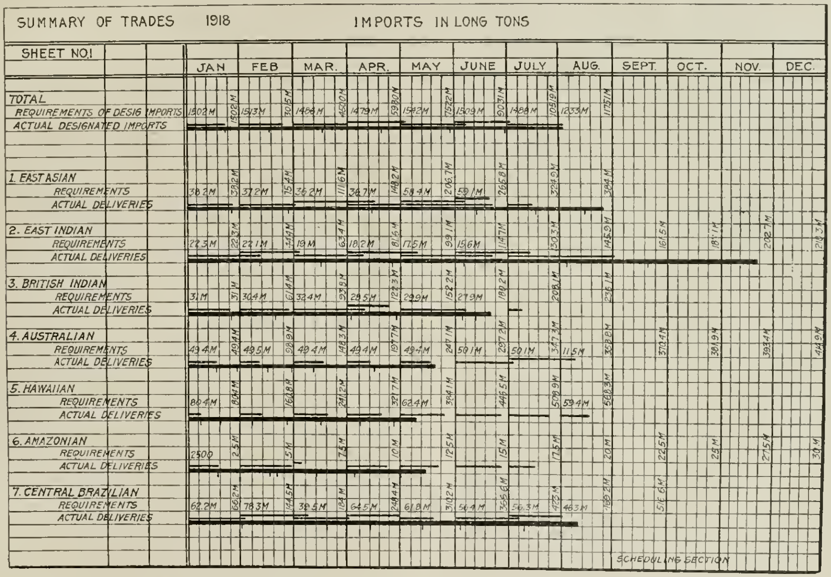
Robert B. Wolf. The faculty of recording past events as a guide to future actions is what Mr. Polakov claims to be the secret of the success of Mr. H. L. Gantt's method of recording plant progress by the chart method. These graphical charts make it possible for those in charge to be conscious of a greater portion of the *past* in the *present* than is the case with the old historical or descriptive methods, and it is because of this greater consciousness of past events that the future can be more definitely predetermined. This, of course, results in a maximum of production with a minimum outlay of *time*.

This concept, according to Mr. Polakov, was more specifically indicated by the Polish engineer, Alfred Korzybski, who brings out, for the first time, the outstanding difference between the three kingdoms of the organic world—the vegetable, the animal, and the human.

and the animal to "bind space," he next turned his attention to the records of human activities. He soon realized that the outstanding characteristic which distinguishes the human being from the animal is its capacity to record past experiments, to make them available for future generations.

All of the world's great religions were based upon the recorded teachings of their founders. Our whole system of law is based upon past precedents recorded in our court proceedings, and modern science is primarily an accurate history of the results of past happenings in the organic and inorganic worlds. It is this recording of events in *time* which is a distinctly human faculty and through it man becomes conscious of the operation of the principle of causation, for without this power of recalling past events man could not have come to a realization of the absolute unchangeableness of natural law.

This faculty of holding or fixing past events to make the knowledge of them a source of power for future generations, is what Korzybski calls "binding time." His third generalization is that man is therefore a "binding time" class of life. The natural effect of this is that each succeeding generation of mankind is able to begin approximately where the preceding one left off, whereas in the animal world each succeeding generation is obliged to begin practically where the preceding one began.



Foreign Trade May be Regulated by Gantt's Analysis as Well as Any Other Human Activity

It has been my privilege to review Count Korzybski's book and in order to discuss Mr. Polakov's paper intelligently it will be necessary briefly to explain Korzybski's expression "binding time" to which Mr. Polakov makes frequent reference.

Korzybski, who had ample opportunity to observe the destructive effects of commercial competition in Europe, concluded that human standards were but little above the animal standards and that the "survival of the fittest" naturally resulted. It was in the hope that he could find a fundamental distinction between the various classes of life that he began his researches by studying the accumulated records of the past.

He first turned his attention to the lowest form of organic life, the vegetable, and very soon found its main function to be the storing up of solar energy. The vegetable organism, which does not move about, but is attached to the earth, draws up through its roots the inorganic chemical substances from the earth and forms them into a cell in which the energy of the sun is confined. He therefore concluded that the function of the vegetable class of life is to "bind solar energy." Coal, for instance, is of vegetable origin and in burning it we release sun power.

He next directed his attention to the records of animal life and at once noted that the outstanding thing which distinguished it from the vegetable is its freedom to move about in space. As all life proceeds by multiplication, i. e., geometrical progression, each species of animal life was soon in conflict with every other species. This animal characteristic of movement *in* space and occupation *of* space resulted, of course, in a struggle for self-preservation. This was especially true in an environment which stimulated rapid reproduction of the species. Darwin observed this when he enunciated the principle of the "survival of the fittest"—no two physical bodies can occupy the same space at the same time.

These observations led Korzybski to his second generalization, namely, that because of this fundamental faculty of movement in space, the animal was destined to increase its power of movement by its occupation of more space. The animal, he therefore concluded, was a "binding space" class of life.

The far-reaching effects of this new realization of human life are expressed by Korzybski in his conception of what human competition *should be*, namely, *competition in time*—"survival of the fittest"—yes; but in *time*, not in *space*.

Man, therefore, by the basic law of his nature, is compelled to work for posterity. The animal is conscious of only one dimension of time, the present—man alone consciously uses all three: past, present and future. This is why real education, by means of the *true* presentation of the facts of the past, is the only cure for wars; also why humanity must resist any dogmatic attempt to keep the individual in ignorance. Safety lies only in a true evaluation of the past, in order that *present* humanity can consciously create a *future* which will be in harmony with the universal creative purpose.

My intense interest in the subject-matter of Mr. Polakov's paper is the amount of light that this concept of man as a "time binding" class of life throws upon my own past experience.

In Non-Financial Incentives[1] I showed how men invariably put forth their best efforts when furnished with continuous records of past performances. *In all such records the individual competes with his own past and with the past performances of others.* This is the secret of the baseball player's interest in the batting average, for it is only the animal that lives in the present, that competes with the present. Present competition is "space" competition, and therefore destructive.

Intelligent effort is creation, and as no such self-expression can be obtained without some degree, at least, of conscious use of past experience, it follows that this conscious use of time is the very essence of creation. It requires time to create a universe, a garden, or an automobile, and the production records of Gantt show clearly that it is only an efficient *use of time* that makes greatest productivity possible.

Gantt's conclusion that the Golden Rule is the most practical doctrine

[1] Presented at Annual Meeting of A.S.M.E., Dec. 3–8, 1918.

upon which to conduct business, makes an intellectual as well as an emotional appeal, looked at from the point of view of man as a "binding time" class of life, for it is only when every man does to every other man what he would have all men do to him that the human race can make its greatest progress in the *future*.

Judged by the same standard, that other great Christian injunction, "It is more blessed to give than to receive," is recognized to be the *only* practical guide to human life. Getting is "space binding" and therefore animal. Sooner or later our accumulations will conflict with those of others and a physical conflict is inevitable. We must cease our efforts to possess *things* and make *giving, which means rendering service*, our main object in life. In this way only can the human race attain a maximum of creative power, the possession of which insures an abundance of all "things" needed.

Alfred Korzybski. My tribute to the memory of Gantt will be not only the homage of a friend and admirer, but the proof that his philosophy is scientifically true. A rigorous proof is necessary, because the word "service" belongs to that category of words the meaning of which can be completely reversed by the verb, be it "give" or "take." Gantt took the "rendering of service" as an axiom; my observation.... was that our civilization had quite another axiom: "We preach give, we practice take." The problem which interested me was how to find a way out of this contradiction that would be irrefutable. If one of them is a true and natural law for humans, then the other is not; if our words are true, then our deeds are not true, or if our deeds are true then the words are camouflage. I found the solution by applying mathematically rigorous thinking.....

I defined the classes of life by emphasizing their incontestable dimensional characteristics; plants are "Chemistry-binding," animals are "Space binding," humans are "Time-binding" classes of life.

These definitions make it obvious, that:

1 The classes of life have different dimensions, and that as in mathematics the intermixing of dimensions makes a correct solution impossible, so in life the results of such elementary mistakes produce tragic consequences.

2 The old formula on which our civilization is built, Human equals Animal plus or multiplied by Spark of Divinity, is basically and elementarily wrong and is a mathematical nonsense identical with such an absurdity as X square inches equals Y linear inches plus or multiplied by Z cubic inches.

3 This basically wrong formula on which our civilization rests is the cause of all the periodical collapses, wars and revolutions.

4 The old system was built on animal "space-binding" standards, and human "time-binding" impulses were all the time in rebellion.

5 As the theory of gravitation and calculus made engineers and mathematicians masters of inanimate nature, so these tangible and incontestable definitions give them a positive base which will enable them to approach and solve human living problems by establishing the mathematical fact that man is man and not an animal ....

8 For the "time-binding class of life" it is obvious, then, that in this dimension "time binding" is the natural law, and, if analyzed and understood, is the highest human aim.

9 Such "natural laws" as "survival of the fittest" for animals, which is the "survival of the fittest in space," result in fight, or the survival of the strongest; whereas such a law, to be a *Natural Law* for humans, must be in the human dimension, which obviously would be the "*survival of the fittest in Time*," resulting in the survival of the best.....

11 All of our ideas have to be revised and the animal "space-binding" standards either rejected as dangerous and destructive, or transposed for "time-binding" standards which will correspond to the natural impulses and laws for humans.....

We are the masters of our own destinies; the responsibility is ours to correct the mistakes of our ancestors and to establish a scientific philosophy, scientifically true law, scientifically true ethics and a scientific sociology, which will form one unified science of man and his function in the universe.....

Gantt's concept of rendering service is scientifically true because it is "time-binding" and therefore true for the human dimension. This is why Gantt's concept has counted for so much, and will survive "*in Time*."

Charles W. Wood wrote that he had had many talks with Mr. Gantt and that he was in agreement with his facts and principles. Mr. Gantt, however, had to use phrases to express himself and one might disagree with a phrase. "Engineering," he said, "is an exact science, but English is not." A phrase used by Mr. Gantt and quoted by Mr. Polakov, to which he would take exception, was: "Reward commensurate with service."

Mr. Wood referred to numerous instances in industry, the school and the home where for the best interests of all the reward does not always go to the efficient, the brilliant or to the strong. For example, to whom should the teacher devote the more attention and, consequently, the greater portion of the public funds—to the bright child, or the dull one? We will all answer, "to the dull one." He needs more, and unless we give him more, things will go hard not only with him, but with the bright ones, too.

But if this principle doesn't work out in any of the other human relations, why do we try to apply it to industry? Doesn't it defeat the very aim which Mr. Gantt had in mind? Can we reach industrial coördination by trying first to establish absolute justice in the distribution of the product? One of his chief reasons for objecting to this phrase, Mr. Wood said, is that capital and labor both perform a service and there are so many loose-thinking efforts to find an equitable system of reward for each.

Isn't it more to the point to suggest rewarding both capital and labor according to their respective needs—which practically abolishes the whole concept of reward as we understand it today?

It is fairly easy, it would seem, to determine what a worker needs. He needs every possible encouragement to express himself to the limit in creative work: and to do this he needs to be freed from economic and social insecurity. Self-preservation and race-preservation are fundamental instincts, which must be attended to if one is to be set free for work worth while. Unless the worker can be certain of eating, and unless he is given a chance to love and mate and bring forth children, the workers will not be in a position to earn very much and our whole industrial organization may be destroyed by the pangs of hunger and sex.

And isn't it easy, also, to discover what capital needs? Capital likewise needs perfect functioning: and if it is allowed to function perfectly it will cause no trouble. Capital, in fact, is an inanimate thing which can be perfectly controlled by engineering; and it should be easier to discover its exact needs than to ascertain what the normal requirements of the living workers are.

There is, Mr. Wood admitted, another factor in our present industrial order, which is not so easily disposed of. It is not living labor. It is not inanimate capital. It is a group of living persons known as owners. Some of them perform service. Some of them do not. How are we to reward them? According to the service they personally render, or according to the service their capital performs? And if we pay them for what their capital does, how can we reward the *capital* commensurately? It might be that they would not put this reward back into necessary reinvestments but spend some of the money upon themselves. That would not be "reward commensurate with service." It would not be paying the capitalist for what he does but for what he owns.

Once again, isn't it the scientific solution to consider not what the capitalist does, nor what he owes, but what he needs? He is human and he needs what every human being needs—a chance to function perfectly as a creative human being. If he is capable of rendering service, should he not be equipped to render all he can?

It would seem that Mr. Gantt did answer many of these questions and that his work must lead us to a clearer conception of industry as an agency for the supplying of human needs rather than a scheme for the gratifying of inhuman greed. Instead of seeking to establish rewards commensurate with service, are we not seeking to establish service commensurate with human possibilities? And does not the establishment of such service bring with it all that the human heart can wish?

Hugh Archibald contributed a discussion in which he drew on his experience in the coal-mining industry to illuminate the principles developed by the author.

Some years ago he was telegraphed for to rescue a mine from being drowned out; the pumps would not work. He found a new boiler plant with water-tube boilers equipped with Dutch ovens, rated at 1500 hp., and about a thousand horsepower of engines altogether in which to use the steam. But there was no insulation on the steam lines and the weather was near zero. There was one line 2000 ft. long which was leaking at every joint; there were no steam traps before the engines; there was no valve between the old boiler plant and the new and steam was condensing in the cold old boilers. Steam, even, was pouring through an old steam-jet blower, making a forced draft up a cold chimney. No wonder that the forcing of the boilers would not run engines and pumps!

Around the mines the industrial structure was working about as well as that steam plant. It needs to be made over and in doing so fundamental laws need to be known. There are leaks to be stopped, insulation to be applied, and steam traps to be installed.

Mr. Polakov has pointed out three elements of "rendering rigorous service," said Mr. Archibald. The first of these is that reward should be commensurate with service rendered. No wage payments which would conform to this rule exist in the coal mines. For instance, mine foremen, who by law are in charge of all inside workings and who may have under them from one hundred to five hundred employees, are paid about a dollar an hour, while the diggers of coal are paid at the rate of two to three dollars an hour. The mine foreman does not suffer from intermittent employment or from "unemployment within employment," as the digger of coal does, so that at the end of the year his earnings are more than the man he employs. The digger of coal, on the other hand, suffers so much unemployment that he has to be rewarded, in part at least, for the time during which no service is rendered.

The second point which Mr. Polakov makes for rendering rigorous service, is the elimination of idleness before securing additional means of production. The intermittency of operation of coal mines has become common knowledge. Almost every one knows that bituminous coal mines operate on an average about 230 days in a year and that not even anthracite mines are in service continuously. There is a great overdevelopment of coal mines and yet more are being opened every day.

A third point for service is the "utilization of available knowledge without awaiting new discoveries." It is safe to say that if engineering work such as H. L. Gantt did in manufacturing were done in and around coal mines, the output of the mines on the days when they were operating would be increased fifty per cent and the cost of mining coal reduced.

Back of all these points is the fundamental law that the purpose of human life is to "bind time," which has been stated by A. Korzybski and to which Mr. Polakov calls attention.

If disregard of fundamental laws produces machinery which will not work, the same disregard will produce social structures which will not work. And if "binding time" is one of the human purposes (and it surely is), then coal mining is violating that law and the coal industry needs redesigning. For as it is now operated, it does not bind time but captures idleness.

We need to know fundamental laws that engineers may design structures which others can operate. Mr. Polakov's paper has contributed to the possibility of a better design.

Locomotives and Locomotive Terminals

Salient Points Brought Out in Discussion of Papers on Increasing the Capacity of Old Locomotives and Modernizing Locomotive Terminals, Presented at Railroad Session of A.S.M.E. 1920 Annual Meeting

Two important papers presented at the Railroad Session of the Annual Meeting of The American Society of Mechanical Engineers were those entitled Increasing the Capacity of Old Locomotives, by C. B. Smith,[1] and Modernizing Locomotive Terminals, by G. W. Rink.[2] Mr. Smith discussed the problem of providing adequate facilities for keeping old locomotives in service and adapting them to new demands of suburban and local service, emphasizing the need of making provisions for carrying out a program of reconstruction and improvement. The paper by Mr. Rink dealt with the question of providing adequate facilities for the proper maintenance of locomotives at engine terminals, which has an important bearing on the ability of the railroads to handle the increased traffic demands of the country. Abstracts of these papers were published in the January issue of Mechanical Engineering. The papers brought forth considerable discussion, the most important points of which are presented in the following extracts.

Increasing the Capacity of Old Locomotives

P. M. Hammett.[3] Programs for the application of improvements to locomotives should be carefully studied by each railroad in the light of its own traffic conditions, as no general conclusion is justified. On roads thoroughly constructed and well maintained, new locomotives may be of greater weight and power than can be obtained by the reconstruction of old engines and should be preferred in so far as their greater ability can be continuously utilized. Where conditions do not permit large increase in weight, improved devices should be applied to existing locomotives of such type and age as have further profitable service life of ten or more years.

Roads having main lines or branches where light traffic does not call for maximum performance should be cautious in the application of devices of expensive character to locomotives for such service.

Shop plants on many railroads are inadequate in quantity and capacity to the needs of normal maintenance. In such cases the application of improvements to existing locomotives has been limited rather by shop capacity than by restriction of appropriations. Those improved devices receive most rapid acceptance which impose less burden on railroad shops, either by their nature or by reason of general engineering development and complete manufacture of material by those promoting and offering them to the railroads. Any extensive program for improvement of locomotives should include as an essential part, a study of the period which may profitably be allowed for its execution, and provision of facilities sufficient for its execution within that period.

J. C. Hassett.[1] An improvement policy was inaugurated on an eastern road in 1910 and 1911 and the first superheater locomotive with piston valves was completed in April 1912. To date 160 locomotives have been so converted, representing an average annual production of 20 locomotives. The fuel saving per locomotive per year varies from $2000 to $3000 at present prices for coal. This has been done without any retarding effect on the output of locomotives regularly scheduled through shops and without any drastic revisions or increase of shop forces.

Experience in applying superheaters to locomotives, applying piston valves, outside valve gears, etc., shows the cost to be about $8500, covering betterment, renewal and overhead charges, as compared to $40,000, the cost of a new locomotive at the time the modernizing was done.

Another phase of this superheating problem is the retention of the old slide-valve cylinders and Stephenson valve gear through the application of a piston-valve type of steam chest. One locomotive was so equipped about six years ago and has been giving continous and satisfactory service since. This application can be made for approximately $1800 less than the amount required to add new cylinders and outside valve gear.

In reference to the weaknesses of the main frames of locomotives built during the past ten years, alluded to by the author, probably no road has been immune. A certain group of 52 locomotives of the 4-6-0 type was built in various lots during 1904, 1906 and 1907. These 52 locomotives sustained 30 per cent of the total frame failures of approximately 1250 locomotives on the road.

In the final analysis of this serious situation it was found that the frame sections were, and had always been, too small, based on the areas of sections established by best engineering principles. In the preparation of the new design, the sections were increased.

Locomotives are receiving heavier frames at an approximate cost of $3500 per locomotive, including additional cross-ties, boiler supports, etc. The performance of these locomotives to date has been very creditable.

The extent to which application of heavier frames of proper size can be made to old locomotives will be in large measure limited by the increased weight which can be placed on axles, bearings, spring riggings, etc., without renewal of these parts.

H. B. Oatley.[2] The writer desires to bring out the features which have prompted the very extensive superheating programs which have been in vogue on many of the railroads for a considerable period. The table accompanying this discussion gives

COMPARISON OF SATURATED AND SUPERHEATED-STEAM LOCOMOTIVES OF VARIOUS TYPES

	4-4-0		4-4-2		2-6-0		0-6-0		2-8-0	
Cylinders, in	20 × 24		22 × 26		19 × 26		20 × 26		21 × 30	
Wheel diameter (drivers) in	69		80		63		51		63	
Boiler pressure, lb. gage	190		205		200		180		210	
Tractive power (maximum) lb	22470		27470		25300		31100		37500	
	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.
Weight on drivers, lb	94000	96000	124100	126000	125500	128000	144600	147600	172500	176500
Factor of adhesion	4.18	4.27	4.51	4.59	4.96	5.06	4.65	4.74	4.6	4.7
Heating surface, tubes, sq. ft	1957	1035	2474	1335	1732	948	1750	987	3194	1737
Heating surfaces, flues, sq. ft	....	402	....	506	....	392	....	412	....	650
Heating surfaces, firebox and water tubes, sq. ft	232	232	166	166	158	158	156	156	189	189
Total heating surface, sq. ft	2189	1669	2640	2007	1890	1498	1906	1555	3383	2576
Superheating surface, sq ft	....	314	....	435	....	296	....	306	....	530
Combined total heating surface,[1] sq. ft	2189	1983	2640	2442	1890	1794	1906	1861	3383	3106
Total water evaporated, lb	31530	25930	32228	25728	26720	22120	28430	23610	40960	32510
Steam per hp-hr , lb	27	19.5	27	19.5	27	19.5	27	19.5	27	19.5
Boiler horsepower	1165	1330	1196	1320	999	1135	1052	1210	1515	1667
Boiler hp. increase, per cent	....	14	....	10.2	....	13	....	15	....	10
Maximum cylinder horsepower[2]	1265	1369	1655	1786	1202	1300	1199	1297	1543	1667
Per cent boiler hp. of cylinder bp	92.3	97.5	72.3	74	82.9	87.4	87.7	93.2	98.1	100

[1] American Locomotive Co.'s method used but figures are those used by Locomotive Superheater Co.
[2] American Locomotive Co.'s figures used.

[1] Mechanical Engineer, Boston and Maine Railroad.
[2] Assistant Superintendent Motive Power, Central R. R. of New Jersey, Mem.Am.Soc.M.E.
[3] Supt. of Motive Power, Maine Central Railroad, Portland, Me. Mem. Am.Soc.M.E.

[1] Mechanical Engineer, N.Y. N.H.& H.R.R. Co.
[2] Chief Engineer, Locomotive Superheater Company, New York. Mem. Am.Soc.M.E.

some comparisons between saturated and superheated locomotives of some of the types mentioned by the author.

By the addition of a high-degree superheater it has been demonstrated that the steam consumption per horsepower-hour is reduced about 28 per cent. The figures commonly accepted as representing good practice are 27 lb. for saturated steam and 19.5 lb. for superheated steam. It will be noted that in the case of the 0-6-0 type boiler the horsepower has been increased 15 per cent; for the 4-4-0 type 14 per cent; for the 2-6-0 type 13 per cent, for the 2-8-0 type 10 per cent, and for the 4-4-2 type 10.2 per cent.

The maximum cylinder horsepower, using the American Locomotive Co.'s figures, has, by the addition of a superheater, been increased about 8 per cent.

When considering existing locomotives the increase in the maximum tractive power requires consideration of (1) the factor of adhesion, and (2) the strength of the running gear, which has to withstand the thrust of the piston.

As in all other problems, the cost of making improvements must be balanced against the advantages which can be realized.

W. O. Moody.[1] Where a program involves the modernizing of a large number of locomotives, it necessarily follows that the work must extend over a period of years, which time may be extended due to market conditions, as an inflated price situation may make it advisable temporarily to suspend the work.

Water and fuel conditions in different localities may be governing factors in determining the policy of reconstruction, so that what would answer all requirements to a class of power in one section would not guarantee equally favorable results elsewhere.

To do this work under a well-studied program on any extensive scale will call for increased shop facilities either in space or old tools replaced by modern, so that the old shop is also modernized to be in harmony with its new output.

By purchasing many of these devices, on the open market, machined and assembled, the back shop is relieved of a fair percentage of the burden of manufacture.

Outside valve gears can be purchased and applied without a very great increase in shop work over a link motion, which may require renewal of a large number of parts.

It would be well to send to each of the larger roads a questionnaire prepared with a view to bringing out their program, with list of engines modernized to date, and those remaining, to furnish a general idea of the extent to which this work is being done.

We also have another factor which determines the reconstruction program. A road may have a satisfactory class of saturated engines, which on later orders have been equipped with superheaters and larger cylinders, so that it is a wise policy to have the superheated type serve as models when reconstructing the saturated ones and thus reduce class, and likewise the storehouse stock and patterns.

Some prominence is being given to one feature not mentioned among the author's eighteen items of improvement: namely, the booster which apparently has a wide field of application to either freight or passenger power, depending somewhat on local conditions for the most favorable results.

E. A. Averill[2] gave as an example of what can be accomplished on even some of the more modern locomotives built within the last six or eight years, results recently obtained from road tests on locomotives equipped with feedwater heaters. Tests were made on three different railroads and showed an average of $237 saved in fuel cost per month per locomotive.

Feedwater heaters which will raise the temperature of the water from 40 or 50 deg. to from 230 to 250 deg. have been in successful railroad service for over three years. These heaters filter all the water formed from the condensed exhaust steam and return it, free from oil, to the tender. This adds about 14 per cent to the capacity of the tender and greatly extends the distance that can be made between stops for water.

On most locomotives an increased boiler capacity can be fully used in regular service, and furthermore, since any boiler is most economical and most efficient at its lower rates of working, an appliance which makes the boiler larger always shows returns.

J. T. Anthony.[1] Of 65,000 locomotives in service on American railroads, only 35,000 are equipped with superheaters, 43,000 with arches, 37,000 with automatic fire doors, 15,000 with power reverse gears, 2000 with automatic driving-box wedges, and only 30 with feedwater heaters, to mention only a few of the items listed by the author.

The brick arch can be installed in the roundhouse in less than 24 hours, and to use a conservative figure, is good for an average reduction in fuel consumption of 10 per cent, or an increase in boiler capacity of 11 per cent.

There is probably a wide diversity of opinion as to the relative merits of the 18 items given by the author as desirable improvements and there are several other items that could be added to a program for the rehabilitating of old locomotives, such as the booster, radial buffer, automatic grate shaker, and thermic siphon. Perhaps the author had the latter device in mind when he mentioned improved circulation and increased firebox heating surface.

There are only three methods of increasing the heating surface of an existing firebox, i.e., by the installation of combustion chamber, the installation of arch tubes, or thermic siphons. At the present time there are only 6000 locomotives equipped with combustion chambers, and something over 100 equipped with thermic siphons, this device being of rather recent origin.

Frank McNanamee[2] said that he concurred with the first two statements of the author's paper, but that the second did not go far enough. In other words, he said, it was not enough to modernize existing locomotive equipment by adding new locomotives to it or by rebuilding old types. The new locomotives and the modern devices with which the rebuilt ones were equipped must be maintained. Superheaters, brick arches, mechanical stokers, feedwater heaters and other modern devices mentioned by the author must be properly maintained to be effective. The modernizing of locomotive terminals and the provision of an organization to maintain the improved devices is a third method.

G. W. Rink said that the conditions of the C.R.R. of N.J. were similar to those mentioned by the author, there being a heavy suburban traffic which required the services of all the locomotives owned by the road. A constructive program was under way for modernizing the locomotives by the application of various devices. The program consisted, he said, in the application of superheaters and cylinders, thus increasing the tractive power of suburban locomotives so that they could haul 11 or 12 steel coaches rather than nine as previously. A number of tender frames had been changed, enlarging the capacity from 5000 to 7500 gal. Outside valve gears were also being applied to heavy consolidation locomotives equipped with Stephenson motion.

Modernizing Locomotive Terminals

William Elmer[3] presented a discussion of this paper to show that much could be accomplished by closer supervision of existing terminals through a system of daily reports. He said the greatest effort should be made to get the maximum possible mileage and service out of the engines and that the first thing to do is to impress everybody with the value of an engine-hour. In support of this he noted the following instance:

On one of the divisions of the Pennsylvania Railroad the freight earnings were $4,000,000 in a recent month. The average number of serviceable freight locomotives was 78 and they were on the road 52 per cent of the time. As there were 720 hr. in the month this is the equivalent of an average of 41 engines working constantly, or 29,500 locomotive-hours. As they earned $4,000,000 each engine-hour was worth $137. Now if every man connected with the motive-power department could be made to realize that an engine is worth from $100 to $200 an hour, he believed we should see a great improvement in the pace of everybody around a locomotive terminal, from the hostler to the foreman.

Mr. Elmer described fully how by means of complete daily statistics of the engines under and awaiting repairs at the various

[1] Mechanical Engineer, Illinois Central R. R. Co., Chicago, Ill. Mem. Am.Soc.M.E.

[2] Vice-President, Locomotive Feed Water Heater Co., New York. Mem. Am.Soc.M.E.

[1] Vice-President, American Arch Company. Mem.Am.Soc.M.E.

[2] Assistant Director, U. S. Railroad Administration.

[3] Division Superintendent, Pennsylvania Railroad, Altoona, Pa. Mem. Am.Soc.M.E.

called upon in an emergency are fundamental. In arranging the tracks and various terminal facilities, it must be borne in mind that if the best operating results are to be obtained, the terminal should be planned to restore power to service in the shortest possible time.

Serious consideration is now being given by the motive-power departments of several roads to the use of more small back shops and fewer general-system shops. This seems to work itself out best, unless the number of locomotives turned is quite small, by having these back shops located at every other terminal; that is, the intermediate terminal simply serves for turn-back purposes and handling light running repairs. It has been found that the efficiency obtained from large aggregations of labor and tools is lower than from smaller units, where more intense supervision is possible. Furthermore, smaller units simplify the labor problem and tend to maintain a continuity of repair service in case of local labor difficulties. Finally, a larger number of shops reduce materially the dead mileage of locomotives between the terminal where they are released and the shops where they are repaired.

Serious mistakes have been made recently in connection with some recently built terminals in selecting their location without giving proper consideration to the labor side of the question. It is more economical to pay more for terminal property if this is necessary in order to insure a constant supply of labor.

Drainage is another factor to consider in locating a terminal, bearing in mind that the turntable pit, drop pits, and pits under the track hopper at the coaling station are the controlling points.

No terminal track layout is complete without separate tracks for inbound and outbound movements and at least four tracks leading to and from the turntable. It should also be so arranged that locomotives may receive coal, water and sand inbound or outbound.

The test of terminal facilities is their ability to function in zero weather. While a terminal may function readily under normal traffic and weather conditions, it cannot be considered adequate if it fails under unusual conditions. At a terminal handling 170 locomotives in 24 hours the writer recently found 15 locomotives waiting at the ashpits to have their fires cleaned. Two improvements were necessary to relieve this situation: more tracks over the ashpit and greater ash storage capacity, as the pits were of the shallow-water type located between the rails. It will be seen that if this delay occurred every day and averaged 30 min. per locomotive, the capitalized earning power of the locomotives would more than finance the entire cost of a terminal of this kind.

Roundhouse and Shop. The author makes only passing reference to the type of roundhouse to be used. Generally speaking, the writer believes that all roundhouses should be of fireproof construction and that terminals handling 75 locomotives and up should be provided with bridge cranes, or at least jib cranes at each stall. Recent experience seems to show that it is a mistake to provide only a bridge crane in a roundhouse, as the demand for service is more than one crane can supply. Therefore it is probably better to provide jibs at each stall in addition to a bridge crane and use the jibs for the lighter work.

Light-Repair Shed. A development which seems to have real possibilities has been put in practice on several roads and takes the form of a light-repair shed. Locomotives requiring the minimum of attention from the repair force are put through this shed, which may be located near the roundhouse, where it can be under the supervision of an assistant to the roundhouse foreman, and convenient to the storehouse and machine shop.

Coaling Stations and Sand Storage. The writer believes that the question of coal-storage capacity at terminals has not received sufficient attention. Coal in the bins sufficient for a 24- or 48-

[1] The H. K. Ferguson Company, Cleveland, Ohio.

be such that sand can be protected from the rain and snow.

Ash Handling. In districts where the winters are severe, the location of the ashpits with relation to the enginehouse is important. The distance should not exceed 1000 ft. and should preferably be about 700 ft. from the house. The purpose of this is to prevent the detrimental action of cold air on the flues and permit the uninterrupted movement of the engine to the house.

In considering the type of ashpits to be used, time should be the controlling factor. It can be shown, for instance, that the depressed-type pit is cheaper to operate than a water-type pit, particularly when the fixed charges of both are considered; but the reliability of the water type under all weather and labor conditions is what has convinced many roads of its superiority over other types.

Turntables. The longer turntables result in a more economical use of floor space in the enginehouse. In other words, about 54 stalls can be obtained with a 100-ft. table and 72 stalls with a 125-ft. table. Larger tables permit more track approaches to the table without frogs and result in a smaller angle of spread in the sides of the stalls. Some engineers have figured that the saving in floor space in the enginehouse resulting from the use of a 125-ft. table over that of a 100-ft. table would pay for the increased cost of the longer table. A new development in turntable construction which permits the handling of large Mallets on short tables is the 3-point bearing table. This is now in use on the Pennsylvania Lines and is being considered by a number of other roads.

Inspection Pits. General opinion seems to agree with the author that the inspection pits are essential to modern terminal operation and that the inspectors should be protected from the weather. An office should be provided at this point where the crews, as well as inspectors, can make out their reports. This office should be connected to the roundhouse by a pneumatic-tube system for the transmission of reports. As a matter of interest, it has been found that more satisfactory results can be obtained from these tubes if they are installed overhead rather than underground.

Recently several have suggested that certain light repairs be undertaken at the inspection pit. Inasmuch as the time required at the ashpit largely controls the movement of power to the roundhouse, in many instances it would be possible to undertake light repairs at the inspection pit. This would consume most of the time which in many terminals is wasted by locomotives waiting for their turn at the ashpits.

Wash Pits. Another development which has been adopted by several roads is the installation of a wash pit for cleaning locomotives by oil, water and air spray. This method, it is said, gives better results than attempting to do the work in the roundhouse and is much cheaper.

Heating and Ventilation. Recently the writer heard a discussion of this subject as it relates to enginehouses and concluded that in some instances, at least, the motive-power departments were opposed to the hot-blast heating system.

The satisfactory results obtained by many roads recommend this system above any other for roundhouses, because it does assist in ventilation, which is essential for good results in the roundhouse. The blast may be controlled by dampers at the outlets and it has the advantage of being serviceable all the year round. In the summer months outside air may be forced through the system for ventilating purposes only.

The author refers to the smoke-exhaust system as being used for the purpose of meeting the objection to smoke on the part of the public. There is real economy in the smoke-exhaust system, in that it saves the live steam used in the blower lines and at the same time makes possible a reduction in the amount of fuel required to get good heat in the house during the winter months.

Oil House. The author specifically recommends that the oil

house be in a separate building. In a recent discussion of this subject by railroad-building engineers, it was agreed that for small terminals better results could be obtained by making the oil house a part of the storehouse so that it could be handled by the storekeeper.

Storehouse. The storehouse is a terminal facility that usually does not receive the attention that it should. Generally, very few labor-saving devices are provided for unloading or transporting supplies and there are instances where very substantial savings could be made if these matters were seriously considered.

T. N. Gilmore[1] In considering the extent of the shop facilities to be provided, it seems necessary to classify engine terminals into three classes, of equal importance.

The first we may designate as the divisional terminal, more remotely located from the main shop and where in connection with the roundhouse, which would be supplied with all the usual facilities, there would be a small erecting shop with its machine shop.

Second are main divisional roundhouses which would be responsible for maintenance of running repairs on all locomotives running out of them. Such a terminal would be supported more or less directly by a main shop, located adjacent thereto.

Third are the intermediate or engine-turning roundhouses where all locomotives entering the terminal run out of a main roundhouse at the opposite end of their runs, where running repairs are maintained.

In the first class, where a considerable number of engines are given light classified repairs between general overhaulings in the main shop, it seems desirable in point of time and cost to provide a separate shop equipped with unwheeling device and crane for handling the heavy parts of the locomotives, with a very complete outfit of machine tools, including those required for renewing and turning tires of drivers, truck and trailer wheels, heavy driving-box work and quite thorough repairs to the locomotive, with boiler-shop facilities for renewing flues, and a blacksmith shop.

A shop of this kind should be fully provided with standard trams, gages and templets in order properly to maintain established standards, and should be provided with a sufficient line of standard reamers and hand tools. The shop management should also be furnished detailed drawings of the locomotives in service.

The engine terminal supported more or less indirectly by a nearby main shop would require its own machine shop with machine tools sufficient to take care of the general heavy running repairs, depending upon the main shop or the storeroom for manufactured material such as crankpins, rods, crossheads, knuckle-joint pins, etc.

Of equal importance, however, is the full complement of mechanics' hand tools in sufficient number to avoid one workman's having to wait on another for a tool. In fact, the tool equipment should comprise all modern labor-saving appliances that will contribute to economy and speed of performance.

At the intermediate terminals where provision is made elsewhere for other than minor running repairs, the facilities, aside from the roundhouse, would consist of oil house, sub-store, suitable coal and cinder plants and water supply, including a sufficient dependable supply of steam for heating and other requirements, and also, where boilers are to be washed out, a hot-water boiler-washing system.

As before mentioned, the engines running into this class of terminal, at the opposite end of their runs, go into a roundhouse fully equipped to take care of running repairs.

It is relatively a simple matter on a comparatively short, compactly situated railroad system to decide on the location of each of these types of terminals. It becomes a very different matter, however, to locate and classify these terminals on the larger systems extending from New York to Chicago, St. Louis and Cincinnati and from Chicago to the Pacific Coast and St. Paul to the Coast and on systems where there are many branch lines.

In support of this general classification of engine terminals, the writer holds that every locomotive in service should have a home and an organization responsible for obtaining the proper average mileage between heavy general repairs.

[1] Vice-President, Dwight P. Robinson Company, New York. Mem.Am. Soc.M.E.

In the recent discussion on electric and steam locomotives the point was brought out that the electric locomotive could not be successfully operated under certain overload conditions, where the steam locomotive, if overloaded, would manage to get along somehow in a more or less indifferent manner.

It is a lamentable fact that the steam locomotive too often is continued in service in such condition that it may be said to be getting along somehow, resulting in poor transportation results and bad fuel economy.

The engine terminals of a railroad cannot be expected to maintain heavy power in good condition without the support of modern general repair shops to regularly and periodically put the engines into 100 per cent condition.

No locomotive terminal can be made modern without giving it an up-to-date organization. There should be no division of authority.

The proper spirit of coöperation should be built up and maintained between the different departments to enable this to be successfully carried out without friction and to the benefit of all departments.

L. G. Plant.[1] The locomotive terminal is a unique mechanical facility in that it admits of very little standardization. There are, however, certain well-defined principles relating to terminal layout that should govern in modernizing locomotive terminals. It is safe to say that where trackage is ample, a well-defined routine for the movement of every locomotive can be strictly adhered to.

With respect to coal chutes and sanding facilities, it should be borne in mind that the particular type of construction and the particular mode of operation are of no significance unless they insure both capacity and reliability in operation. The cost of delivering coal to locomotives is an important item and the coal chute should also be designed so as to minimize this cost.

The arrangement of fire-cleaning facilities and ash-handling apparatus is easily the most vital feature exterior to the roundhouse. The importance of these facilities lies in the fact that whereas the time consumed in taking coal and sand can hardly be in excess of ten minutes, the time over the ashpit may easily take one or two hours unless these facilities are reasonably adequate. The superiority of the water pit at any point where a considerable number of locomotives are to be handled can hardly be questioned, but this should be so designed that the locomotive ashpan is accessible to fire cleaners working on either side of the locomotive. Moreover a short transverse pit serving several pits is always preferable to a long longitudinal pit serving but one or two tracks. The principles which have been referred to as governing the track layout at the terminal apply with equal force to the arrangement of the ashpit.

The author is to be commended for his emphasis on the advantages of suitable inspection pits over which the locomotives pass before having their fires drawn.

Those sections of the paper dealing with heating, ventilation and lighting elaborate upon details that are very essential to the successful operation of any locomotive terminal. The author, however, has questioned the advisability of using the down-draft system of ventilation without putting sufficient emphasis upon the fact that this system as applied to roundhouses on the Pennsylvania Lines West has enabled the use of 75-ft. overhead cranes throughout the entire circumference of the roundhouse, which is in itself a most important labor- and time-saving facility.

The installation and maintenance of the down-draft system referred to is doubtless an expensive item, but it should be borne in mind that by this means locomotives can be fired without the use of the steam blower and that the elimination of noise as well as smoke and steam from the interior of the roundhouse is a most desirable feature.

The mention of cranes suggests the question as to whether one of the most important elements in the modernized terminal has not been overlooked in the presentation of this paper. That is the use of cranes, electric tractors and other means employed for removing and replacing heavy parts of the locomotive and for conveying materials about the terminal.

(Continued on page 272)

[1] Associate Editor, *Railway Age*, New York.

The Properties of Steam

AT the end of last year there was published in London a work entitled, The Properties of Steam and Thermodynamic Theory of Turbines, by Prof. H. L. Callendar, which has attracted a great amount of attention. *Engineering* says that the author's Royal Society papers embodied in this treatise "undoubtedly constitute the most illuminating and reliable work on the properties of steam accomplished by any engineer or physicist since the pioneering labors of Regnault, Rankine and Kelvin." The following abstract is made from articles in the issues of that journal for Jan. 21 and 28, 1921.

In the complete equation of state for gases and vapors

$$V - b = \frac{RT}{P} - c \qquad [2]$$

there is a term c known as the co-aggregation volume. It represents the diminution of volume due to the pairing of the molecules.

The problem of determining how this co-aggregation volume c varies with the temperature, pressure and volume of a gas has occupied the attention of physicists for years. The Van der Waals equation of state leads to a very complicated expression for c and moreover expresses the relation between the temperature, pressure and volume of a gas qualitatively only. It would hardly be going too far to assert that of late years the Van der Waals equation has been a hindrance rather than a help. It has tempted investigators to endeavor to include in a single formula all the properties of a body whether in the liquid or the gaseous state, right up to the critical point. This feat has not been accomplished for any single body, and the attempt to do so in the case of steam where reliable data near the critical point were wholly lacking has been ill advised at the best. This has been emphasized recently by a new and accurate determination of the critical temperature, which turns out to be some 9 deg. cent. higher than the value adopted by the German and American computers who have published elaborate tables on the properties of steam.

Some 20 or 25 years ago the properties of steam were considered as adequately established by the Regnault formula:

$$H = 1091.7 + 0.305\,(t - 32) \qquad [a]$$

Based on this formula, Professor Peabody devised his throttling calorimeter for estimating the quality of steam supplied to engines under test, but when it was used in certain tests it was found that the wetness of the steam supplied by the boilers as calculated from Regnault's formula persisted in coming out negative. In other words, the throttling calorimeter declared the steam supplied to be superheated when it was not. This led to an exhaustive investigation at McGill University by Professor Callendar, which showed conclusively that the Regnault formula was wrong.

German investigators substituted for it empirical formulas which neglected, however, to take into consideration the fact that there is a close connection between the thermal properties of steam and its specific volume. Because of this the elaborate tables compiled in America on the basis of German experiments and formulas are claimed to fail to satisfy the test which consists in that the work done in a given cycle should be the same whether it be measured on the temperature-entropy chart or on the indicator diagram.

Callendar attacked the problem in a different manner. He devised new and extremely accurate methods of determining total and specific heats and of determining with precision the law for the adiabatic expansion of steam. He also devised formulas to represent the properties of steam and laid down the principle that these formulas must be consistent with each other. Any formula for the total heat of steam must be consistent with Equation [2] *ante*, and with the experimentally demonstrated fact than the adiabatic expansion of steam is represented by the equation

$$PT^{-\frac{13}{3}} = \text{constant}$$

The adiabatic expansion of an ideal gas satisfying the equation $P(V - b) = RT$ can also be represented by a formula of this kind. The more usual formula in this case is $P(V - b)^{\gamma}$ = constant, but on substituting for $V - \gamma$, this takes the form

$$PT^{\frac{\gamma}{1-\gamma}} = \text{constant.}$$

Any adiabatic expansion is effected at the expense of E, the internal energy of the body. In the case of the ideal gas it is well known that this internal energy (expressed in ft-lb.) can be represented by the formula

$$E = \frac{1}{\gamma - 1} P(V - b)$$

where γ is the index in the usual formula for the adiabatic expansion of such a gas. The above expression represents, in fact, the work which can be done by the gas when expanded adiabatically down to zero pressure. Now so far as the internal energy of steam is due to the molecular velocities and spins, it must be capable of being represented in the same way. Hence in the case of steam we may write—

$$E = \frac{1}{\gamma - 1} P(V - b) + B$$
$$= \frac{10}{3} P(V - b) + B$$

The work done in an adiabatic expansion is equal to the change in the internal energy, and if B be constant this change of internal energy will be exactly the same as it would be in the case of an ideal gas having the same value of γ as steam has, and it is perhaps fairly obvious that the law for adiabatic expansion will then be expressed by the same formula.

Whether B is or is not constant is a matter for experiment. Since we cannot conveniently measure directly the internal energy of steam, these experiments are best made by determining the total heat H which is defined nowadays by the relation—

$$H = E + PV$$

This differs from Regnault's definition in that Regnault took no account of the energy required to drive his feed pump. In this equation all quantities of energy must, of course, be expressed in ft-lb units.

The difficulty of determining accurately the total heat of steam has been solved by Callendar, who did it by comparing the total heat of high-pressure steam with that of superheated steam at atmospheric pressure, which latter can be determined with considerable precision. In making an experiment the high-pressure steam is withdrawn down to atmospheric pressure through the equivalent of a porous plug and its temperature noted after passing this plug. In an operation of this kind the steam retains after its expansion its original total heat, and as the total heat of superheated steam at atmospheric pressure is known from the preliminary experiments made, a very simple method of finding the total steam at higher pressures is thus provided.

It is of interest to note that the results obtained by Callendar agree quite well with the unknown unextrapolated figures published by the German investigators and with direct determinations of specific heats made by Prof. Carl Thomas.

These observations show that within the experimental range B may be taken as constant. Callendar thus obtained the following formula for the total heat of superheated dry saturated or super-

saturated steam expressed in British thermal units (in this formula the pressures are taken in pounds per square inch):

$$H = \frac{13}{3}\frac{p}{777.8} \times (V - 0.01602) + \frac{0.01602}{777.8}p + 835.2 \ldots [b]$$

With this expression for the total heat the observed law of the adiabatic expansion of steam is satisfied, but it is also necessary that the equation of state be satisfied, namely,

$$V - b = \frac{RT}{P} - c \ldots\ldots\ldots\ldots\ldots\ldots [c]$$

This gives a clue as to the character of the variation of the co-aggregation volume with the pressure and the temperature, which is determined mathematically. The expression finally derived for [c] is quite a complicated one and involves a number of coefficients of which Callendar has shown that they are so small as to be negligible at ordinary pressures, though they may become important as the critical point is approached.

In this connection the physical meaning of the critical point is discussed. In general, if any liquid is exposed to a gas, some of the gas is dissolved. When the gas in question is its own vapor the rule still holds and Callendar has shown that the observed increase in the specific heat of water as the temperature rises is almost wholly accounted for by the latent heat of the dissolved steam. The amount of this dissolved steam present increases as the pressure of evaporation rises and hence the latent heat required to produce this dissolved steam increases with the temperature of the water and this occasions an apparent increase in the specific heat of the liquid.

For pressures not near the critical point but within the practical range the volume is given accurately by the expression (temperatures in centigrade degrees and pressures in pounds per square inch):

$$V - 0.01602 = 1.07061\frac{T}{p} - 0.4213\left(\frac{373.1}{T}\right)^{\frac{10}{3}}$$

The equation for the total heat of steam and that expressing the relation between the volume, temperature and pressure which are given above are fundamental and from them all other equations required may be derived. As an example, the original article shows how the expression for the entropy is derived and how and why this expression must apply also to dry saturated steam. The latter, however, is equal to $\phi_w + \frac{L}{T}$, where ϕ_w is the entropy of water at the absolute temperature T, and L is the latent heat of steam at the same temperature. If we equate these two expressions and solve the resulting equation for p, this (if Callendar's formulas are reliable) should be equal to the saturation pressure as determined by Regnault and others. The test is a very crucial one and it turns out that the agreement is extraordinarily close, the computed figures differing less from the results obtained by different experimenters than these do from each other.

Indeed, Callendar has shown that his equation for the saturation pressure can be put into a form which is with the exception of a corrective term depending on the co-aggregation volume is identical with the theoretical expression for an ideal liquid and vapor as deduced by Rankine in 1866.

Another test which any set of reliable steam tables should successfully pass is that the specific heat must be the same whether deduced from the total heat or from the pressure, volume and temperature. Since the specific heat at constant pressure can be expressed mathematically as—

$$\left.\frac{dH}{tH}\right]_P$$

but is also equal to the expression

$$\frac{1}{J} \times T \times \left.\frac{dV}{dT}\right]_P \left.\frac{dP}{dT}\right]_\phi$$

where the suffix P denotes that the volume is changed at constant pressure, and the suffix ϕ that the pressure is changed at constant entropy, that is, say, by adiabatic expansion.

It is claimed that it will be found on trial that all the tables based on the German formulas for the total heat and specific volume of steam fail to satisfy this test, the discrepancy being as much as 20 per cent, and that the only tables which do so are those based on Callendar's work.

Among other things, Professor Callendar in his treatise gives an analysis of Professor Stodola's experiments on the losses in a convergent-divergent nozzle. Stodola himself was not satisfied with the conclusions to which his own analysis apparently led, as this indicated a frictional loss of some 20 per cent, and the losses were distributed in a somewhat anomalous way. Callendar shows that when the supersaturation of the steam is taken into account the frictional loss comes out at from 6 to 10 per cent, which is a much more reasonable figure.

As regards the state of supersaturation in steam, Professor Callendar takes the view that after the Wilson line is crossed the steam temperature during the remainder of the expansion is that corresponding to the Wilson line, while the water temperature is the saturation temperature corresponding to the pressure. From this it follows that in the first approximation the Wilson line can be regarded as replacing the saturation line on the old theory and that formulas deduced on the hypothesis that the steam expands in thermal equilibrium require only a small adjustment to suit the actual conditions.

The trouble with expressing the phenomena attending the expansion of wet steam in thermal equilibrium is due to the great complication of the exact expression for their reheat factor. Professor Callendar finds, however, that it can be obtained with remarkable accuracy from the semi-empirical formula—

$$\frac{\epsilon}{\eta} = 1 + (1 - \epsilon)x$$

where ϵ denotes the efficiency ratio and η the hydraulic efficiency of the turbine, while x is equal to u, the adiabatic heat drop divided by $2(H_\phi - st)$. Here H_ϕ denotes the total heat at exhaust had the expansion been adiabatic, and $st = t - \frac{t}{300}$, where t is the final temperature centigrade. This formula will greatly add to the facility with which turbine tests can be analyzed, and in view of what has been said above should be capable of modification to meet the case of the expansion of wet supersaturated steam. In view of the fact that the total heat of steam in ft-lb. units is given by the relation—

$$H = \frac{\gamma}{\gamma - 1} \times P(V - b) + Pb + B$$

on neglecting b a formula of the type $P(V - b)^\lambda$ = constant, can be transformed into an equation of the type—

$$H - B = kP^m = \text{constant}$$

For superheated or supersaturated steam expanding with a hydraulic efficiency η, the value of m is $\frac{3\,\eta}{13}$. Callendar finds that an equation of the same form can be made to represent with great accuracy the expansion of wet steam in thermal equilibrium. In that case the value of m is fixed by the condition that

$$\frac{P_0V_0}{P_1V_1} = \frac{P_0{}^m}{P_1{}^m}$$

while k and B are determined by the initial and final values of H and P. This equation is very simple to apply and should also be suitable for the expansion of wet supersaturated steam. We are thus furnished with a new method of turbine analysis. The difficulties under which we have hitherto labored are well illustrated by the circumstance that after a most careful and extensive series of tests on a small reaction turbine made a few years ago in his laboratory by one of our leading authorities, the task of interpreting the records obtained had in the end to be abandoned in despair. (*Engineering*, vol. 111, nos. 2873 and 2874, Jan. 21 and 28, 1921, pp. 63–65 and 93–94, *tcA*)

[The statement made in the foregoing abstract to the effect that American steam tables based on German formulas are in error, in some respects as much as 20 per cent, is of course one for which the author of the articles is responsible. Similar but less specific comment appeared in an article on a new theory of the steam turbine, by H. M. Martin, in *Engineering*, July 5, 1918, which was quoted in the Survey Section of September 1918, p. 785.]

Short Abstracts of the Month

AERONAUTICS

The Leitner-Watts All-Metal Propeller. It is stated that all but one of the problems of the metal propeller have been solved in this device, and that one is weight. In their present form these propellers are very much heavier than corresponding wooden screws.

The blades are each made up in the form of a shell of sheet steel and the necessary taper in thickness is obtained by using laminated construction, there being three laminations—one at the top, the second about halfway between the tip and the boss, and the third at the root. The laminations are at present riveted together, but later on it is intended to employ electric spot welding.

The two halves of each blade are attached to one another at the edges only by welding, but in order to stiffen the shell thus formed small struts are placed between the two faces at intervals.

The method of inserting these struts is shown in Fig. 1. The struts are shouldered at both ends and the hole in one face of the

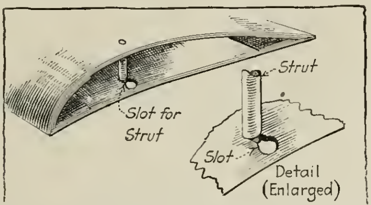


Fig. 1 Method of Inserting Small Struts between Front and Rear Faces of the Leitner-Watts All-Metal Propeller

blade is made just the right size to take the thin portion of the strut. In the other face of the blade is cut a hole large enough to accommodate the thick portion of the strut. From this hole runs a slot of a width corresponding to the shouldered portion of the strut. To place in position, the strut is inserted in the large hole, its other end being pushed into the small hole on the opposite face, and the shouldered portion is slid into the slot. The strut is then secured in position by soldering washers over the two strut ends.

The root of the blade is constructed in a very substantial manner. Balance of the blades is secured by using small balance weights carried on short lengths of tube secured to the inner end of the central plug in the blade root. These propellers have an adjustable but not a variable pitch, which means that the pitch angle of the blades can be altered over a wide range (10 deg. each way), thus making the propeller suitable for a number of different conditions by setting the pitch according to requirements. (*Aerial Age Weekly*, vol. 12, no. 22, Feb. 7, 1921, pp. 559–560, 3 figs., *d*)

AIR MACHINERY

Relation of Air Pressure to Drilling Speeds of Hammer Drills, H. W. Seamon. Data obtained in 1500 tests made by the United Verde Copper Co. to determine the most economical air pressure for the operation of hammer drills under varying conditions of use, and to investigate the variation in drilling speed at different air pressures.

Twelve models of drills, all of the wet type, were used at gage pressures ranging from 40 to 130 lb. per sq. in. Seven drills were of the heavy mounted class, three of the jackhammer type and two stopers. The drilling was done in massive sulphide ore of uniform hardness, the same face being used for all tests. Horizontal holes were drilled with the mounted machines and vertical holes with the stopers.

Shop measurements of the power of the drills were made on a Paynter rock-drill tester, which records the number of blows per minute and the strength of the blow, and the values thus obtained were assumed to be the same in the testing ground under the same gage pressures.

Tables are given in the original paper showing for each one of the drills tested the number of blows per minute, the strength of the blow, the horsepower developed, the drilling speed, the air consumption, the efficiency and the distance drilled, under air pressures varying from 40 to 130 lb. per sq. in.

From the figures obtained an empirical formula is derived for the "factor of desirability" of a certain type of drill in terms of its cost of operation and maintenance.

Analysis of the results obtained leads to the following general conclusions:

There is little or no increase in mechanical efficiency of the drills above 90 lb. pressure.

The distance drilled per air indicated horsepower is greatest for the jackhammer type at 90 lb., and increases at a slow rate for the other machines at the higher pressures.

The average thermal efficiency is greatest at about 95 lb.

The factor of desirability, while increasing as the pressure, shows a comparatively slow rate of increase for pressures above 100 lb.

The average drill is made to be used at a pressure of 80 lb., or less; using pressures much exceeding this will invalidate the present replacement agreements with the manufacturers, thereby increasing the upkeep cost.

The increased breakage at the higher pressures, with the consequent loss of time of the drill runner in changing or repairing the machine, would tend to reduce the factor of desirability, as this item of expense is not included therein.

The increased breakage of drill steel would tend to limit the pressure, although there are not sufficient data on this point to determine the maximum. (Abstract of paper presented at the New York Meeting of the *American Institute of Mining Metallurgical Engineers*, Feb. 1921, 14 pp. and 14 tables, *e*)

ENGINEERING MATERIALS

Effect of Temperature, Deformation, Grain Size and Rate of Loading on Mechanical Properties of Metals, W. P. Sykes. Researches conducted at the National Lamp Works to establish the relations existing between temperature and mechanical properties in molybdenum, nickel, and an aluminum-copper alloy. The molybdenum used was of the quality that is drawn into wire 0.003 in. in diameter for use as filament supports in incandescent lamps, and its chemical analysis showed less than 0.1 per cent of impurities. The nickel was obtained as 0.09-in. wire, annealed, of composition 99.8 per cent nickel and 0.15 per cent iron. Finally the alloy samples contained 3 per cent copper, 0.42 per cent iron, and 0.21 per cent silicon. Seven specimens of molybdenum, five of nickel and seven of the aluminum-copper alloy were tested. The individual specimens of each class were heat-treated and prepared in different ways.

Measurements were made of the tensile strength, reduction of area and elongation at temperatures varying from —185 to 1000 deg. cent. in the case of the molybdenum samples, and from —185 to around 600 deg. cent. with the nickel and aluminum-copper specimens. The results obtained are given in the original paper in separate tables for each specimen tested. Sets of curves are also constructed indicating temperature against tensile strength, elongation and reduction of area in each case, and photomicrographs of the metals at the place of rupture are analyzed and interpreted.

The following general conclusions are formulated:

Excluding allotropic changes and other specific characteristics, all metals possess the same fundamental properties and those exhibited by any one metal are functions of the temperature at which the observations are made. The maximum reduction of area by fracture in tension occurs in a piece of metal in which single grains occupy the entire cross-section. In the case of two aggregates, the one of smaller grain size suffers the greater reduction. The ultimate result of decreasing temperature is a complete loss of ductility and probably eventually a reduction in tensile strength. Brittleness is first observed in metals having equiaxed structures.

The smaller the grain size of a sample the lower is the temperature to which ductility is preserved. Deformation of a metal below its annealing temperature makes its maximum ductility at any temperature below that of working less than that of the same metal in the unworked condition. But the worked sample will retain its power of elongation to a lower temperature. (Abstract of paper presented before the *American Institute of Mining and Metallurgical Engineers* at the New York Meeting, Feb. 1921, 35 pp., 38 figs., *e*)

Tests at Mellon Institute on Heat-Insulating Materials

Characteristics of 85 Per Cent Magnesia as a Non-Conducting Covering, Edward Weidlein. The data presented in this report were obtained during the course of an investigation conducted for the Magnesia Association of America by the Mellon Institute of Industrial Research, where the author holds the position of associate director.

The object of the investigation was to obtain facts regarding the

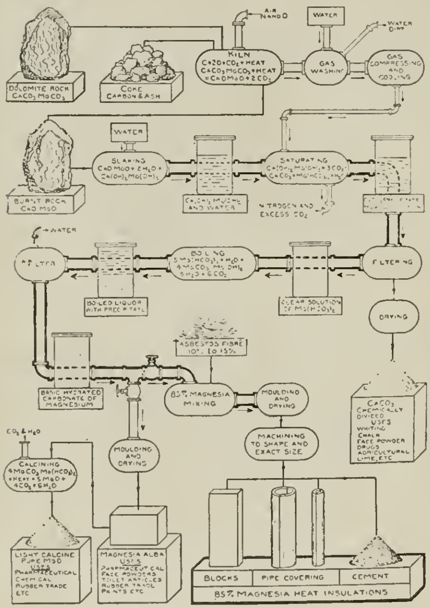


Fig. 2 Flow Sheet Showing Steps in Production of 85 Per Cent Magnesia

value of 85 per cent magnesia as a heat-insulating material. It is stated that the name "85 per cent magnesia" denotes the fact that the covering contains 85 per cent of basic magnesium carbonate. The remaining 15 per cent is asbestos, which is introduced as a binder to insure the required structural strength and durability. The flow sheet shown in Fig. 2 illustrates the method of manufacturing this product. The value of 85 per cent magnesia as a heat-insulating material is increased greatly by the interlacing and felting together of the crystals to produce a block of magnesia containing 90 per cent of voids, which take the form of exceedingly small air pockets.

At the Mellon Institute an investigation of heat loss from bare pipes was carried out with the results given in Fig. 3, where the full curves show heat losses from bare pipes as predicted from Péclet's formula, and the dotted curve and points indicate the experimental results obtained by various investigators. The Péclet values agree closely with the experimental findings and can be used safely.

Fig. 4 gives results of tests with pipes insulated with five different makes of magnesia coverings in 1-in., 2-in. and 3-in. thicknesses. The comparison with Fig. 3 will show a striking contrast between the losses from the bare pipe and the losses from covered pipes, and the difference increases with the temperature because the loss from bare pipe increases much more rapidly in proportion than the loss from covered pipe.

Further tests have shown that if the covering is alternately wetted and dried, the average value is the same before and after wetting and drying, and the treatment apparently does not effect the mechanical strength of the covering.

Tests on several old magnesia coverings have shown that the heat-insulating capacity slightly increases with time in some cases, and falls off materially in other cases, this latter taking place particularly where the covering happened to be saturated with oil.

As regards the influence of covering on rusting of steam pipes, the results of tests indicate that pipe coverings in general, especially if alkaline in composition, do not of themselves promote rusting on steam pipes when they become wet. On the contrary, they are claimed to act as a protecting coating since the oxygen does not get into intimate contact with the surface of the pipe. But an electric current flowing through the covering may either promote rusting of the pipe or it may retard corrosion, depending on the direction in which it is flowing. The greater the current flowing the greater will be the rusting effect. (Paper presented at the recent New Orleans Meeting of the American Institute of Chemical Engineers, abstracted through *Heating and Ventilating Magazine*, vol. 18, no. 2, Feb. 1921, pp. 30–34, 11 figs., *eA*)

Static and Dynamic Tension Tests on Nickel Steel, J. J. Thomas and J. H. Nead. Experimental investigation at Watertown Arsenal, Watertown, Mass., of the relation between static

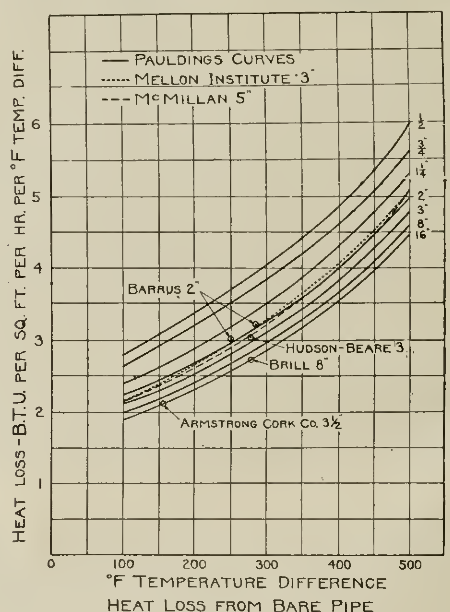


Fig. 3 Curves of Heat Losses from Bare Pipes

and dynamic tensile tests as measured by the work required to break test specimens slowly in a tensile testing machine, and rapidly by means of a falling weight. It was desired to ascertain the part played by ductility under different rates of application of load.

Five pieces of nickel steel, 0.505 in. in diameter and 10 in. gage length, containing 0.42 per cent carbon, 0.48 per cent manganese, 0.09 per cent silicon, 0.035 per cent sulphur, 0.035 per cent phosphorus, and 3.20 per cent nickel, were used. One piece was annealed, one was oil-hardened, and three were hardened and

of varying hardness, were then tested slowly in tension and the stress-strain diagram plotted. Five similar pieces were also tested in an impact machine with a recording device for drawing the stress-strain diagram.

From tables in the original article it appears that both the specimen that was quenched but not drawn, and the one that was drawn up to 300 deg. cent., required very little work to break under either a radidly or a slowly applied load. The figures obtained for elongation and reduction of area indicate that ductility is independent of the rate of application of the load. Comparing the corresponding values of work under the two tests, it is concluded that as the elongation is about the same and the work is noticeably greater, the resisting force of the metal is greater for suddenly applied loads.

For low drawing temperatures both ductility and work of rupture are very low. As ductility increases the work of rupture

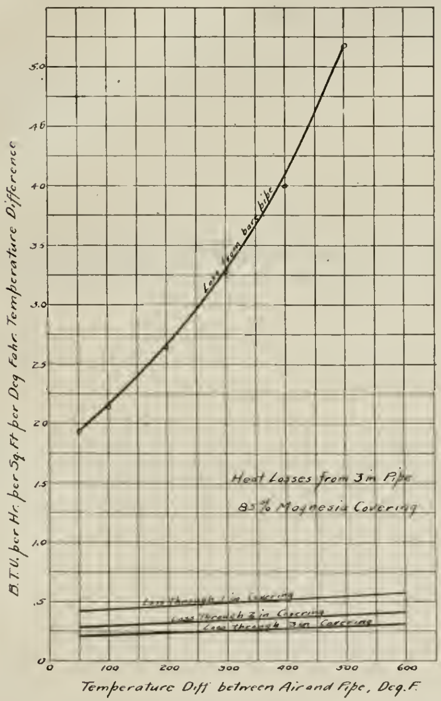


Fig. 4 Curves of Heat Losses from Pipes Insulated with 85 Per Cent Magnesia

increases. For hard steels, a small force, less than the elastic limit, if applied with sufficient velocity, develops enough kinetic energy to cause rupture. It is evident, therefore, that force alone is not the proper criterion by which to measure the strength of material. The work unit is more valuable as a measure of strength, and as ductility is an indication of the work required to rupture it is wise to specify a high ductility for all parts subject to shock. Ductility as measured by elongation and reduction of area in the ordinary tension test is important not for the part it itself plays but as an indication of strength as measured by work units. Steel is in its best condition when quenched and drawn just under its critical temperature.

The results of the static test demonstrate that for a slowly applied load nickel steel is hard and brittle when drawn at temperatures of 300 deg. cent. or lower. Beyond this point, however, a real softening effect is obtained. For low drawing temperatures the maximum strength, yield point, and elastic limit, occur at the same point, thus giving a brittle steel that fails without removed, or to the hard martensitic structure of the steel. For higher drawing temperatures there is a marked increase in the ductility and a greater resistance to shock. The modulus of elasticity increases slightly with the higher drawing temperatures, but this increase is probably too slight to have a commercial value. (Paper presented before New York Meeting of the *American Institute of Mining and Metallurgical Engineers*, Feb. 1921, 13 pp., 19 figs., *e*)

FUELS AND FIRING

Catalytic Heating, R. Villers. Description of a device employing flameless combustion and designed by two French engineers, Louis Lumiere and J. Herck.

In this apparatus gasoline is used as a fuel and is decomposed by catalysis into water vapor and carbon dioxide, platinum in the presence of air being used as a catalyzer. The first employment of these heaters was found on military aeroplanes in winter when it was necessary to keep the water in the radiator warm and when it was not desirable to use an open flame because of the danger of fire. The construction of the device is diagrammatically shown in Fig. 5. A layer *A* of asbestos impregnated with platinum serves as the base of the cone *B* held by its small end against a similar cone *C*, which, in its turn, forms the top of a reservoir *D*. This reservoir is filled with a spongy material, such as cotton, which, by absorbing the gasoline prevents there being an excess of the liquid. A wick *E* extends into this reservoir and causes the evaporation of the liquid into the chamber between the walls of the upper cone and the platinized asbestos *A*. Once started by heating the platinized asbestos to the proper temperature, the action continues indefinitely as long as there is fuel, and produces a temperature of about 250 deg. cent. (482 deg. fahr.) in the top layer.

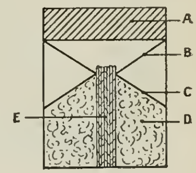


Fig. 5 Thermix Catalytic Heater

The preliminary heating of the platinized asbestos required to start the operation of the device may be accomplished by putting a few drops of gasoline or alcohol upon it and lighting them, or by an electric resistance. The advantage claimed for this device lies in the fact that the combustion takes place without the production of any flame, odor, or exhaust products, in addition to which the efficiency of combustion is very high because of the fact that the gasoline is decomposed completely without any residue and is claimed to develop its entire heating value without any losses. To extinguish the heater, all that is necessary to be done is to shut off the admission of air by means of a special cover.

The apparatus designed in accordance with the principle explained above has been placed on the market in France under the name of "Thermix." (*La Nature*, no. 2438, Dec. 25, 1920, pp. 415–416, 5 figs., *d*)

Furnace in which Air is Forced Between the Bars

The Turbine Patent Furnace. Description of a furnace designed on the principle of the impulse turbine. In its construction the air trough corresponds to the nozzle and the fire bars to the blades of the turbine. The air for combustion is forced between the bars which offer but slight resistance and the design is such that each fire bar receives an equal amount of air which is distributed through the narrow air spaces in the form of fine spray. Fig. 6 shows the furnace applied to a Babcock water-tube boiler. Its outstanding feature is the dead plate (7 in the figure) which slopes downward, thus bringing the furnace from 3 in. to 5 in. lower than the ordinary level and giving more room for combustion in the furnace proper. Air is admitted through the chamber as required, through the door fixed under the first bridge. The fire bars are constructed with interlocking lugs so that they cannot be displaced by the rake, and the air spaces slant upward and backward, reducing the amount of fine ash or coal that drops through to

a minimum. The bottom lugs project forward and intercept the air, thus insuring an evenly diffused supply throughout the fire. The grate consists of from four to six furnaces, each receiving its own air supply, which besides insuring an evenly burning fire makes the use of steam jets for creating the draft very simple.

TABLE 1 DATA OF COMPARATIVE TESTS OF TURBINE PATENT FURNACE AND FURNACE WITH ORDINARY FIRE BARS

Type of Furnace	Ordinary Bars	Turbine Furnace Bars
Duration of test, hr	6	6
Fuel average, lb. per hour	1,045	1,506
Ash, per cent	17.8	16.0
Total water evaporated, lb	25,800	50,800
Average steam pressure gage, lb. per sq. in.	152	157
Average feed temperature, deg. fahr	210	250
Lb. water per lb. fuel as fired	4.11	5.63
Lb. water per lb. fuel from and at 212 deg. fahr.	4.34	6.00

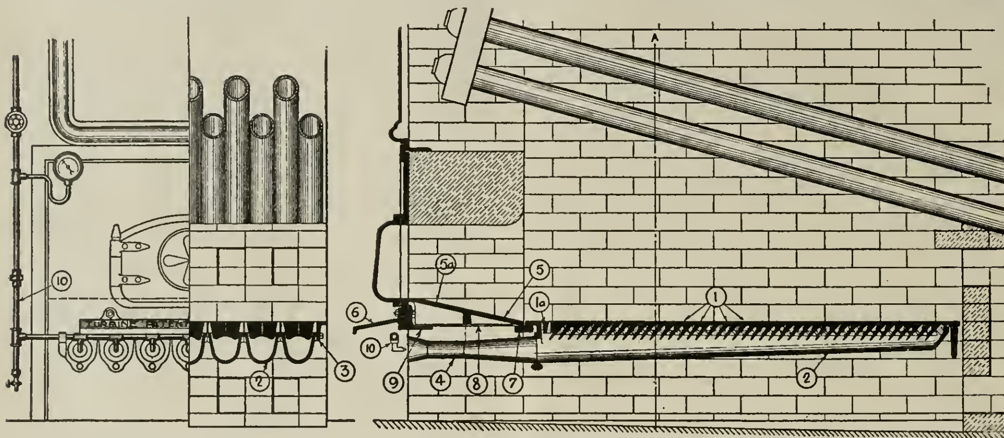


Fig. 6 Turbine Patent Furnace as Applied to a Babcock Water-Tube Boiler

Table 1 is claimed to represent results of a comparative test of the turbine furnace and ordinary fire bars carried out recently at the Birmingham Works of the General Electric Company. (*The Electrical Times*, vol. 59, no. 1525, Jan. 6, 1921, p. 11, 2 figs., *d*)

HEATING AND VENTILATION (See Engineering Materials)

HYDRAULIC MACHINERY (See Lubrication)

INTERNAL-COMBUSTION ENGINES

The Carbonization of Lubricating Oils in Internal-Combustion Engines, Frederic H. Garner. The mechanism of carbonization of oil is described by the author as follows: The major part of the oil getting into the combustion space is probably present as a fine spray. The heat of the explosion may be sufficient to completely burn the smaller droplets, but the larger droplets will be only partly burned by the momentary heat of the explosion. Thus carbon and asphaltenes are formed from the oil. If the carbon so formed is light in texture, it will be blown out of the exhaust, but if dense asphaltic material is formed in the ensuing compression stroke, it will tend to adhere to the piston face and cylinder walls, giving carbon deposits.

This makes the suction stroke the most important of the whole cycle from the point of view of lubrication, as the leakage of oil occurring during the stroke is the origin of the carbon deposit. On the other hand, as carbon formation is determined mainly by the character of the oil spray in the combustion space rather than the oil film on the walls, the rapid carbonization of oil, that is, its coking value, will be a more important factor in the testing of lubricating oils for internal-combustion engines than the gradual carbonization at lower temperatures.

In an investigation carried out by the writer the evaporation losses and degree of carbonization over a wide range of temperatures were determined for a series of lubricating oils from petroleum representing asphaltic and paraffin-base crudes, and the means used in the investigation are described in some detail. (*Petroleum Times*, vol. 5, no. 107, Jan. 22, 1921, pp. 93–95, *e*)

LUBRICATION (See also Internal-Combustion Engines)

Lubrication of Hydraulic Turbines, Niagara Falls Power Company. The lubrication of the recently installed hydraulic turbines of the Niagara Falls Power Company is of great interest both because of the tremendous size of the units and because of their modernity. There no striking novelties of any kind, but the installation is of interest as one in which great care has been taken to create the best possible conditions of lubrication. Special attention is called to the method of using oil in the governors.

In these turbines the thrust and upper guide bearings are supplied with oil by separate pipes leading from a storage tank of 2000 gal. capacity in the upper part of the power house, the feed to the bearings being by gravity. The pressure obtained is not only sufficient but actually somewhat excessive and a regulating valve and oil meter are installed in the thrust-bearing line to regulate the supply. After passing through the bearings the oil from all the sets runs to a common header and thence to the filtering system. An oil of 180 sec. (Saybolt) viscosity at 100 deg. fahr. has been found suitable for the bearings, but it must be kept so as to be non-emulsifying with water and not to break down on continual use. It is stated that the oil and bearings have been so thoroughly developed that the oil emerging from the thrust bearings shows a rise in temperature at full load of only 6 deg. fahr. and the loss in power due to bearing friction is only 26 hp. or seven hundredths of one per cent of the power of the unit.

Another place where oil is used is in the governors which control the amount of water flowing into the turbines. This control is effected by 20 swinging guide vanes situated around the circumference of the runner. These vanes are operated by means of a ring which in turn is actuated by pistons in large cylinders. The displacement of these pistons is controlled by a governor.

Originally oil was used as the actuating medium in these pistons, but as it is almost impossible to prevent leakage, not only was a large amount of oil wasted but the compartment where the gates were installed soon became slimy and unsightly. This condition was obviated by using a mixture of soluble oil and water in place of oil alone. It was found that a one per cent mixture of soluble oil in water was sufficient to furnish adequate lubrication to the moving parts and prevent rusting and corrosion of the metal. (*Lubrication*, vol. 6, no. 11, December 1920, pp. 1–8, 9 figs., *dg*)

Chemistry of Lubrication—The Deeley Oil-Testing Machine

Friction and Lubrication, R. Mountford Deeley. Description of experiments on lubrication and of a special machine designed by the author for testing oils, accompanied by general remarks on the mechanism of the phenomena of lubrication.

The friction experiments described in the article were made under conditions which insured that the surfaces should be in actual contact, and it is claimed that any differences in the frictional coefficients shown by the oils tested must have resulted from the contact of oily metals, and not from the free molecules of the liquid itself. The experiments were made with the machine shown in Fig. 7.

Three pegs, each $^5/_{32}$ in. diameter, rested upon the flat surface of a disk of metal which could be slowly rotated. These pegs were secured concentrically to an upper disk which could be weighted as desired and which actuated a spindle to which a spiral spring and recording finger were attached. When the lower disk was rotated the pegs were carried with it by friction until the surfaces slipped owing to the stress on the spring, and the finger then gave the value of the frictional stress reached. To damp the oscillations of the finger the spindle to which the finger and spring were attached was geared to a small train of wheels, the freely revolving end wheel of the series having a weighted rim to increase its inertia. When measuring the static coefficient a pawl and ratchet were thrown into gear with the indicating finger to prevent it from moving toward zero if an oil film should form and the surfaces part. By very slowly moving the driving handle the finger was quickly brought to the position giving the static coefficient. The movable disk upon which the pegs rested lay in a circular dish, which could be filled with oil and slowly rotated.

To insure clean surfaces the metals were ground in water with flour of carborundum and then carefully polished and dried. Such clean surfaces are very sensitive to any contaminating agency.

One of the interesting things found was that while animal and vegetable oils largely displaced mineral oils from surfaces, mineral oils would not displace animal or vegetable lubricants. Surface may be contaminated with oil and yet not be wet. The coefficient of friction—static—varies very much with the condition of polish of the surfaces, as well as with the nature of the contamination.

When the surfaces are properly ground and polished and no lubricant is used, the static coefficient becomes greater and greater as the surfaces continue to rub against each other.

The tests have shown that the friction depends not only on the oil used but on the metals.

Table 2 gives the static coefficients and efficiencies of a number of oils tested between mild steel and cast iron and mild steel and gun metal. The percentage efficiency e has the value

$$e = 100 - (\text{static coefficient} \times 100).$$

There is a marked difference between the friction of the various oils when the mild steel is opposed respectively by cast iron and gun metal. Rape and olive oils give the best results and mineral oils the worst, castor coming between the mineral lubricants and the rest. Rape and olive are of equal value between mild steel and cast iron, but rape is the better between mild steel and gun metal.

TABLE 2 COEFFICIENTS OF FRICTION AND EFFICIENCIES OF VARIOUS LUBRICANTS

	Mild steel on cast iron		Mild steel on gun metal	
Lubricant:	Static coefficient	Efficiency, per cent	Static coefficient	Efficiency, per cent
Clock oil	0.271	72.9	0.275	72.5
Bayonne	0.213	78.7	0.234	76.6
Typewriter	0.211	78.9	0.294	70.6
Victory red	0.196	80.5	0.246	75.4
F.F.F. cylinder	0.193	80.7	0.236	76.4
Manchester spindle	0.183	81.7	0.262	73.8
Castor	0.183	84.7	0.169	83.1
Sperm	0.127	87.3	0.189	81.1
Trotter	0.123	87.7	0.152	84.8
Olive	0.119	88.1	0.196	80.4
Rape	0.119	88.1	0.136	86.4

The value of such a test as an indication of the lubricating value of an oil depends entirely upon the mode of preparing the surfaces.

The author comes to the conclusion that the oil film formed between the metals is really a combination between the molecules of the lubricant with the molecules of the metallic surfaces. He believes it is possible that the molecules of a liquid lubricant or those of a lubricating grease penetrate the metal for some considerable distance and form on its surfaces a comparatively thick film of a compound which acts as a lubricant.

In his estimation the unsaturated molecules of the lubricant seem to attach themselves to the molecules of the metals they wet and form skins capable of preventing the free molecules of opposing metallic surfaces from adhering. If such be the case it is reasonable to suppose that friction coefficients between such metallic skins would vary with the metals in contact as well as with the nature of the oil. (Preliminary Report communicated to the Lubricant and Lubrication Inquiry Committee of the Department of Scientific and Industrial Research, Dec. 5, 1918. Not previously published. Abstracted through *The Engineer*, vol. 131, no. 3395, Jan. 21, 1921, p. 78, 1 fig., *etA*)

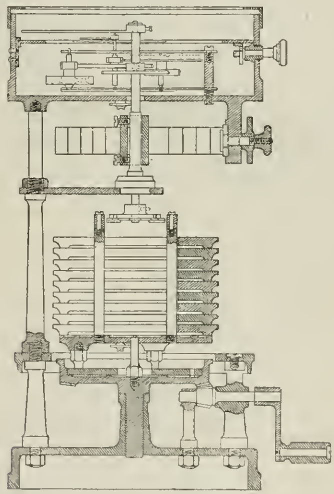


Fig. 7 Deeley Oil-Testing Machine

In connection with the foregoing abstract it is desirable to call attention to an editorial in the same issue of *The Engineer*, p. 74, under the title, Is Lubrication a Chemical Phenomenon?

In this editorial is reported a statement made by Mr. Deeley personally to the writer thereof to the effect that the oil film which he considers a compound formed by the oil with the metal is not a mere mixture or interlacing of the molecules, but is a definite union attributable to the action of the interatomic forces. In other words, it completely and exactly fulfills our conception of a chemical compound and in the case of a fatty lubricating oil may conveniently be referred to for purposes of discussion as oleate of iron, copper, cupro-tin, etc.

In this connection it is to be noted that common soap is formed by the union of fatty acids with sodium or potassium. The alkali can, however, be replaced by various other metals. Thus "soaps" formed by the union of fatty acids with iron, nickel, cobalt, zinc, magnesium, aluminum, copper or mercury are possible, and are actually made and used for a wide range of industrial purposes. The suggested union of the oily molecules with the molecules of the contacting surfaces in a partially lubricated bearing is thus not a chemical absurdity so long as we confine ourselves to animal or vegetable oils. In the case of mineral lubricating oils, however, the nature of the suggested compound is less readily pictured, although it is possible, by means of Mr. Deeley's theory, to propound an explanation of the facts reported by Messrs. Wells and Southcombe—in support of their "germ" theory—regarding the addition of small quantities of free fatty acid to mineral lubricating oils which was described by them in a paper before the Society of Chemical Industry (*Journal of the Society of Chemical Industry*, cp. Mechanical Engineering, June 1920, p. 356).

MACHINE PARTS (See also PUMPS)

Locking Ratchet Device for Trolley-Car Brake Handle

THE THOMAS PATENT RATCHET DEVICE. One of the important parts of equipment which have undergone no improvement since the horse-car days is the locking ratchet device at the bottom of the driver's brake handle. The original method of kicking a dog or pawl into gear with the ratchet wheel at the bottom of the brake spindle is still universally employed. A new type of this device is adapted to suit the double-spindle type brake gear largely used on various tramways.

It is claimed that this brake ratchet enables the driver to apply his brakes more quickly and to "feel" the brakes better, thereby reducing the wear and cost of brake shoes and wheel tires, and also preventing skidding of wheels. In case of emergency the driver can devote his entire energies to applying the brake, without having to worry about engaging the ratchet dog and pawl with his foot, as at present. Since the ratchet wheel is held by four ratchet dogs or pawls instead of one, as at present, the risk of the brake gear being released through wear is reduced. The foot pedal is provided with a cover to prevent passengers treading on it, thus releasing the brake gear when the car is at rest. The ratchet device thus presents very marked advantages over the existing type and it is anticipated that it will be widely adopted for tramway hand brakes. In this connection the device illustrated, which was developed in England, is of interest.

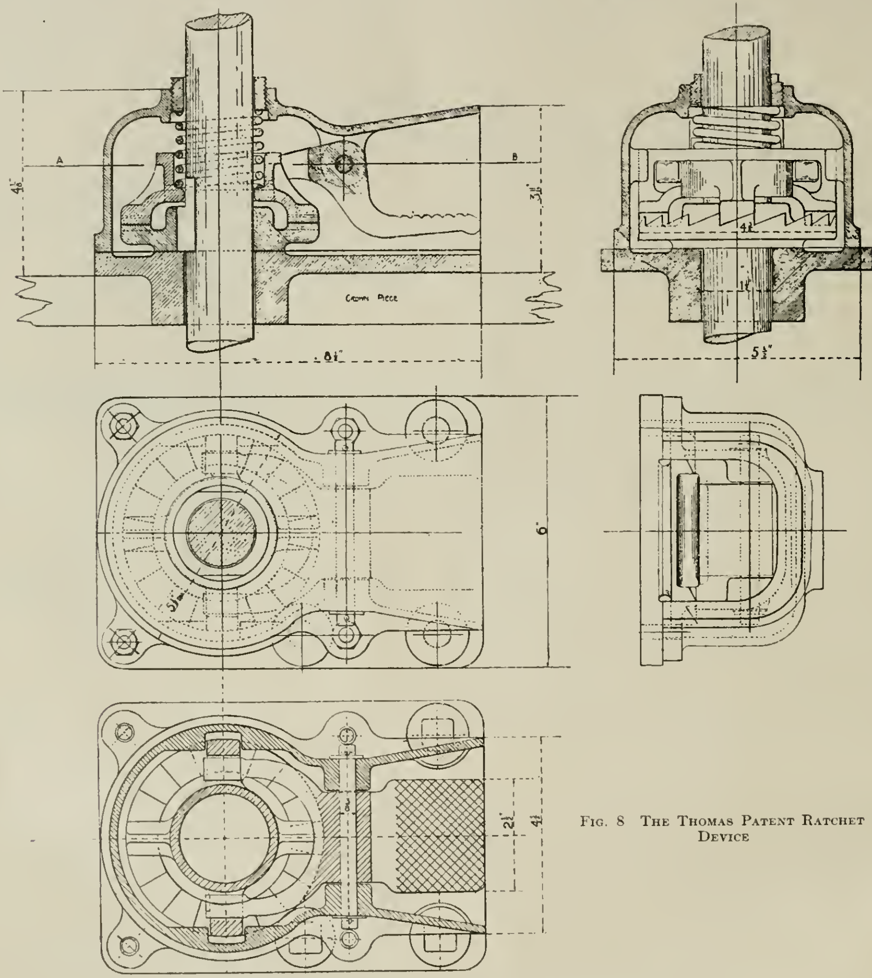


FIG. 8 THE THOMAS PATENT RATCHET DEVICE

shown in Fig. 8. It consists of the usual ratchet wheel, keyed on to the brake spindle, but instead of the teeth being on the side or edge of the wheel as at present, they are on the top and are of the rack type. Engaging in this wheel is a four-tooth dog wheel or pawl, which is held in position by a coil spring surrounding the brake spindle, and prevented from rotating by projections which engage lugs on the inside of the casing. To apply the brake on a car fitted with this new device, it is only necessary to turn the brake in the "on" position. A foot pedal (almost flush with the floor) operates a fork, which lifts the four-toothed wheel or pawl free of the ratchet wheel, thereby allowing the brake gear to be released. This foot pedal can also be made to slide sideways instead of being pressed down. All this gear is encased in a dust-and-grease-tight box, which insures protection from dirt. This fitting can be (*The Tramway and Railway World*, vol. 49, no. 3, Jan. 13, 1921, pp. 25–26, 1 fig., *d*)

There has been some decline in the use of vanadium in automobile steels, but experiments made with the metal in the production of high-grade non-ferrous alloys are reported to have been highly successful.

MACHINE SHOP

Electric Rivet Heaters. During the war both in this country and in Europe several types of electric heaters were developed. Such heaters work somewhat like electric resistance-welding machines and consist essentially of a static transformer furnishing a heavy current at a low voltage (in America, 5 and $2^1/_2$ volts), and means for holding the rivets. The heating takes place with great rapidity, but in order that there may be no delay the machine is designed to take two or three rivets at once, so that there is always at least one fully heated rivet ready for use. In some ways the three-rivet machine has an advantage over the two-rivet, since with three sets of electrodes rivets can be placed and removed when they are hot without having to operate a switch, as the two rivets which remain in position insure that the circuit is not actually broken.

In British machines plug switches are used to obtain the proper currents for each size of rivet. With a little practice the operator soon acquires the knack of putting the plugs in the proper holes for the particular class of rivet to be heated. It is stated that steel rivets $^5/_{16}$ in. in diameter can easily be heated at the rate of 1000 per hr. and $^1/_2$-in. diameter rivets at the rate of 600 per hr.

Table 3 is of interest as showing the output and power consumption with rivets of various kinds. (*The Railway Engineer*, vol. 42, no. 492, Jan. 1921, pp. 23–24, 1 fig., *de*)

TABLE 3 OUTPUT AND POWER CONSUMPTION OF ELECTRIC RIVET HEATERS

Rivets	Output per Hour	Maximum Power
$^5/_{16}$ in. × $^3/_4$ in.	600	
$^1/_2$ in. × $1^1/_{16}$ in.	250	6 kw.
$^9/_{16}$ in. × $1^1/_2$ in.	100	
$^5/_{16}$ in. × $^3/_4$ in.	600	
$^1/_2$ in. × $1^1/_{16}$ in.	700	12 kw.
$^9/_{16}$ in. × $1^1/_2$ in.	300	
$^9/_{16}$ in. × $1^1/_2$ in.	500	20 kw.
$^3/_4$ in. × $2^3/_8$ in.	220	

Hack-Sawing Machine of Novel Design

New Hack-Sawing Machine. Description of a power hack saw recently placed on the market by an English firm. The machine is very heavy, having a weight of 580 lb. and is designed to cut bars up to 6 in. in diameter.

The cut takes place on the backward or draw stroke, feed being effected by an adjustable weight carried on the top of the extended arm. On the forward, non-cutting stroke, the saw is relieved in a somewhat unusual manner. As seen in the arrangement, Fig. 9, the extended arm B, on which the saw frame is carried, is suspended by means of a roller chain from a spring-loaded drum A. Around a portion of this drum a number of fine ratchet teeth are cut, which are alternately engaged and disengaged with a pivoted pawl seen on the under side. During the forward, non-cutting stroke, the two members are engaged, consequently the drum is locked, the attached roller chain holding the extended arm stationary, and the saw is clear of the work. At the end of the stroke the pawl is disengaged, which allows the drum to be turned sufficiently to lower the frame on to the work, when the cut is freely effected, due to the weight mentioned. The alternate engaging and disengaging of the pawl is effected by means of a cam mounted on the crank driving shaft, which is in contact with a roller (not shown) carried in the rocker arm C. During the forward stroke the rocker arm is raised, and by reason of unequally weighted ends the pawl, pivoted thereon, drops into engagement, thus locking the drum and transferring the lifting to the saw frame. As the rocker arm is lowered at the end of the stroke, the outer end of the pawl makes contact with the adjustable stop E, Fig. 9, and is thus tilted clear and releases the drum. The drive, as mentioned, is by tight and loose pulleys, which replace the usual dog-tooth driving clutch. At the end of a cut the belt is automatically moved over on to the free pulley, thus stopping the machine. The belt fork is attached to a tension spring, which always tends to draw it over to the free pulley side. On moving over the belt fork by hand to start the machine, it is retained in position by a catch and is released at the completion of a cut through an abutment striking the lower end of the catch as the frame drops forward. (*Machinery* (London), vol. 17, no. 435, Jan. 27, 1921, p. 524, 2 figs., *d*)

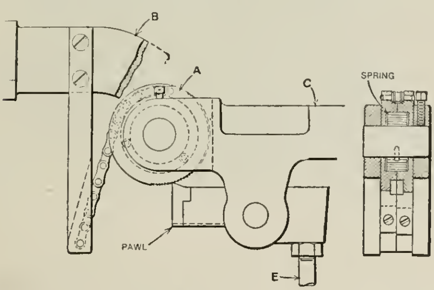


Fig. 9 New Hack-Sawing Machine. General Arrangement Showing Method of Relieving Saw During the Forward, Non-Cutting Stroke

MACHINE TOOLS

British-Made Full-Automatic Screw Machine

The "Empire" Full-Automatic Screw Machine. Description of a small automatic machine of British design and manufacture, an unusual feature of which is that it can be set up to produce two pieces for each complete revolution of the camshaft, thus doubling the capacity. A full description, however, cannot be given here, as the illustrations are not suitable for reproduction.

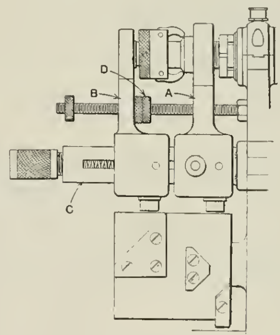


Fig. 10 Stock-Feed Mechanism of the "Empire" Automatic Screw Machine

The stock-feed mechanism is shown in Fig. 10. The collet is of the push-to-close type, and is controlled by the usual fingers and coned sleeve. This is operated by the bracket A, in turn controlled by the cams on the cam drum immediately below. The feed fingers in the spindle are operated by the bracket B, which is kept pressed toward the headstock by a spring housed in the bracket carrier C. The stock-feed cam on the cam drum thus draws the feed fingers back over the stock against the spring in C, and the nut and lock nut can be set to control the extent of the return movement, and consequently the amount of stock fed; the adjustment of the nuts D can therefore be used in certain cases instead of a stop in the turret, leaving all six turret stations free for tools.

Very effective overrunning die and tap holders are supplied for use in the turret; in addition to releasing in the usual manner, a spring blade bears on the holder and prevents rotation during withdrawal of the tap or die when the machine is reversed.

The machine throughout is substantial in design, and the idle movements of the turret cross-slide and reversing clutch are very rapid, allowing very close setting. If the machine is cammed for dealing with one piece per camshaft revolution, two threading operations can be undertaken, in addition to forming, drilling and parting, but where fewer operations are required the camming can be arranged to give two pieces for each camshaft revolution.

The gear train between the camshaft worm drive and the feed shaft from the planetary gear allows of ten feed changes, so that with the standard turret slide cams supplied a great variety of work can be undertaken. Setting up is very straightforward, and all adjustments can be made without going to the rear of the machine. By means of a double countershaft with cone pulleys, twelve spindle speeds are possible.

The capacity is up to $^1/_2$-in. stock, and the maximum length that can be turned is $1^1/_2$ in., although the maximum stock feed is $2^1/_2$ in. A pump, capacious suds tray and sump are provided.

The turret slide-cam drum has three T-slots, into which fit tenons turned out of the solid with the standard cams which are manufactured in ring form and afterward cut out as required. T-bolts secure the cams in the position desired, but the tenons take all side thrusts during operation and prevent the bolts from loosening.

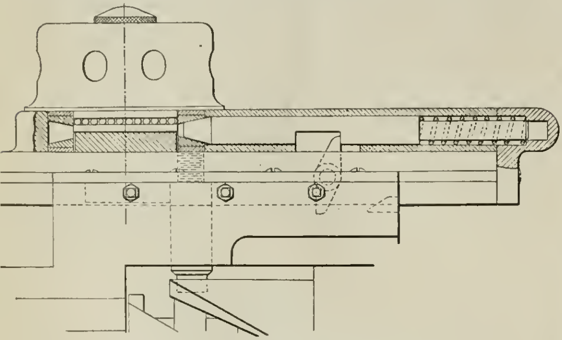


Fig. 11 Turret Indexing Mechanism of the "Empire" Automatic Machine

The turret indexing mechanism is shown in Fig. 11, and the substantial proportions and bearing surfaces of the indexing pin will be noted; the pin and indexing bushes are hardened and ground. The turret is supported below by a ball-bearing thrust washer. The cross-slides are positively advanced by cam levers and standard cams secured to a cam disk immediately below; the front and rear slides are independent and are spring-returned. (*Machinery* (London), vol. 17, no. 434, Jan. 20, 1921, pp. 492–493, 5 figs., *dA*)

Large Form-Grinding Machine

Bryant Form-Grinding Machine, Ellsworth Sheldon. This machine is said to be capable of regularly grinding pieces 10 in. long and of any diameter up to 12 in., by feeding the wheel straight toward the center of the work with a traverse of only $^1/_8$ in., and even this slight movement may be dispensed with, if necessary.

The machine is a development of the "bar" type, but the usual principle has been reversed. The bar carries the work and the wheel is mounted upon the bed in a stationary position. The wheel head when once set for the work in hand has no further movement until wheel wear makes it necessary to reset it. The movement of the work toward the wheel, the feed movement, is obtained by swinging the work carrier which is suspended from the bar.

Not only are cylindrical pieces of work reduced sufficiently to remove irregularities and make them round and smooth, but work having several diameters is produced with almost equal facility, each piece being exactly like every other piece and finished in a matter of seconds as regards grinding time and to limits of accuracy comparing favorably with other grinding methods.

Fig. 12 shows the various movements of the machine. The work centers are carried in the frame *AA* suspended from the main bar *B*, which latter is the feature that gives to the Bryant type of machine its name. The center at the driving end does not revolve, nor has it any adjustment endwise, except as the whole frame is moved. The rear spindle, which is a sleeve, may be adjusted longitudinally for a distance of 12 in. to accommodate various lengths of work and, in whatever position it may be, is firmly clamped to the lower member of the frame *AA*, the latter corresponding to the cross-slide of other types of machine.

An inner spindle, carrying the tail spindle, has a limited movement endwise for the purpose of mounting and demounting the work. This movement is controlled by the lever *C* through a spring-supported cam that holds the tail center strongly in place, while still allowing it to recede as the work expands under the influence of the heat generated by the grinding operation.

The bar *B* slides, and also turns, in adjustable bearings supported by the frame of the machine. Telescoping sleeves upon the bar protect the bearings from dirt and particles of abrasive. Endwise movement of the bar, of course, causes a traversing movement of the work across the face of the wheel, and the swinging movement provides for feeding the work to the wheel.

The bracket *D* is permanently fastened to the base of the machine and carries the cross-feed screw and sizing mechanism. The inner end of the cross-feed screw carries a hardened bearing shoe, upon which rides a bearing bar fastened to the carriage and held at all times in contact with the shoe by heavy counterweights. A pawl engaging with the ratchet *E* automatically turns the latter forward until it is disengaged by a shield that partly covers the ratchet wheel. A graduated dial enables the operator to set the shield to disengage the pawl at any predetermined point.

The machine is semi-automatic in its operation in so far as, after the work has been ground to a specified diameter, the wheel is automatically withdrawn from the cutting position. This action insures a very close duplication of size, as the grinding time of the wheel, after it has reached a positive stop, is exactly the same on every finished piece. That is to say, the length of time that the wheel is allowed to grind after reaching a positive stop for a set diameter is the same for each piece ground.

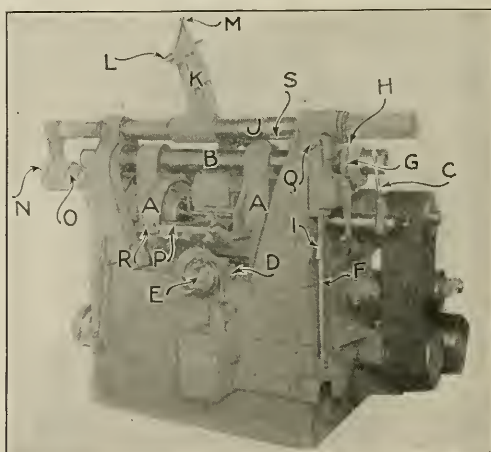


Fig. 12 Bryant Form-Grinding Machine, Front View

Traversing movement is transmitted to the bar *B* by means of an eccentric near the upper end of a vertical shaft, to be seen at *F*. The eccentric straps are connected to the clamping collar *G*, which may be tightened upon the bar by a movement of the operator's wrench upon the head of the clamping screw *H*. The squared projection upon which the crank wrench is shown in the picture is the end of a pinion shaft by means of which the operater may move the main bar by hand in either direction to any desired position, first loosening the clamping collar *G*. All wrench-operated parts of the machine are fitted by the one crank wrench.

Fastened to the front of the carriage at *P* and held thereto by the three large hand-operated clamping screws to be seen under the carriage is a bar about 12 in. long, the inner profile of which is an exact replica of that of the piece to be ground. This piece is called the master bar and is produced by toolroom methods, for upon its

accuracy depends the accuracy of the product. The machine has no control over *relative* diameters. Actual diameter of the work as a whole is completely under control of the operator through the cross-feed screw and sizing mechanism, but, if one diameter upon a stepped piece is too large or too small in relation to other diameters upon the same piece, the fault is in the master bar and must be corrected there. (*American Machinist*, vol. 54, no. 8, Feb. 24, 1921, pp. 305–308, 9 figs., *d*)

POWER PLANTS

Non-Condensing Turbine Plant of the Western Felt Works. In felt works there is a considerable demand for steam for drying and heating, and when the company (located in Chicago) installed in the early part of 1920 two turbo-generators they made them non-condensing in order to satisfy the large and continuous demand for exhaust steam.

The two turbo-generators have capacities of 500 and 300 kw., respectively, at 80 per cent power factor, and supply three-phase 60-cycle cycle current at 220 volts.

As practically all the exhaust steam is utilized, the water rates are not of great importance, but the guarantees are as follows when the machines are supplied with steam at 150 lb. pressure and 100 deg. superheat: For the 500-kw. machine at one-half load, 40 lb., and for the full load of 500 kw., 37.1 lb. per kw-hr. For the smaller machine the water rates are 53.9, 45.1 and 40.9 lb. per kw-hr., respectively. (*Power*, vol. 53, no. 8, Feb. 22, 1921, pp. 294–297, 4 figs., *d*)

New Hammermill Plant. Description of a plant operated in conjunction with the paper mill of the Hammermill Company, Erie, Pa., the most interesting feature of which is that it employs superheated steam for both prime-mover operation and manufacturing processes.

There are four 509-hp. water-tube boilers, each built for 250 lb. gage pressure, though ordinarily operated at 235 lb. gage and equipped with superheaters for raising the temperature of the steam 150 deg. fahr. above that corresponding to the pressure. Whenever possible these units are worked at 175 per cent of their rated capacity, which has been found to be the loading providing the greatest overall economy.

In addition to superheated steam, saturated steam is also available for the operation of such auxiliaries as the stoker engines, pumps, etc. (*Power Plant Engineering*, vol. 25, no. 4, Feb. 15, 1921, pp. 201–204, 6 figs., *d*)

PUMPS

Formulas Dealing with Valves of Reciprocating Pumps

Investigation of Automatic Pump Valves and Their Influence on the Operation of Pumping Machinery. Ludwig Krauss, D.E. Notwithstanding the very extensive use of reciprocating pumps, no sufficient information is available for such design of valves as will prevent their knocking. It is with this in view that an investigation on the suction and pressure valves in pumps was recently undertaken in the machinery laboratory of the Technical High School in Dresden.

The experimental pump took water either from a suction tank 9.5 m. (30.2 ft.) below the pump or from a well of a turbine installation.

The construction of the pump shown in the original article does not represent anything unusual. It is a double-acting pump with an output of 120 cu. m. (4237 cu. ft.) per hr. at 75 r.p.m. and at a pressure head of 10 atmos. For test purposes it was rebuilt into a single-acting pump and so constructed that it was possible to change the spring arrangement on the valve while the pump was running and that the same amount of water could be handled at several speeds of the pump. This latter was achieved by using on the same piston rod pistons having diameters of 90, 118 and 140 mm. (3.54, 4.36, 7.5 in.).

Figs. 13 and 14 show the various valve-lift diagrams for the suction and pressure valve in triple magnification. The indicator drums were running at a uniform speed and as their speed of rotation could be measured, the velocities of valve lifts could be easily derived from the diagrams. Two other figures in the original article give the pressure-difference diagrams for the pressure valve and suction valve.

As regards the planning of the test, it was decided to determine the influence of such factors as agree in practice on the play of the valve, on the degree of delivery through the valve and on the indicated efficiency. The factors which were considered to be variable within wide limits were the delivery head, the volume of water handled and the load on the valve.

To determine the play in the valve, suction heads of 2, 4 and 6 mm. of water were employed and water admitted under a pressure of 2.5 atmos.; furthermore, the pressure head could be raised as high as 10 atmos.

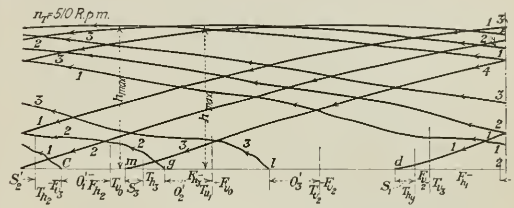


Fig. 13 Pressure-Valve Lift Diagram

To determine the delivery, the volume of water handled was varied from 10 to 115 cu. m. (353 to 4060 cu. ft.) per hr. by varying the speed of rotation of the pump from 25 to 150 r.p.m. and then using four different pistons with areas of from 47.12 to 185.85 sq. cm. (7.2 to 28.6 sq. in.).

The data of the tests are presented in numerical form and also as curves.

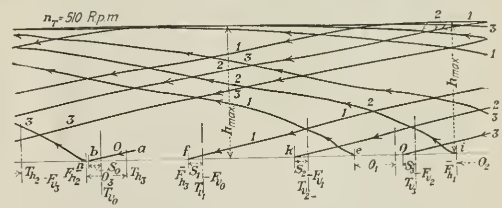


Fig. 14 Suction-Valve Lift Diagram

The following represents the main general conclusions arrived at from the results of the tests:

Opening and Closing of the Valves. In general, it may be said that the valves have a tendency both to close and to open late. A valve does not open immediately after the closing of the opposite valve, but there is a lag which is greater in proportion to values of the suction head, the suction valve load and the speed of rotation.

Knock at Opening of the Pressure Valve. The strength of this knock is determined by the timing of the opening of the pressure valve and also by the delay in the closing of the suction valve. On the other hand, it is but little affected by the increase in load of the pressure valve and by increase in the pressure head as long as the operation of the pump is kept within normal limits. The knock is decreased by the unloading of the suction valve, whereby the suction capacity of the pump is increased, and by lack of tightness of the pressure valve. This is explained by the fact that after the closing of the suction valve a water-free space is formed under the pressure valve. As a result the water reaches the lower face of the pressure valve only a certain time after the reversal in the direction of the stroke, and does it with a blow, which, in the case of a pump running low, has a dull sound, and a poorly running pump a loud, hard, metallic sound.

Knock at Closing of the Pressure Valve. This knock is the louder the smaller the initial compression of the spring and the greater the maximum valve lift, but even with a large initial compression

of the spring and a slight valve lift it can be heard. It has not been found possible to locate a clearly defined point at which the pressure valve closes without a blow. Because of this, it is not possible to test the correctness of the Klein law, in accordance with which the product of the speed of rotation per unit of time times the maximum valve lift is a constant at the same valve load at the point where the closing of the valve takes place free of knock.

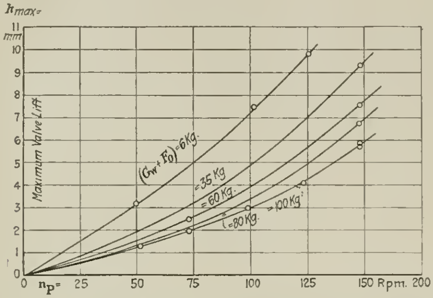


Fig. 15 Variation of Maximum Valve Lift with Speed of the Pump and Load on the Valve

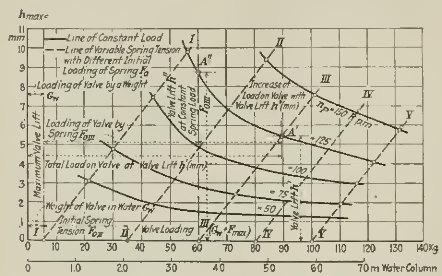


Fig. 16 Variation of Maximum Valve Lift with Sprino Tension on the Valve and Speed of the Pump

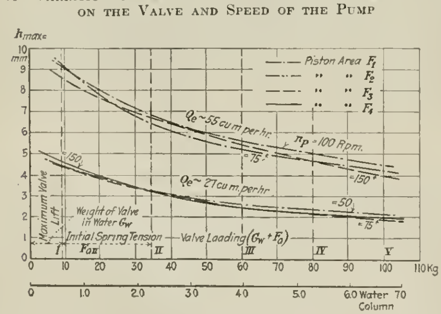


Fig. 17 Variation of Maximum Valve Lift with Load on the Valve and Volume of Water Handled per Unit of Time

The knock at the closing of the suction valve was under the same conditions and a normal valve clearance always found lighter than the knock in the closing of a pressure valve of the same construction, a fact which could be determined both by listening and from the measurement of the velocity of the valve closing.

Velocity (v_s) *of Valve Closing.* This was determined from the curves of valve lift and it was found that at quiet running v_s = 80 mm. (3.14 in.) per sec.; at ordinary running v_s = 100 to 120 mm. (3.9 to 4.7 in.) and at noisy running v_s is greater than 130 mm. (5.1 in.) per sec. These values can of course vary with individual valves.

The maximum lift h_{max} is a function of the volume of water handled, the load on the valve, and the dimensions and design of the valve, but is entirely independent of the pressure head employed.

Apart from the violent oscillations in the suction valve when the suction of the pump is poor, it is usual to make the maximum lift of both suction and pressure valves the same with the same spring load. If sufficient experimental information is available to determine the value of the coefficient of justification μ_P, then the maximum valve lift may be calculated with a precision sufficient for practical purposes from—

$$h_{max} = \frac{Q\pi}{\mu_P l \sqrt{2g \dfrac{P_{max}}{f\gamma}}} \qquad [1]$$

where Q is the volume of water handled in cubic meters per second, l the length of the clearance in meters, P the load on the valve in kilograms, and f the free valve-seat area expressed in square meters.

It is impossible to express in a general manner the maximum value for h_{max} for any given case, but it can be determined by experiment and in the original investigation a table is given. This table is not reproduced in the article from which this abstract is made. By increasing the load on a valve the lift may be decreased simultaneously with the increase of the valve resistance. This can safely be done in the case of the pressure valve but not with the suction valve because it might produce in the suction valve a loud knock at the instant of opening the pressure valve, and the irregular operation of the valve.

In this connection the curves in Figs. 15, 16 and 17 are of interest, of which the first gives the values for the maximum valve lift for a given speed of the pump in revolutions per minute and for valve loads varying from 6 to 100 kg., all other conditions being the same. The next figure gives the maximum valve lift at a given load for speeds of the pump varying from 50 to 150 r.p.m., and finally the last of the three gives the maximum valve lift at a given load for volumes of water equal to 27 and 55 cu. m. per hr., respectively. From this last figure it would appear that, all other conditions being equal, the valve lift is mainly determined by the volume of water handled.

The second part of the article deals with various individual results obtained from the tests and may be abstracted in an early issue if space is available. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 5, Jan. 29, 1921, pp. 116–122, 23 figs., *etA*)

RAILWAY ENGINEERING (See Machine Shop)

SHIPBUILDING (See also Machine Shop)

Reaction Propulsion of Ships—The Hotchkiss System

Hydraulic Propulsion of Ships. Hydraulic or reaction propulsion of vessels, whether air or water craft, is an old idea and has been tried many times, though thus far never successfully.

Reaction propulsion has certain advantages, the first being the relative simplicity of the propulsive equipment and elimination of the propellor with its appendages, which means not only fewer parts but absence of a rapidly rotating element outside of the ship hull subject to fouling and breakage. The elimination of the propeller leads also to the reduction of vibration. To this is added the ease with which the motion of a hydraulically propelled boat may be reversed simply by deflecting the stream forward without even reversing the prime mover. This adds to the ease with which the vessel can be maneuvered and makes it possible to eliminate the rudder, another element outside of the ship hull subject to all kinds of untoward accidents.

Finally, the thrust developed by the discharge of the stream of water is independent of the depth at which the stream is discharged, while the depth of immersion of a screw propeller greatly affects the thrust. From these considerations it follows that racing cannot occur in a hydraulically propelled boat. In addition, the depth of water in which the ship operates efficiently is limited solely by the draft of the hull and not by the draft required for the efficient working of the propeller.

Among the disadvantages cited against hydraulic propellers the chief is lack of efficiency. Various causes have contributed to the lack of efficiency shown by the systems tried in the past. If we regard hydraulic propulsion as consisting simply of the use of an internal propeller, it is obvious in the first place that loss will occur

by virtue of the fact that the stream of water has to be brought to and discharged from the propeller through pipes and passages or orifices of some description. The frictional losses in such passages have no counterpart in the external propeller, for in this case the water is drawn from and discharged into the immediately surrounding fluid. Again, in reaching and leaving the internal propeller, the water may in its flow be called upon to change its direction of movement to a considerable extent, with a consequent considerable loss of energy. The water passages, too, may change in cross-sectional area, and as a result loss will arise by the conversion of pressure into velocity and velocity into pressure.

Lately, however, several reaction propulsion systems have been tried out. The Mélot system as applied to aircraft was described in Mechanical Engineering, April 1920, p. 234. The Hotchkiss and the Gill systems have recently been tried out for water craft.

The Hotchkiss system was tried on a weldless steel launch measuring 24 ft. in length overall and 6 ft. 3 in. in beam, with a draft of 1 ft. 5 in. on a displacement of two tons. The machinery propelling the vessel consisted of an 8-b.hp. motor coupled through reduction bevel gearing to two Hotchkiss pumps.

The general principle of the Hotchkiss system is illustrated in the diagram of one of the pumps given in Fig. 18. The pump consists of a four-bladed impeller rotating within a cylindrical casing, in which are formed three openings, namely, one in the lower half of each vertical side, and one in the lower portion of the periphery. In the diagram the two strips of the casing separating these three holes are represented as having been cut out, so that the holes really form but one hole. It will be convenient, however, to regard them as being in three. The casing is considerably wider than the impeller blades, so that between the edges of the blades and the vertical walls of the casing there is a passage on each side of considerable area.

In the diagram the movement of the boat is supposed to be toward the left. The impeller is driven in the direction of the arrow shown against it, and creates a vortex inside the casing. The water is drawn into the casing in two streams through the two side holes. Inside the casing these two streams converge, and finally become one, which, passing centrally between the two entering branches,

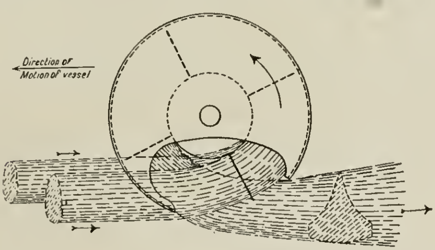


Fig. 18 Diagram of the Hotchkiss Pump Used for Reaction Propulsion of Ships

is discharged sternward. The peculiar section which, according to Mr. Hotchkiss, the discharge stream assumes will be noted. It enables the discharge stream to pass between the entering streams without touching them, while at the same time it fills up nearly all the vacant space between them, on the assumption that the entering streams are circular or oval in section.

The essential feature of the Hotchkiss system is thus the creation of a vortex that travels along with the vessel. The water is drawn directly into the vortex without the intermediation of pipes or conduits of any description, and, therefore, frictional losses are practically avoided. The relative momentum of the incoming water, it is claimed, is not lost, but forms part of the momentum of the discharge stream.

The system is still in the experimental stages and no reliable data as to efficiency are available. It is stated, however, that the boat developed 5.6 knots (9.46 ft. per sec.) with the engine running at 950 revolutions and developing $7^3/_4$ b.hp. The speed of discharge of the stream from the pumps is calculated by Mr. Hotchkiss to be 16.4 ft. per sec. Calling these two speeds v and V, respectively, the slip is $(V - v)/V$, or 42.3 per cent. The jet efficiency, in accordance with the usual formula, is $2v/(V + v)$, or 73 per cent. Mr. Hotchkiss takes the efficiency of the pumps at 90 per cent, so that the propulsive efficiency comes out at 65.7 per cent. Taking the efficiency of the engine at 75 per cent, the overall efficiency is thus 49.3 per cent. Such an efficiency, it is stated, would not be considered bad in a similar vessel propelled by screw.

These figures, however, have not been checked by any reliable outside authority and are cited merely because of the revival of interest in reaction propulsion. (*The Engineer*, vol. 131, no. 3398, Feb. 11, 1921, pp. 140–142, 3 figs., *d*)

SPECIAL MACHINERY

Novel Rotor-Balancing Machine

The Martin Rotor-Balancing Machine. Description of a simple device for balancing rotary bodies—of particular interest because of its great sensitiveness. This latter is such that, for example, when balancing a rotor of 10,000 kg., a variation of 1 kg-cm. can be easily discovered by sliding a weight of 1 kg. along the beam. This corresponds to a deviation of the center of gravity of the rotor in a horizontal direction off the axis of 0.005 mm., or approximately one fifty-thousandth of an inch.

The same result is expressed in a different way, as follows: When balancing a 10-ton Zoelly rotor of 6 ft. diameter, an overweight of as little as 10 grams (one-third ounce) on its circumference, or one-millionth part of the rotor's weight, can be readily detected.

Furthermore, the apparatus indicates the correct plane in which this overweight lies and in which its moment acts. These results

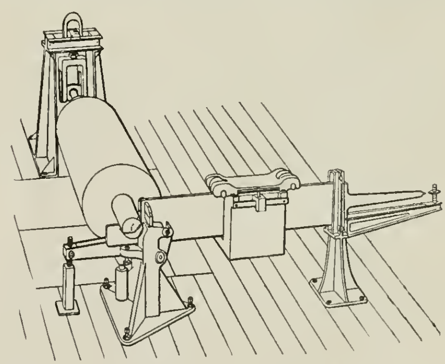


Fig. 19 Martin Rotor-Balancing Machine

are obtained without rotation, as it is merely necessary to turn the body to six or eight fixed positions and when actually balancing no rotation takes place. Because of this the method is not affected by the inertia of the body and the angle of lag cannot affect the results.

The machine (Fig. 19) consists of two main portions arranged to support the shaft of the rotor to be balanced. At one end the shaft is hung in a universally jointed stirrup and at the other in a bearing which is mounted on the short arm of a steelyard lever.

Having placed the rotor to be balanced in the bearings, the main weight of the steelyard is adjusted so as to bring the arm into equilibrium. The rotor is then turned a few degrees and the arm again adjusted by moving the jockey weight, this adjustment being recorded. The rotor is then turned through another section, and the necessary adjustment again made by means of the jockey weight, and so the process is continued for a complete revolution. The results are plotted to a horizontal base, and the sine curve obtained shows a maximum and minimum which indicate the points at which the center of gravity is farthest from, and nearest to, the supporting point of the balance. By multiplying the jockey weight by its displacement, a moment is derived from which the eccentricity of the center of gravity and the necessary correc-

tion are obtained. Table 4 gives some actual results that have been obtained with a large balance.

On all built-up turbines, such as the Zoelly and Curtis types, first the shaft and then each disk put on is successively balanced; the final balance obtained will then be without any disturbing couple, and many times more accurate than any result obtainable by other methods. In a drum-type turbine, such as the Parsons rotor, the overweight is taken out partly at each end in relation to the position of the center of gravity, the sum of this moment being equal to the total moment of overweight. Reduction-gear wheels can also be balanced by this machine, and for bodies which are of relatively large radial and small axial dimensions, a mandrel (in itself balanced) to take such parts can be used on the machine. The machine could also be used for standardizing rotary parts. (*The Electrical Review*, vol. 88, no. 2253, Jan. 28, 1921, pp. 101–102, 4 figs., *d*)

TABLE 4 RESULTS OBTAINED WITH A LARGE-SIZE MARTIN ROTOR-BALANCING MACHINE

Turbine rotors balanced:	Weight, kg.	Out-of-balance moment found, kg-cm.	Weight removed (dependent on the radius), kg.	Corresponding correction of rotor's c. of g., mm.
High-pressure rotor....	2678	3.75	0.208	0.014
Low-pressure rotor.....	5370	5.8	0.23	0.0108
High-pressure rotor....	6792	36	1.35	0.053
Low-pressure rotor.....	9103	13.2	0.244	0.0145
High-pressure rotor....	6781	21.7	0.8	0.032
Low-pressure rotor.....	9216	34.1	0.695	0.037
High-pressure rotor....	7200	10.8	1.391	0.015
Low-pressure rotor.....	9203	58.9	1.1	0.064

STEAM ENGINEERING (See Power Plants)

TESTS (See Engineering Materials)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Professional Engineering Service Announcements

One hundred and twenty engineers and engineering concerns are now represented in the Professional Engineering Service Section of Mechanical Engineering (see pp. 106–112 of Advertising Section). This is a substantial increase over the number in the March issue, and fifty per cent more than in February. Since the addition of a classified index to this section its usefulness to those in need of specialized engineering assistance has greatly increased; and users of cards are benefited accordingly.

The classified index comprises approximately 150 headings, under which the users of professional cards are listed according to the lines in which they specialize. The card announcements appear on pages directly following, so that after a reader has selected one or more names from the classified index, he can easily find the corresponding cards giving more detailed information regarding the services offered.

With the increase in size and completeness of the Professional Service Section it becomes more and more a clearing house for engineering service by experienced engineers who have specialized in different fields of activity.

A new alloy patented in France and adapted specially to the manufacture of valves for internal-combustion engines, is composed of nickel, about 67 per cent; iron, 1 to 5 per cent; and copper, 28 to 32 per cent. It is said to have the same coefficient of expansion as cast iron, to offer great resistance to the destructive action of the high temperatures to which the valves are subjected, and to be insensible to corrosion by the hot combustion gases.

LOCOMOTIVES AND LOCOMOTIVE TERMINALS

(*Continued from page 258*)

The trend in locomotive-terminal development is undoubtedly toward facilities for executing a greater and increasing variety of heavy repairs. In fact it is not beyond the range of possibilities to comprehend a development in locomotive terminals that will supersede many of the functions now belonging to the central erecting shop.

B. P. Phelps[1]. One of the first considerations of a new terminal should be that of ground enough to permit an expansion of each unit at least 100 per cent over the original installations. Terminals in cities should be located out far enough from the region of expensive real estate to secure enough land at a reasonable price to allow for such a ratio of expansion; unless there are peculiar operating conditions which prevent. In a developing country, the demand on terminal facilities is doubled in a period of ten to fifteen years. Therefore such layouts as shown by the author,[2] while conveniently arranged for the present needs, may soon be outgrown.

As a further provision for expansion, when the initial installation of a roundhouse includes less than a complete circle, no permanent buildings or tracks should be placed within the circle to be in the way of completing the roundhouse.

The writer would suggest that in general the storehouse should be next to the roundhouse and centrally located with reference to the machine shop, blacksmith shop, and car department. Efficient means should be provided for handling stores from cars to platform and building and also to the several shops.

The back shop (locomotive repair shop) is most convenient if located at the back of the roundhouse and about the center of the circumference of the outer wall. It would appear that a back shop located as in Fig. 1[2] would be inconvenient for machinists working on locomotives to get machine work done, especially men in the north roundhouse.

The blacksmith shop should be handy to both the roundhouse and back shop as the work done in this shop is about equally divided between running or roundhouse repairs and back-shop repairs.

On Western railroads running through districts of bad water, flue-repairing facilities demand much consideration.

In one paragraph Mr. Rink mentions the use of blow-off water from locomotives for filling boilers. Numerous tests made in bad water districts have shown that blow-off water contains one hundred and fifty to five hundred grains of soluble salts per gallon or the equivalent of about a barrel of salt to a locomotive boiler full of water. These salts do not settle but remain in solution at ordinary temperatures. Concentration of these salts in a boiler will cause the water to "prime" or "foam," which is objectionable. Except in emergency cases it is far preferable to fill boilers with fresh water.

G. W. Rink, in his closure, spoke of the chart mentioned in the discussion by Wm. Elmer, on which was recorded the frequency with which a locomotive found its way into the shop and which indicated when a locomotive was ready to go back to the main shop for general repairs. This, he said, brought out the fact that most main shops were inadequate and that they could not keep up with the necessary repairs. Therefore he thought the roundhouses ought to be helped as much as possible by providing them with as many facilities as could be afforded.

He said that he preferred jib to overhead cranes for roundhouses as the overhead crane was not capable of serving several gangs of men working on different jobs.

He pointed out that the loss of time in getting a locomotive into and out of a roundhouse was responsible for many makeshift repairs, as not enough time remained if the motive power were being used intensively. The train and engine must go whether the repair is made or not, unless the case is serious enough to warrant taking the locomotive out of service.

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[1] Engineer of Shop Extensions, Santa Fe System, Topeka, Kan.
[2] Mechanical Engineering, January 1921, pp. 13 and 14.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A3-21. Viscosimeter. Use of MacMichael Viscosimeter in petroleum products is the subject of Report 2201 of the Bureau of Mines, by W. H. Herschel and E. W. Dean. The MacMichael viscosimeter is of a torsional form and has been described by W. H. Herschel in the *Journal of Industrial and Engineering Chemistry*, vol. 12, 1920, pp. 282–286. It takes a shorter time for a determination than the Saybolt viscosimeter and gives moderately accurate results with oils that are not perfectly homogeneous. The instrument requires careful attention to manipulate it. This viscosimeter consists of a rotary oil cup which is motor-driven and a torsional pendulum suspended above the cup by a piano wire. The pendulum consists of a tube enclosing the suspension wire and carrying a disk at its lower end. The deflection of the suspension is converted into absolute viscosity. The report gives the relation between kinematic viscosities and Saybolt viscosities, as well as the method of translating readings of the MacMichael viscosimeter into absolute viscosities. Bureau of Mines, Washington, D. C. Address Director.

Cement and Other Building Materials A5–21. Repeated Stresses in Concrete Beams. The Bureau of Standards has just issued Technologic Paper 182 which is for sale by the Superintendent of Documents, Washington, D. C., at 15 cents per copy. It describes the results of tests made on concrete beams 4 in. by 6 in. in cross-section, using a span of 8 ft. The beams were reinforced both top and bottom. The load was applied at two points each 6 in. from the center of the span, and at the rate of 17 cycles per minute, each cycle including an upward and downward application of load. By means of a system of levers a dead weight used for load was multiplied ten times at the beam. The loading mechanism was driven through a walking beam. Four beams were tested to failure and a fifth beam was loaded through two million cycles, although the beam did not appear to approach failure.

The four beams on which the tests were completed failed by tension in the steel. The beam showing the highest stress withstood the smallest number of repetitions. The largest number of repetitions was so small that failure in the steel would not have been expected as the observed stresses were low. Other factors than the intensity of the tensile and compressive stresses must have caused the early tension failure.

All tension failures in reinforcing bars occurred at sections where large cracks extended entirely across the section of the beam. It is possible that in some cases the bending at these cracks was sufficient to make the bending of the bar an important factor in causing failure. The slipping of the bars and the resulting opening of the cracks must have increased this action. The quality of steel used in the reinforcement was poor, although this does not account for the small number of repetitions. After 7000 cycles the slip in the end of the bar in one beam was less than 0.001 in. This is less than the amount taken as the criterion for safe conditions of bond. After 400,000 cycles the slip in the bar was so great that failure by slipping seemed imminent. This investigation was undertaken for the Emergency Fleet Corporation in connection with the development of concrete ships. Bureau of Standards, Washington, D. C. Address Director.

Cement and Other Building Materials A6–21. Tannic Acid in Concrete. The effect of tannic acid on the strength of concrete is the subject of Bulletin No. 7, by Prof. Duff A. Abrams, of the Structural Materials Research Laboratory, Lewis Institute. The Bulletin is a result of four years' investigation to determine the effect of organic impurities in sands. Natural sands could not be used for a quantitative analysis and so aggregates were prepared in which known quantities of organic impurities were present by the addition of tannic acid. The amount of tannic acid varied up to 0.40 per cent of the aggregate by weight. Compression tests were made on 3-in. by 6-in. concrete cylinders with various mixes ranging from 1 : 5 to 1 : 2. The size of the aggregate varied from a fine sand to $^3/_4$ in. Tests were made at ages of 7 days, 28 days, 3 months, 1 year and 2 years, the series including 2000 tests. The following conclusions were derived:

The results were comparable with the effects produced with natural sands containing organic matter.

All percentages of tannic acid in all mixes and ages reduced the strength of the concrete.

Less than 0.1 per cent of tannic acid reduced the strength of the concrete to one-half its normal value.

The lean mixtures are more affected than rich mixtures.

Mixtures from finer aggregates are less affected than those from coarser aggregates.

The reduction in the strength of concrete is a function of the concentration of the tannic acid in the mixing water.

Wetter consistencies are less affected than drier consistencies.

The strength falls off rapidly for small percentages of tannic acid at the beginning of the increase and less rapidly as higher percentages are reached.

The 7- and 28-day strengths are reduced by a greater amount by tannic acid than the strengths at ages of 1 and 2 years.

Some 1 : 5 mixes disintegrated before the time of test.

When higher percentages of tannic acid were used with finer sands 1 : 7 mixes were destroyed in removing them from the mold.

Care should be taken to remove surface loam from concrete sands. Loam can be generally removed by washing.

Address Prof. Duff A. Abrams, Lewis Institute, Chicago, Ill.

Chemistry, Mineralogical and Geological A1–21. Potash Production. See *T. Poole Maynard E1–21.*

Fuels, Gas, Tar and Coke A5–21. Stenches for Determining Leakage. Technical Paper 267, by S. H. Katz and V. C. Allison, on Stenches for Detecting Leakage of Blue Gas and Natural Gas, has recently appeared from the Bureau of Mines. The report contains a number of tables, two illustrations and extends over 22 pages. It deals with the properties, intensities, quantities and cost of production of stenches and describes the method of impregnation. Bureau of Mines, Washington, D. C. Address Director.

Fuels, Gas, Tar and Coke A6–21. Sulphur Distribution in Carbonization. A study made by Prof. C. C. Thomas and U. O. Hutton, of Johns Hopkins University, Baltimore, Md., in collaboration with the Bureau of Mines was intended to determine the distribution of sulphur in carbonization of coal in gas retorts. The experiments were of three classes: first, to determine the sulphur production in gas with uniform charges of 300 lb. at different temperatures, a second set to study the effect of varying the size of the charge, and a third set to determine the effect of spraying the coal with milk of lime before charging. The article describing this research is given in the *Gas Age* for Feb. 10, 1921, and gives curves showing the rate of gas production, the effect of temperature on sulphureted hydrogen and sulphur variation, the variation of organic sulphur with the charge, the variation of carbon disulphide and organic sulphur, the effect of carbon disulphide, the effect of spraying the coal with lime, the effect of the size of the charge and the variation of the sulphur. The experiments show that the sulphur in the gas may be reduced by low temperatures, the use of larger charges, and the spraying of milk of lime over the coal.

Mechanics, General A1–21. Repeated Stresses in Concrete Beams. See *Cement and Other Building Materials A5–21.*

Metallurgy and Metallography A9–21. Metal Arc Welds. See *Welding A1–21.*

Petroleum, Asphalt and Wood Products A2–21. Properties of Crude Oils. The Bureau of Mines has issued report No. 2202 on the Properties of Typical Crude Oils from the Eastern Producing Field of the United States, by E. W. Dean. Bureau of Mines, Washington, D. C. Address Director.

Petroleum, Asphalt and Wood Products A3–21. Lighter Hydrocarbons. The Bureau of Mines has recently issued Bulletin 162, by J. N. Wadsworth, on the Removal of Lighter Hydrocarbons from Petroleum by Continuous Distillation. This bulletin contains drawings and detailed descriptions of apparatus and equipment. In addition its 162 pages comprise 31 tables showing various data from the plants, and 49 plates of drawings of apparatus and 45 figures. Bureau of Mines, Washington, D. C. Address Director.

Properties of Engineering Materials A1–21. Repeated Stresses in Concrete Beams. See *Cement and Other Building Materials A5–21.*

Properties of Engineering Materials A2–21. Standard Samples. Standard samples of materials of known composition are issued by the Bureau of Standards at different prices. A new standard cast bronze has been placed in stock and renewals of certain cast irons, bessemer steel and other materials have been added. Bureau of Standards, Washington, D. C. Address Director.

Welding A1–21. Arc Metal Welds. The properties of arc metals and arc welds as determined by tests form the subject of a paper printed in *Power*, Feb. 15, 1921, by O. H. Eschholz, of the Westinghouse Electric & Manufacturing Company. The paper shows the different ways in which the metal of the weld was applied and tested, including the form of specimens used and the appearance of broken specimens under

tension, compression, bending and impact. The article gives microphotographs. The investigation shows that properties of metals deposited from bare electrodes are dependent on the direction of stress relative to the direction of depositing the metal in the weld and also on the procedure during deposition. The greatest resistance occurs when the load is applied parallel to the direction of layer deposition and least when applied perpendicular to the layers. The strength of the weld in mild-steel plates was almost as great as the strength of the plate with high-carbon steel, which amounted to 70 per cent of the strength of the plate. The test showed that the strength of the weld with the same metal used for the arc pencil depends on the surfaces welded together, the weld absorbing from the parent metal certain materials which give it additional strength.

The presence of small quantities of iron oxide and nitride does not appear to greatly effect the properties of the metal when stressed by static load, although under repeated load and in impact testing these substances affect the strength. The field of bare alloy electrodes and covered electrodes shows development possibilities.

Wood Products A2-21. Smoke Making for Testing Circulation in Kilns. Technical Notes 127 of the Forest Products Laboratory gives a device for making smoke to be used for testing circulation in kilns. This can be used for testing circulation in any space. It consists of two bottles held in a frame, one filled with ammonia, the other with hydrochloric acid. Air is blown into the hydrochloric acid bottle through a tube in the cork above the level of the acid. Another bent tube leads from this cork into the open end of the ammonia bottle. This apparatus may be carried on a handle without danger of fire. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A3-21. Strength of Wooden Boxes. Moisture content of wood greatly affects strength of the box. Within a week of manufacture a box made from green lumber is greatly reduced in strength. As the wood dries the nails lose their grip. After one year boxes from green lumber proved to be 1/6 as strong as similar boxes tested at time of manufacture. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A4-21. Plywood. Wood has a tensile strength in the direction parallel to the grain which is 20 times higher than the strength perpendicular to the grain. The shearing strength across the grain is much greater than that parallel to the grain. Wood shrinks a greater amount across the grain than with the grain. For the above reasons plywood is used to make a stronger product for the same weight. The desire is to obtain material which has an equality of properties in two directions. It has been shown that an increase in the number of plies results in the decrease of the tensile and bending strength, parallel to the grain but increases these at right angles to the grain. Hence when the strength should be equal in two directions a great number of plies should be employed. A large number of plies increases the resistance to splitting from screws and bolts. U. S. Forest Products Laboratory, Madison, Wis. Address Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Apparatus and Instruments B2-21. Micrometers. Micrometers for Electric Purposes. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Electric Power B1-21. Sky-Line Cables. A method for calculating sky-line cables is the subject of a bulletin in preparation by S. H. Anderson, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Electric Power B2-21. Current Suppression. Current suppression by means of parallel resonance is the subject of a bulletin in preparation by H. G. Cordes, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Foundry Equipment, Materials and Processes B1-21. Facing Sands. Experiments on Facing Sands for Molds to Reduce Chill and Eliminate Searching Influence of the Metal. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Heat B1-21. Heat Transfer. A study is being made by Mr. Christian Gierloff of Trondhjem, Norway, on the heat losses through building materials similar to the work which is being done at the University of Saskatchewan by the construction of small cubic houses of different wall construction which are heated by electric means.

Hydraulics B1-21. Hydraulic Formulas. The rationalizing of hydraulic formulas is the subject of a bulletin by C. W. Harris, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Machine Design B1-21. Victrola Device. Repeating Device for Victrola Records. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Machine Tools B2-21. Multiple Die. Multiple Die for Thread Cutting. University of Pennsylvania, Department of Mechanical Engineering, Philadelphia, Pa. Address Prof. J. J. Morris.

Welding B1-21. Electric Welding is the subject of a bulletin in preparation by Addison G. Bissell, of the Engineering Experiment Station' University of Washington, Seattle, Wash.

Wood Products B1-21. Motor-Truck Logging is the subject of a bulletin in preparation by F. Malcolm Knapp, of the University of Washington, Seattle, Wash.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Heat C1-21. Superheated Steam on Cast Iron. See *Metallurgy and Metallography C1-21.*

Metallurgy and Metallography C1-21. Cast Iron with Superheated Steam. It is desired to obtain references and results on the subject of the action of superheated steam on cast iron. Address R. Z. Hopkins, Hudson Motor Car Company, Detroit, Mich.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

T. Poole Maynard E1-21. L. E. Mallory, V. R. Waite and J. T. Nash are associated with Dr. T. Poole Maynard in geological and industrial engineering at Atlanta, Ga. Mr. Mallory is devoting his time to mechanical and chemical engineering, Mr. Waite to mining, Mr. Nash to civil and drainage engineering and Dr. Maynard to geology. The recent work of these gentlemen has been the investigation of methods of producing potash from Georgia potash slates. After laboratory investigations a plant was put into operation resulting in the production of 1000 tons of potash by treatment in a rotary kiln, resulting in the recovery of about 98 per cent potash and definitely establishing the commercial feasibility of this process.

Other investigations are being carried on for the application of American clays in manufacturing industries. By the application of simple technical control, uniform products can be prepared.

This group of engineers is prepared to make geological investigations and to care for mining and chemical operations and plants and to furnish advice to manufacturers.

Address T. Poole Maynard, Ph.D., Atlanta, Ga.

University of Washington E1-21. The Engineering Experiment Station of the University of Washington at Seattle, Wash. has issued to date the following 11 bulletins, which may be purchased at various prices varying from 25 cents to 80 cents on application to the Director of the Experiment Station:

1 Creosoted Wood-Stave Pipe and Its Effects upon Water
2 Ore Resources of the Northwest
3 Industrial Survey of Seattle
4 Mining and Metalliferous Mineral Resources of Washington
5 Electrometallurgical and Electrochemical Industry of Washington
6 Ornamental Concrete Lamp Posts
7 Multiplex Radio Telegraphy and Telephony
8 Voltage Wave Analysis
9 Coking Industry of the Pacific Northwest
10 Compressed Spruce Pulleys
11 Linear-Sinoidal Oscillations.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society.

Cement and Other Building Materials F1-21. The Effect of Organic Impurities on Concrete. A bibliography of one page giving 17 references to the effect of organic impurities when mixed with concrete. Address A.S.M.E., 29 West 39th St., New York.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Engineer Not a Good Mixer

TO THE EDITOR:

The engineer's training and duties, which call for sustained mental concentration, conspire to make him seem uninteresting or out of his element when not talking shop. Except in large cities, which support engineers' clubs and similar organizations, he finds himself more or less out of human touch even with his professional brethren. As a result of these circumstances the engineer is apt to develop a manner of reserve which not only is not wholesome but is a drag on his greater worth both to himself and to society.

How to counteract this manner and induce the spreading of a wider comradeship is a subject which may well deserve the earnest consideration of our organization. Anything that facilitates the spirit of fellowship and better understanding cannot fail, in the writer's estimation, to stimulate progressive thought and action in our ranks. OTTO H. L. WERNICKE.

Gull Point, Fla.

The Position of the Engineer in Industry

TO THE EDITOR:

Such addresses as those delivered recently to engineers by Mr. Hoover, Major Miller, and Mr. Gompers, have brought out clearly the fact that the position of the engineer in industry has really become a unique one. While enjoying the confidence of the owner of industry he has overcome some of the prejudices and gained the approval of organized labor. This recognition of the growing place of the engineer in industry by both the owner and the worker not only opens a wider field for him, but involves also a twofold responsibility.

Now that we are surrounded by changed conditions in the business world and with a definite reaction setting in against organized labor, how much of a modification will be found in the attitude of the engineering profession, and will the newly acquired responsibility fade into the background? Obviously the changed attitude of labor, prompted largely by the fear of discharge, while enabling the owner to obtain a greater per capita output and more favorable concessions, contains little of constructive value to the furtherance of real coöperation. Will not the times directly ahead of us offer fewer inducements and greater difficulties for these efforts to create a basis for real understanding?

The writer recalls about ten years ago when the efforts of the engineer to introduce scientific management into the industries were coming to the attention of the general public, that certain machinists' trade unions caused a cartoon to be circulated which was intended to arouse the worker against the efficiency movement in shops. The central figure in the picture was an extremely busy machine operator who frantically and literally spread himself between two machines. He was flanked on each side by an inquisitive time-study artist, while in large letters referring to the seat of his reasoning powers was the caption "solid ivory." While this same view may yet be had generally by workers, there is nevertheless ample evidence that the engineer's efforts have convinced many of the labor leaders of their value. But now with conditions tightening up there are many instances of cuts in the worker's earnings without due regard to the smaller drop in living costs. These circumstances are quite likely to cause the worker to feel that somehow the efforts of the engineer have made it possible for the employer to get more out of him and at a lower cost.

On the other hand, the employer has recently given evidence of opposition to the engineer's attempts in the cause of harmony The recent attack upon Mr. Hoover by a Chicago manufacturer's paper, condemning his conference with labor leaders, is a case in point. An article in the current number of a prominent industrial magazine shows one instance of the lack of appreciation of the efforts made to create shop councils and give employees a means of representation. These are clearly indications of what may be expected if the present industrial condition continues.

No one who is at all familiar with the facts can doubt the beneficial effects of the engineer in industry during the period of maximum demand just passed. But now with demand at a minimum, is the resulting clamor from both sides to deprive the engineer of the advantages already gained which would aid him in increasing the "field of common interest" referred to by Mr. Hoover? Surely it is possible to determine a definite attitude toward such matters as shop councils, employee education and representation and collective bargaining, all of which have a vital relaton to the establishment of a basis of understanding. Will it be frankness or secrecy, enlightenment or ignorance, mutual interest or suspicion and distrust, which will dominate our industries? On the outspoken opinion of the engineering profession and the attitude with which this question is met, much will depend.

It is of course recognized that there are many things to be settled in the proper development of rational industrial relations, but the basic facts can be recognized and adhered to, in spite of the reaction felt and expressed in many quarters. The training of the engineer and his habit of thought in basing judgment on facts and figures can be best put to use now when the extremists on both sides are attempting to undo a work of real constructive value. As one writer has expressed it, "They who have a big message for an anxious nation are the engineers and production experts, who are able to see that industry has a human as well as a material side."

GILBERT R. HAIGH.

Lansing, Mich.

Endorses Idea of Engineers' Official Directory

TO THE EDITOR:

I am of the opinion that an official biographical directory of the members of the four national engineering societies would supply a real need. I have often had to obtain information regarding the professional careers of various engineers with whom I was not personally acquainted, and have had much trouble and inconvenience in obtaining it. It occurs to me that some such publication as you suggest on page 30 of MECHANICAL ENGINEERING for March, prepared by the societies themselves, working in coöperation, might replace their year books once every five or ten years.

The last edition of Who's Who in America contains 23,000 names and is sold to subscribers for $6.50. Making allowance for duplicates, I suppose there would be less than 50,000 names in a Who's Who Among Engineers. With the edition twice as large as that for Who's Who in America, the total price, it seems to me, should not exceed $10, and might be materially less.

The societies already have a large amount of the necessary biographical information and competent editorial staffs to prepare it. If the matter is begun now, probably the first edition could not be issued before 1925. I should think that in that same year these societies could omit issuing their annual year books, the saving from which could be applied to this new publication. There would undoubtedly be a large sale from such a volume to libraries, advertisers and commercial interests.

I sincerely hope the project can be carried through, not only for the convenience to the members of the engineering profession, but also for the legitimate publicity that it would bring to the general public regarding the work and lives of engineers.

S. M. Woodward.

Iowa City, Iowa.

The Monotony of Repetitive Production Methods

To the Editor:

I do not believe that Dr. Moss's comment in the March issue of Mechanical Engineering on the monotony of repetitive produc ion methods is quite comprehensive enough. There are unquestionably operators, men who are past middle life, who welcome the monotony of repetitive work on account of the fact that they are sure they can perform these accustomed duties satisfactorily, and also on account of the tendency to resist any sort of change that is found among older men. Any shop foreman has had numbers of instances of this sort in his experience—men who have done one thing so long that, if put on something no harder but new, they go to pieces on the strange work. Lack of self-confidence holds many men of all ages and degrees of mentality to those things that they are sure of. It is not that they do not like variety, but they are afraid of it.

There is another type of men both young and old who are found to resist change. In this group might be included the heavy, unimaginative types, the nerveless, stolid immigrants, the Man-with-the-Hoe types, and the youths who frequently make good operatives but are incapable of further advancement. The fact of the matter is that under present production methods this type of man is entirely acceptable to employers. They are not uneasy or dissatisfied unless stirred up by some one whose business it is to do it. An ambitious, active-minded man if held down to monotonous work either gets out of it as soon as possible or frets over it, which means a dissatisfied workman, and this may mean all kinds of trouble.

If Dr. Moss desires to secure evidence of the fact that there are certain types of men who do not prefer monotony of work, let him go into the toolroom of his shop and ask each of the toolmakers—die sinkers excepted—if he would rather run a nut-tapping machine or a semi-automatic screw slotter at the same pay as he is receiving as a toolmaker. And I may be doing the die sinkers an injustice at that.

L. L. Thwing.

Columbus, Ohio.

Development of Power from Wave Action

To the Editor:

During the summer of 1919 while residing at Oswego, N. Y., the writer made frequent trips along the southern shore of Lake Ontario, where in many places the outcropping rock forms a series of ledges or shelves against which there is often rather vigorous wave action.

In favorable locations the water, after striking these rocks, would be thrown fifteen to twenty feet in the air. After watching this display on several occasions the writer conceived the idea that if the waves were allowed to enter a funnel-shaped vessel and brought to rest therein, a considerable pressure might be developed at the smaller end; and that this pressure, if means were afforded, might be used to discharge water against a considerable static head. At the particular point investigated the farm land extended down to the water's edge so that excellent use could be made of the water for irrigation. The idea in that case seemed such a practical one that a crude funnel was constructed out of some old sheet iron and anchored with stones. This gave surprisingly good results and seemed to indicate that a more elaborate structure might be justified. To make the scheme more practical, a check valve might be added in the pipe leading from the small end of the funnel and an elevated storage tank provided to receive the water if required. It was planned to construct an experimental wave pump and place it in operation the following summer, but in the meantime the writer moved from Oswego and the matter was dropped.

It was estimated that in two or three days out of each week sufficient wave action was developed to operate the pump, while it often went several weeks without rain. The writer has already considered the possibility of using such a pump to elevate a large quantity of water to a height of four or five feet and allowing this water to flow through a small hydraulic ram and lift a portion of itself to a height of 50 or 60 feet or possibly more. Its limited times of operation might be a serious disadvantage, but on the other hand it might be entirely practical in some cases. It would certainly be an interesting and inexpensive arrangement and the writer hopes that this account may be the means of encouraging some one to undertake the construction of such a wave pump.

Allen F. Sherzer.

Ann Arbor, Mich.

Calibration of Nozzles for the Measurement of Air Flowing into a Vacuum

To the Editor:

The tests summarized in Wm. L. De Baufre's paper on the Calibration of Nozzles for the Measurement of Air Flowing into a Vacuum, which appeared in the November issue of Mechanical Engineering, page 607, appear to the writer to be the most accurate air measurements ever made. He was surprised, however, after reading the description of the theory and elaborate care taken with the tests, to find such great variations in the "average percentage weight-flow efficiencies" as those given in Column 6 of Table 2. This great variation disappears if the "coefficient of discharge" instead of the "weight-flow efficiency" is worked out.

Applying the formula[1] $\Omega = 0.001042\ Q/d^2$, where Ω = coefficient of discharge, Q = capacity of the nozzle in lb. per hr. and d = diameter of the nozzle in inches, to the fourth column of Table 1, the following values are obtained for the coefficient of discharge for the 20 nozzles:

Nozzle	Values	Nozzle	Values	Nozzle	Values
1	0.971	8	0.9715	15	0.9712
2	0.971	9	0.9722	16	0.9712
3	0.972	10	0.971	17	0.891
4	0.9725	11	0.971	18	0.972
5	0.971	12	0.9715	19	0.971
6	0.9715	13	0.9715	20	0.9715
7	0.9725	14	0.9715		

The amazing consistency of these values, except in the case of nozzle No. 17, shows the excellence of Mr. De Baufre's experimental work.

John Hodgson.

Leighton Buzzard, England.

Requirements of an Industrial Appraisal

To the Editor:

We have read with interest Mr. James A. Brown's letter on Appraisal Principles Applied to Industrial Properties, which appeared in the March issue of Mechanical Engineering.

During a lengthy experience as industrial engineers and accountants we have often been shown appraisals, supposedly to assist us in our work. Without being unduly critical, we must confess we have been struck by the variety of opinions among appraisal engineers as to the values to be presented and the manner of presentation. Certainly, they cannot all be right. There must be one best form for maximum applied usefulness. Let us see if we can find it. (We speak particularly of industrial appraisals, having no intention at present of contributing to the controversies raging about the evaluation of public utilities.)

Mr. Brown states very succinctly eleven principal uses of appraisals, whether industrial or public utility, including: (1) Rate setting, (2) depreciation charges, (3) taxes, (4) insurance, and (5) financial arrangements. Let us add one more: (6) Burden distribution for manufacturing-cost determination.

Passing by, for the present, special appraisals for sale, stock issue, loans, etc., it may be interesting to many readers of Mechanical Engineering for us to recapitulate briefly the requirements which, according to our observation, an industrial appraisal should meet.

[1] Derived from Eq. 27 of Hodgson's paper on the Commercial Metering of Air, Gas and Steam, Proc. Inst. C. E., vol. cciv, part 2.

We have found that the chief need in most plants is for an appraisal which will tell the operator just where he is at: i.e., a descriptive detailing of each piece of real property and equipment, with its *origin, date, original cost in place, rate of depreciation and present condition.* The appraisal schedules should present all these, so that each item may later be transcribed on a card, thus initiating a flexible and permanent equipment record. A schedule should include only one class of equipment, as buildings, machines, shafting, etc., much as such items would be classified in the ledger accounts. A total replacement value for each schedule should be given. Moreover, each schedule should be paragraphed and subtotaled by manufacturing departments, buildings and floors.

Total values should be summarized in three ways: by schedules (or ledger accounts), by departments (building space being prorated among these) and by insurable and non-insurable values. The first two, of course, present invested capital; the last, replacement values.

Unless equipment is already numbered, a system of identifying numbers should be used and key drawings made, linking the items listed in the schedules with their location in the plant.

Now, an appraisal so detailed and so arranged, with all values based primarily upon original investment, supplemented by general replacement costs, will serve all the aforementioned purposes. For it will set forth the present state of invested capital for determining net earnings; the amount of annual depreciation of each class of equipment; the insurable values; and the amount of investment in each manufacturing department.

Then, too, as a basis for financial statements, such an appraisal ould carry far greater conviction than a mere generalized estimate of operating worth.

Moreover it is economically stable, based as it is upon invested capital; as, for example, is the computation of excess profits tax by ruling of the Treasury Department; and (rightly or wrongly) of public-utilities rates by the various rate-setting bodies. Upon it may be erected any temporary superstructure demanded by shifting dollar values and the like; but in itself it is like a bank account, which reflects money paid in for years, with corresponding withdrawals. Interest is paid on the balance in dollars, whether these will buy forty cents' worth or a hundred.

Morgan G. Farrell.[1]

New York, N. Y.

The Latin-American Situation Regarding Weights and Measures

To the Editor:

Carrying out the policy of the Society in encouraging discussion of papers presented at its meetings, I give below certain information recently secured relating to weights and measures in use in Latin-American countries and which corroborates that in a paper given two years ago before the Society.

Persistent statements, unaccompanied by facts, have been extensively circulated throughout the United States, tending to controvert the paper in question.

Several years ago the results of an investigation of the conditions regarding weights and measures existing in Latin America were brought to the attention of the A.S.M.E. Committee on Weights and Measures. This investigation had been made in order to obtain information as to what weights and measures were being used in South American countries, as to how far compulsory metric legislation had been effective in supplanting existing systems, and as to what degree confusion had resulted from an attempt to make the change to the metric system.

The sources from which they were received, as well as the representative character of those making reply, were believed to be of such a nature as to merit giving a résumé of those facts. The questions were submitted through the National City Bank of New York, the United Fruit Company, the *American Machinist*, and W. R. Grace and Company. The replies were tabulated and presented to the A.S.M.E. at the Annual Meeting, December 1918, and are to be found in Vol. 40 of Transactions, page 773.

[1] Director of Construction and Appraisal, Miller, Franklin, Basset & Co.

This investigation tended to show that after more than half a century of effort the old systems of weights and measures had not been eradicated, but instead had saddled an additional system on to what already existed, resulting not only in the expense of attempting to make the change but in augmented confusion following the attempt.

Corroboration of this has recently been received from what seem authoritative sources which it will be of interest to publish. The paper above referred to, Mr. Halsey's, was taken up for discussion by a metric advocate, who urges still further legislation to force the metric system on South America, apparently recognizing the failure of the efforts so far made in that direction, and admitting the present chaos resulting from the extensive use of other systems mixed with the metric system in those countries. The gentleman is Senor Carlos Basadre, of Lima, and his findings are published in the June 1920 issue of the *Bulletin of the Society of Engineers of Peru.* Referring to the paper, Senor Basadre says:

> Mr. Halsey's argument is manifestly powerful and based on demonstrated facts, and not merely on theoretical considerations. Without attempting to pass judgment on the advantages and disadvantages resulting from the adoption or rejection of the metric system as the single standard of weights and measures in the United States, let us consider some of the facts established by Mr. Halsey, the failure of the metric system in South America, and the idea that the old Spanish system can be brought into uniformity with the English system.....
>
> Latin-American countries adopted some time age the decimal- metric system; but, with the exception of Uruguay, contented themselves with recognizing it officially without troubling themselves at all to familiarize the mass of the population with its use little by little by means of an active and constant propaganda.....
>
> It can be stated that the official intervention alone has been effective, and this in an intermittent manner at such time as the confusion caused by the use or abuse of heterogeneous weights and measures has created a pernicious situation actually alarming.
>
> What has really happened is that the metric system has become mixed, sometimes more, at other times less, with the old Spanish system, with some English measures, and with the native measures, forming a heterogeneous conglomerate, which can be classified as a third system, peculiar to each country. If this chaotic state has been able to persist up to the present time, it is precisely because in the last analysis it has been the metric system that has always intervened to resolve all the uncertainties and confusions (translated from the original.)

The metric system was made legal in Peru in 1862. In 1869 an executive decree made that system compulsory for public business, and in 1920, fifty-eight years after the law was enacted, the results are as stated by Senor Basadre.

Mr. W. Graham Clark, Special Agent of the U. S. Dept. of Commerce, after several years' investigation of countries in Latin America, names in his reports the systems of measurement in nine of those countries, which he personally visited, and in every case he confirms the findings in the A.S.M.E. paper.

Mr. A. Hyatt Verritt, in a book entitled Getting Together with Latin America, states that he lived many years in those countries and names the systems of weights and measures of eighteen of them; he, with but one exception, confirms the statements of the report.

Mr. V. L. Havens, editor of the *Ingeneria Internacional,* who has had personal experience in most of the Latin-American countries, especially in the purchase of lumber, reports that the metric system is not used to any appreciable extent in the lumber industry, the English and Spanish systems being practically universal.

In *Commerce Reports* for April 21, 1919, in a summary of the various Consular Reports in which particulars are given of the weights and measures used in seven Latin-American countries, there is again a corroboration of the statements in the A.S.M.E. paper. The complete Consular Reports on this matter are now being studied and will be the subject of a later report, but it can now be stated that they fully bear out the statements which have been made as to the difficulty of making the change and the confusion resulting.

Shortly after the beginning of the World War, Mr. O. P. Hood made an investigation of the situation in South America as regards the machine industry. Mr. Hood, who is familiar with both the Spanish and Portuguese languages, spent eighteen months in the South American countries, and as a result of his investigation reported that 39.3 per cent of the machine tools there in use are of American make, while 43.2 per cent are British, leaving a remainder of only 17.5 per cent from possible metric countries. This

shows a preponderance of nearly 5 to 1 in favor of tools made on the inch basis in spite of the fact that Germany had during the prewar period an extremely energetic organization for selling and financing in those countries, and it is believed that German influence was largely instrumental in inducing them to enact legislation favorable to the metric system, such as would work into the hands of German interests.

As Chairman of the A.S.M.E. Committee on Weights and Measures, I would welcome any further information giving the actual facts regarding conditions affecting weights and measures in Latin America.

Luther D. Burlingame.

Providence, R. I.

Details of Diesel-Engine Clutches Used in German Submarines

To the Editor:

At the Philadelphia Navy Yard there is a large ex-German Submarine, the U-140, I believe. Last fall when the navy yard was thrown open to visitors for the benefit of the Naval Relief Association, I went aboard this vessel and was much interested in her

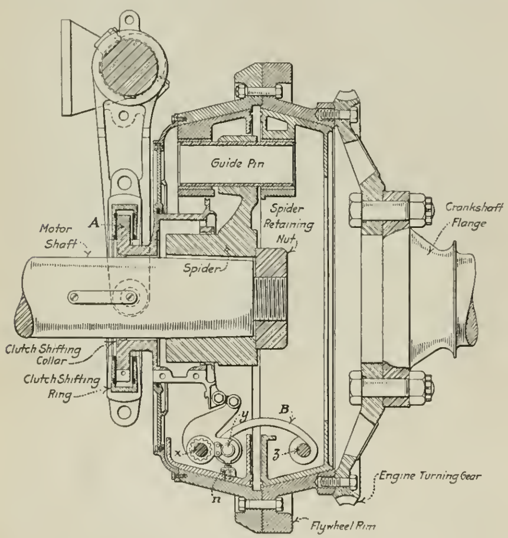

Fig. 1 Sectional View of Clutch

machinery; but what most attracted my attention was the clutches, which were very small for such powerful engines—Diesels, eight-cylinder, 21 in. bore by approximately 28 in. stroke as nearly as I could estimate.

These clutches may possess some very desirable features which would prove of value to our industries. Has the Society any information regarding these clutches or can it be obtained? Any information upon their design will be highly appreciated.

Marmaduke M. Wills.

Fitchburg, Mass.

[The foregoing letter was referred to Lieut-Comdr. Mark C. Bowman, U.S.N., Washington, D. C., who has very courteously supplied the desired information, based on drawings made by the Navy Department. Shortly before the close of the war Lieutenant-Commander Bowman gave a talk on the development of submarine Diesel engines before the Washington Section of the A.S.M.E. in which he showed intimate knowledge of the many details of design and construction. His communication relative to the clutch is given below.—Editor.]

Main Engine Clutches for German Submarines

To the Editor:

A general inspection of surrendered German submarines has indicated that engines for these vessels were of four standard sizes. A 10-cylinder 3000-hp. engine was built for installation in large cruiser submarines. A number of these engines were found in the shops ready for installation at the time of the signing of the armistice, but only one pair was installed in a boat, the U-142, which performed no active war service. Six-cylinder 1750-hp. engines, similar in cylinder dimensions to the 3000-hp. engine, were installed in the U-135, 136, 139, 140 and 141. A large number of 1200-hp. six-cylinder engines were installed in operating submarines and gave excellent service throughout the war. A fourth size, of 530 hp., six-cylinders, was found in late types of mine-laying and coastal boats.

The clutching device for connecting the engine and motor shafts is of special interest in view of the history of such devices in general and has led to numerous inquiries as to its construction. The same type of clutch was installed with each size of engine.

The clutch is of the double-cone friction type, of semi-steel and

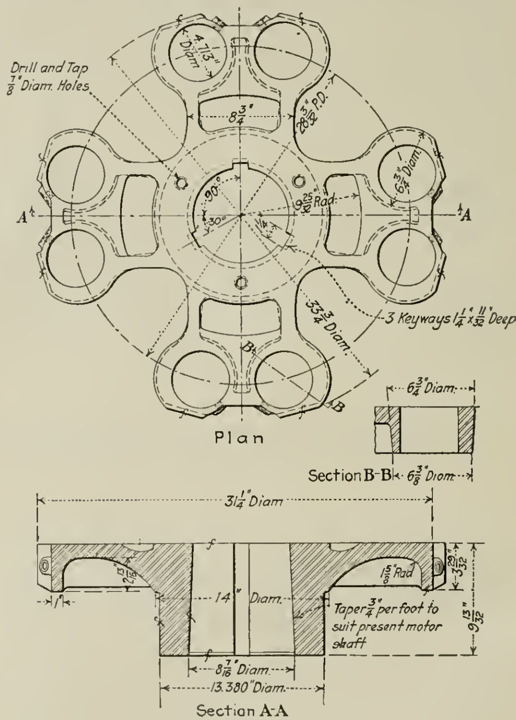

Fig. 2 Clutch Spider

cast iron, operated by air except in the 530-hp. size, which is operated by hand through worm and gear.

The outer casing or female member, which serves as the flywheel, is carried on the engine shaft. This casing, as shown in Fig. 1, is made in two parts bolted together with the inner surfaces machined to cone surfaces, the cones base to base.

The male part is attached to the motor shaft by three keys and a retaining nut, carrying a flange or spider in which are fixed eight large guide pins parallel to the shaft axis and extending through the spider on either side as shown in Fig. 1. Two inner clutch cones are carried on these guide pins, on which they here a sliding fit. They are of semi-steel and their outer or peripheral surfaces are finished to conform to the inner conical surfaces of the female or flywheel part.

In Fig. 2 are detail sketches of the spider and in Fig. 3 are details of the two male cones carried by the spider. These cones are alike except that stops are cast on the after cone (the cone nearer the motor) to limit the travel of the operating collar, as shown at X in Fig. 3.

The machined surfaces of the inner cones, Fig. 3, have oil grooves which insure that when unclutched or disengaged a complete film of oil will fill the clearances between the cone surfaces. The gradual squeezing out of the oil film as the surfaces are forced together enables the clutch to be thrown in when the engine is running.

The clutch is thrown in by forcing the inner cones apart until the male and female cone surfaces engage; and by drawing the cones together and thus releasing the surfaces the clutch is thrown out. The inner cones are drawn together or forced apart by a series of links and toggles actuated by a sleeve (A in Fig. 1) sliding on the motor shaft.

Referring to the lower half of Fig. 1, the center x is shown fixed to the forward cone and center z to the after cone. The clutch is engaged by separating centers x and z by forcing center y down to a line joining centers x and z. An adjusting cam around center x provides adjustment for wear in cones and bushings of the operating gear.

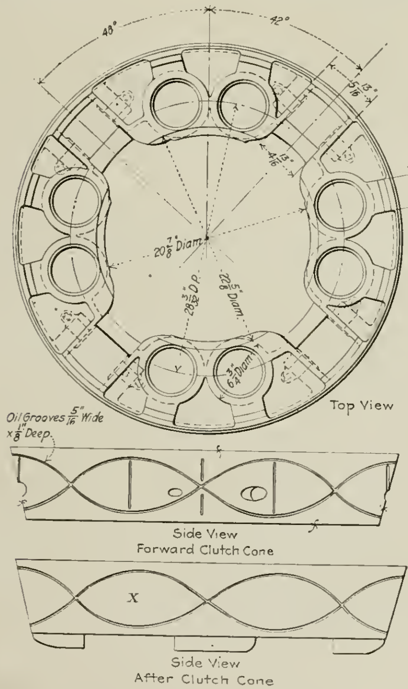

Fig. 3 Details of Clutch Cones

It will be noted that the forward link member B joining centers y and z (Fig. 1) is a steel leaf spring and that a further downward movement of center y against the stop n tends to decompress the spring slightly and to lock the mechanism. This spring is an important element in the mechanism. It is of chrome-vanadium steel with a tensile strength (annealed) of 80,000 lb. per sq. in. and an elastic limit of 50,000 lb. per sq. in. (annealed). It is heat-treated and quenched in oil.

There are four of these sets of operating links equally spaced and placed between pairs of pins in the blank spaces of the spider, Fig. 2.

Fig. 4 shows the clutch in diagram for the 1200- and 1750-hp. sizes, noting the principal dimensions, as also does the following table. No data for the 530-hp. and 3000-hp. clutches are now available.

Horse-power of engine	R.p.m.	Largest diam. revolving part, in.	Cone angle, deg.	Cone diameter, in. max.	min.	Area of friction surface, sq. in.	Crank-shaft diam., in.
1200	450	49-3/16	14	39-5/8	35-15/16	1765.112	9.453
1750	380	49-3/8	14	43-1/16	37-15/16	2608.297	11.219

The operating gear of the clutch used with the 1200-hp. engine consists of a double-acting air cylinder mounted on the floor just inboard of the clutch and connected to the ship's air line under 100 lb. pressure. The piston of the air cylinder drives a crosshead to which is attached a lever, the other end of which is keyed to a shaft supported by a fixed bracket above the clutch. The shaft leads over the clutch and drives a lever leading downward and end-

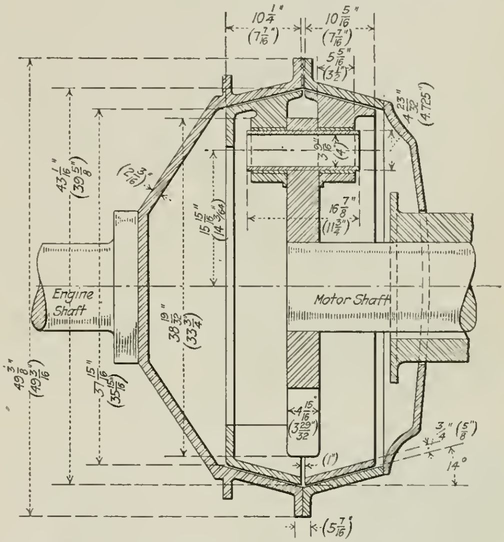

Fig. 4 Principal Dimensions of Clutches
(Dimensions in parentheses are for clutch for 1200 b.hp. at 450 r.p.m.; others for clutch for 1750 b.hp. at 380 r.p.m.)

ing in a fork end or yoke attached to a ring around the sliding collar which operates the clutch.

Assuming that the pressure of the air cylinder builds up to 100 lb. per sq. in. before the operation of clutching is complete and that maximum normal thrust in the cones is obtained when center y is 1 deg. above the line of centers x and z (Fig. 1), the following data are found:

Area of operating cylinder = 18.665 sq. in.
Force on crosshead = 100 × 18.665 = 1866.5 lb.
Force on operating collar through levers = 3732 lb.
Resolved force at center y normal to line of centers, = 1925.2 lb., which produces an axial thrust on each cone of 1925.2 tan 1° = 110,012 lb.
Normal thrust = 110,012 × sin 14° = 26,621.9 lb.
Total normal thrust per cone = 4 × 26,621.9 = 106,448 lb.
Friction area of each cone = 882 sq. in.
Unit pressure = 106,448/882 = 120.7 lb.

Referring to the engine itself,

B.hp. of engine = 1200; r.p.m. of engine = 450
K = coefficient of fluctuation of turning moment = 1.6 for 6-cyl. engine.
M = maximum turning moment of engine in in-lb. = $\frac{1200 \times 63{,}000 \times 1.6}{450}$ = 168,000 in-lb. × 1.6 = 268,800 in-lb. Assuming now that
N = total normal pressure on cones; R = mean cone radius
f = coefficient of friction; $N = M/fr$; $f = M/Nr$

then $f = \frac{268{,}800}{106{,}488 \times 18.89} = 0.133$ (coefficient of friction for steel on iron, freely lubricated).

M. C. Bowman,

Washington, D. C.

MECHANICAL ENGINEERING

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The Opportunity of the Engineer

Dexter S. Kimball

The ease and promptness with which the public as a whole becomes accustomed to and takes advantage of the work of the engineer, using the term in a broad sense, is almost startling. Surprise at and fear of radical innovations in transportation and private service quickly give way to blasé indifference followed instantly by all manner of criticism that these things are not better constructed and managed.

Little outbursts of criticism should not be construed (as they are by some people) as indicating a lack of appreciation of the work of the engineer. They are an integral part of the influences that make for progress. The world in a way has always obtained as much engineering talent as it demanded. It is true that the engineer and inventor have had a tremendous influence in changing man's environment and in making this old earth comfortable and more habitable; but it is also true that these same engineers are, to a large extent, products of their own surroundings; and much of their progress has been made by supplying wants created by the public.

If the engineer has not been appreciated as much as some other classes of men, it is because his service to humanity has not been the highest. The men who render the greatest service to any nation are those who mold its *ideals*, and the philosopher and the poet will continue to wear the bays as long as they lead in this line. True, the work of the engineer has made it possible for us to realize more fully our ideals if we could only take full advantage of the productive processes which he has developed and the leisure that should result therefrom; for every day makes it clearer that highest mental and moral development rest primarily on material prosperity. It is difficult to be high-minded and hungry at the same time.

The engineer most naturally applied his scientific method first to constructive engineering and it has become second nature with him to collect data, to analyze the same and to plan work and predict results on this solid basis. But the administration of modern industry has come to require a considerable knowledge of constructive art, and the natural tendency to seek a solution of the problems of administration on the basis of accumulated knowledge rather than on an empirical basis has made an opportunity for the engineer that has carried him far afield and brought him closely in touch with the administrative side of both private and national affairs. To this new field he has quite naturally brought the analytical methods of his calling, and the art of management bids fair to be placed on a much more rational footing because of his labors in this new field of activity. *Compilation, analysis, prediction,* are the methods he is employing, and stripped of all its technical terms and high-sounding titles so-called Efficiency Engineering or Scientific Management and its correlated branches represent an effort to raise business management of all kinds from the vague empirical basis on which it now rests and place it on a scientific footing comparable with constructive processes. The progress which this movement makes will, as before noted, depend not on the effectiveness of these methods alone, but on the reactive influences which it meets with or awakens. Efficiency is not the sole criterion by which industrial phenomena are to be finally judged. Whether we will it or not, industry is being looked upon more and more as a means of supporting human existence and less as a means of creating individual or corporate dividends. The most efficient kind of factory for the creating of dividends would be equipped with the highest order of labor-saving machinery and management and operated by slaves. And as we move farther and farther away from this extreme ideal so we will become more and more critical of processes and methods of production. It is going to be a nice problem in social and political organization to reconcile the many conflicting reactions, and the full import of the movement will be more and more appreciated as our natural resources become more depleted and the struggle for existence becomes keener.

The influence of this new study on the engineer himself will be far-reaching; for he must draw his basic facts for this work not only from his own field of engineering but also from economics, accounting, psychology and other sciences which heretofore he has known little or nothing about, or has ignored. And this has brought him very close to the pivotal problem of our civilization, namely, the fair and equitable distribution of the wealth which he is so instrumental in creating. If he can master the fundamental truths that lie at the bottom of the problem or if he will have the wisdom and foresight to call to his aid the masters of thought in these lines, it is not beyond reason to hope that as he has conquered the problems of production and is now conquering the problem of administration he may evolve from his riper experiences in these fields a solution of the remaining problem which will be satisfactory to all. It is apparent that the solutions already offered fail to satisfy; but it by no means follows that these are the only possible solutions any more than the old methods of management were the only ones possible. In fact, as we look back even a few years the philosophies of engineering and manufacturing as then practiced seem very inadequate indeed; and the theories of management of yesterday are rapidly passing into obsolescence. We are sadly in need of a new type of industrial philosophy and new methods of distribution. We are in need of a new type of industrial leader; and I believe that if he comes at all in the near future he will come from the ranks of the industrial engineer, using the term in the broadest sense. It is true that other classes of men are familiar with and use the engineer's methods, but he is going to have a particularly advantageous position from which to attack this problem, for the near future will see him a dominant figure in industrial management where he will meet the problem at first hand. Here is his opportunity. It is hardly likely that any one man will be able to solve this difficult problem, and if it is solved it will probably be the work of many brains. But the man who first points out the way to a solution will not need to envy any man his glory, for posterity will surely place him in the ranks of the immortals.

I have every confidence that the engineer will rise to this opportunity and there are many signs that these ideas are stirring in the minds of forward-looking engineers. It is with no small gratification that we all see the elevation of our past-president James Hartness to the gubernatorial chair of his own state, and see Mr. Hoover, an engineer by training and experience, a member

of the cabinet of the new administration. These are pioneer workers in a field where the lawyer and the politician have long reigned supreme, and their stewardship will be watched by all engineers and others with great interest. It is an auspicious beginning that should hearten all who believe in the application of scientific methods to all problems of human existence.

Dexter S. Kimball.

A Place for Non-Scientific Management

Ralph E. Flanders

THE problem of organizing a large machine shop is naturally solved in different ways for different conditions.

For the manufacture of a single product on a large scale—an automobile chassis, for instance—the shop is usually departmentalized according to its product, particularly where the output is great enough to permit continuous production in most of the operations. Thus there will be a department for camshafts and crankshafts, another for rear-axle bevel gears, another for transmission gears, etc.

At the other extreme, where there is a wide variety of product in varying quantities, the usual scheme has been to departmentalize the factory along the line of processes. Thus there will be a milling department, a drilling department, a grinding department, etc., common to all the various products. These are often combined with separate heavy machining and assembling departments, each devoted to a special product.

There is a third method, not often followed, which has decided advantages for the shop manufacturing a limited line in quantities which do not vary too widely. This consists in dividing up the plant into separate departments, one for each of the products and each practically complete in all of its details for the manufacture and storage of parts and for their assembly into completed machines.

At first sight such a solution seems like a backward step, but its advantages become more apparent on study and particularly after actual trial. Our modern methods of management have become absurdly complicated and topheavy, but the proposed method remedies the evil by simplifying the problem. Among other advantages it affords the following:

The entire parts manufacture for a product can be concentrated in one department, eliminating interdepartmental correspondence and friction.

A recurrent routing program can be established, free from the interruptions of other products, so that routing is standardized instead of being in a chronically unsettled state.

Machines may be placed in the general order of the operations and the whole department located beside the stock room, which in turn adjoins the assembling department. Thus trucking and the supervision of widely scattered parts are greatly simplified.

To sum up the possibilities, it may be said that the whole scheme of management may be so arranged that *reference is made to the work itself*, moving in its appropriate channels, instead of to cards or other records. These are often inaccurate and always expensive, and are usually located in some quiet spot far from the scene of action.

It is unnecessary here to go into the various arrangements required to maintain proper relations with other divisions of the work, or for taking care of the unescapable breakdowns of machines and systems. These problems are, in fact, less serious than with more complex schemes of organization.

My faith in the plan is based on my belief that a few ordinary mortals with energy and fair ability can handle separate divisions with success where the work is so arranged that it can be touched by the hand, seen by the eye, and comprehended by the brain; and that the same men will work much less effectively when handling interdependent departments, run by a system of reports and records, even though presided over by a harassed superman of a scientific manager.

Ralph E. Flanders.

The Engineer Cabinet Member

IN placing Herbert Hoover in nomination for the presidency of The Federated American Engineering Societies at Washington, Dean Kimball said that at Leland Stanford University, when Hoover was a student there, it was recognized by those who knew him that "here was a man who would go very far and achieve much in whatever field of activity he might be placed." Mr. Hoover's entry into the Cabinet is but another step in the fulfilment of that prophecy—a step which will be especially gratifying to all engineers in every country of the world.

For Herbert Hoover belongs not exclusively to America, but, in a peculiar sense, to the whole civilized world. He has not been chosen for this new honor simply because he is an engineer, but because of his demonstrated capacity for rendering service of an exceptional character. In short, because he is Herbert Hoover, unselfish, devoted organizer and director of the world's greatest benefaction, preeminent preserver of human life and of faith in human nature.

His fellow-engineers will rejoice in the fact that added to his personal and natural ability have been the training and experience of the engineer with the habit of a clearly defined objective, of marshaling all possible forces of personnel and matériel for the attainment of that objective and directing them in such manner as to secure the hearty, whole-souled devotion and coöperation of myriads of men and women.

His recognition is not based upon partizan political service, past or prospective, but upon the world's conviction that this engineer possesses in preeminent degree the ability to perceive what needs to be done and to organize and direct the means of doing it. Especially have the newly enfranchised women of the country insisted that his genius should be enlisted in the service of the people, and in this they have shown an ability and disposition to recognize genuine service to humanity and to the social order which must be reckoned with by those who in all future times may endeavor to guide political affairs.

By tradition our public offices have been filled mostly by men whose training has been in the law. There have been many good reasons for this, but the time has come when the constructive and directing ability of the engineer is required for the solution of our present-day problems, which are largely brought about by changes in our manner of life resulting from the work of engineers. It seems certain that in greater and greater numbers engineers will be called to serve the people in public office.

Mr. Hoover has set his own high standard of public service and his responsibility to the public will be correspondingly great. We may be sure that his only conception of rendering real service to the administration of which he is a member will be to render a real and genuine service to the people of the country, without regard to partizan considerations.

Whether or not Mr. Hoover is to be followed by a long line of engineers in high and responsible official positions, depends now far more upon him and how he shall conduct himself during his term of office than upon anybody or anything else. His responsibility on that score is to the engineers not only of the United States but of the entire world, all of whom are familiar with his achievements and know that they will be themselves appraised more or less by the degree to which he is successful. Fortunately, no engineer will for a moment doubt that this responsibility also will be most faithfully and competently discharged.

Fred J. Miller.

The Unstabilized Dollar and Efficient Management

THE most striking feature of Professor Irving Fisher's address, How an Unstabilized Dollar Interferes with Efficient Management, at the Springfield, Mass., meeting of the Taylor Society, was the response of the audience of practical plant executives and industrial engineers. It was evident that those who are charged with managerial responsibility in industry have come to appreciate that here is a problem which should no longer be classed as merely "academic." The responsiveness of the audience was no doubt in part due to Professor Fisher's great ability as a speaker

—he is unexcelled in clear and interesting presentation—but it was also due to the timeliness of the discussion. One who has just come from the painful task of writing off inventories following the violent price fluctuations accompanying the change from a sellers' to a buyers' market, is ready to consider as practical and urgent the question whether defects in the monetary system may not be in part responsible—and may not be remediable.

Professor Fisher's discussion followed the well-known and unexcelled four-part outline usually employed by the late Professor Sumner. In answer to the question, What is it? the attention of the audience was called to recent general price fluctuations as evidenced by that new instrument of precise measurement, the index number. In answer to the question, What causes it? the author called attention to the fact that in the United States the value of a dollar is the value of 23.22 grains of gold, and that as the quantity of gold and media of exchange based on gold, including credit tokens, increases in volume, more gold and therefore more dollars will be offered for other commodities (higher prices), and that as the quantity of gold and media of exchange based on gold decreases, less gold and therefore fewer dollars will be offered for commodities (lower prices). In answer to the question, What of it? Professor Fisher reminded the audience of the unwholesome, feverish business activity which results from violent increases in general prices, the stagnation resulting from the uncertainty accompanying violent decreases in prices, the losses to recipients of fixed income—bondholders and salaried persons—in times of price increases, the losses to owners of businesses—stockholders and farmers—in time of price declines, and in general the unfavorable influence on establishing and carrying forward managerial plans in the face of price changes one way or the other. Taking up last the question, What are you going to do about it? the speaker explained his own proposition for stabilizing the dollar and argued that as a practical problem of establishing a better environment for promoting stable conditions for good management the business community should encourage the legal adoption of it or of an equivalent method of solving the problem.

Professor Fisher's plan is to change the law, so that instead of a dollar always having the value of 23.22 grains of gold, the amount of gold which shall have the value of a dollar shall be periodically automatically changed as *general* prices change, as measured by the index number; as prices tend to go up, more gold, as prices tend to decline, less gold, shall have the value of a dollar. The result would be to maintain the quantity of dollars to be offered for commodities stationary, even though the quantity of gold might change. In that way, Professor Fisher believes, *general* prices can be kept fairly stationary. And stable general prices will create a better environment for administrative and managerial plans and activities—a better opportunity for developing generally more precise and therefore better management.

It is essential that business executives and engineers give more thought to such problems. Their traditional attitude is to consider outside their range of interests a study of the social forces which determine the limits of their managerial activities. Unfavorable social conditions they consider "acts of God" which may not be influenced and to which they must submit. They are as a matter of fact generally the acts of men.

The reaction to Professor Fisher's address gave evidence that engineers and executives are showing a greater interest in general economic problems and a disposition to bring their influence to bear on stabilizing the conditions under which they must conduct their business activities. H. S. Person.

San Francisco–New York Mail Delivery and the Railroads

The recent success in delivering mail from San Francisco to New York by aeroplane in less than 34 hours is of considerable interest, not only in aeronautics but in relation also to railroading.

Beginning 20 years ago, and up to the time of the war, vigorous efforts were made to increase the speed of passenger and mail transportation by rail. In Europe the effort was directed to determining the maximum possible speed of transportation with electric locomotives, and in tests at Zossen, Germany, a speed of 200 kilometers (124 miles) per hour was attained. The requirements of operation, however, were so severe as to show the utter impracticability of such speeds for regular traffic, especially when of transcontinental character.

In America the steam locomotive was relied upon to give the fastest possible transportation, but as early as 1910 there began to be the feeling that we had very nearly reached the limit of speed compatible with safety, and that the disturbance to regular traffic occasioned by these fast trains more than offset any advantages which might accrue. This feeling found expression in the addition of two hours of traveling time to the crack New York Central trains between New York and Chicago.

It costs money to lop off even one hour's time between New York and Chicago; and it would cost proportionately more to reduce the time, say 10 hours, between New York and San Francisco, involving as it would a large permanent investment for improvements in roadbed and roadbed equipment, additional trackage at stations, etc.

As long as rail transportation was the only means available for transcontinental traffic there might have been good reasons for going to such expense, but the wisdom of such a course becomes more and more doubtful with the development of aerial service.

While as yet the aeroplane and dirigible are far from being competitors of the railroads, there is every reason to think that one or both will become so for long-distance high-speed mail and passenger traffic, just as the motor truck has become a competitor in short-haul freight transportation—and this within a very few years. This is all the more to be expected from the fact that the demand for high-speed traffic over long distances is at present comparatively small in volume.

The fast letter mail has already been practically taken off the ground. An interesting example of what is being accomplished by the mail service as now established is the reported receipt of a letter at the Engineers' Club, New York, 50 hours after it was mailed at Los Angeles. This letter traveled by aeroplane by day and by train at night, apparently via Omaha and Chicago.

In case the appropriation should be forthcoming, the Post Office Department is stated to have plans for a regular 36-hr. service from San Francisco to New York on the strength of the showing already made.

It will very likely take a good deal longer to lift off the ground the high-speed passenger traffic, but there is scarcely any doubt that this is coming, and, this being so, it does not seem likely that the railroads will ever incur the heavy investment and expense of operation that would be required to cut even half a day from the time between New York and San Francisco, when the chances are that air transportation would cut off two days.

There also looms in the distance the possibility that by utilizing the high-velocity winds apparently ever present at great altitudes, the transcontinental timetable may become a matter of hours rather than of days. It was whispered last fall that the War Department would try during the coming summer a dirigible trip from San Francisco to the Atlantic Coast to follow a trail, say, 30,000 to 35,000 ft. high, with the expectation of making the trip within the scarcely believable time of 10 hours from start to finish.

Progress Report on Superpower Survey

A report submitted late in February to President Wilson by John Barton Payne, Secretary of the Interior, outlines the work which has already been accomplished and indicates what is yet to be done by the Geological Survey in its study of methods for the further utilization of water power and the special investigation of the possible economy of fuel, labor, and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries.

An engineering staff, with William S. Murray as chairman, assisted by an advisory board of business and professional men, of which Prof. L. P. Breckenridge is chairman, is making a thorough study of the problem in its physical, legal and financial aspects. An editorial outlining the plan of study, describing the field, and naming some of those engaged in the work, was given in the November 1920 issue of Mechanical Engineering, p. 642. It is believed that the complete report will be available in July.

The Material-Handling Problems of Ports

Interesting Meeting Held at Newark Under the Auspices of the Materials Handling and Metropolitan Sections of the A.S.M.E.

THE Materials Handling Section presented a program under the auspices of the Metropolitan Section at a meeting held in Newark, N. J., on the evening of March 4, 1921. Following dinner at the Robert Treat Hotel, about 700 members gathered at the Public Service Terminal Building to hear a series of papers devoted to a discussion of the material-handling problems of port operation. The first paper was presented by B. F. Cresson, Jr., chief engineer, N. Y., N. J. Port and Harbor Development Commission.

Mr. Cresson presented the fundamental considerations in the development of a port, upon which the remainder of the program, relating particularly to the use of material-handling apparatus and methods, was built.

Mr. Cresson pointed out that a world-trade port should be able to handle great volumes of business and great varieties of commodities. A great port should comprise a protected deep-water harbor, a substantial length of waterfront, a hinterland of industrial importance, a system of railroad and inland waterway connections to a large producing territory, a good labor market and an appreciation by the political government of the necessities in the layout, ownership and administration of the port facilities. A form of port administration should direct the growth and operation of the port, making it as cheap and easy as possible for commerce to enter and to leave, not seeking to obtain high revenue from the operation of port facilities, but developing them and using them rather as a means to build up the territory tributary to the port. There must be facilities for the handling of bulk commodities and there must be the necessary equipment for the handling of the miscellaneous package freight.

The problem that the port engineer is usually confronted with is the layout within an operating port district of terminal facilities that will best coördinate the transportation lines, both land and water, centering at the port, and in so doing to create a district in which business may expand. Mr. Cresson spoke of the zoning of ports, first, by the segregation of large commodity business, and second, by the segregation into separate districts of business in principal trade routes.

In the development of a port there must be considered, first, the proper location of the terminals; second, the physical layout of the terminal facilities; third, the equipment of the terminal facilities; and fourth, the administration and operation of the port as a whole. The layout of a terminal should depend upon the character of business to be handled, the ships and other craft that are to dock there, and the location of the railroads and highways. These factors affect the width and height of the piers, the placing of tracks, the building of sheds, the width of slips, etc. In some instances the quay system is superior to the pier system. In any case a port must be made up of many different parts, and these should be coördinated not only in their location, design, layout and equipment, but also in their general administration and operation.

The speaker pointed out the importance of the Port Newark Terminal and emphasized the possibility of the construction of a modern terminal that will develop industries and permit rapid and cheap interchange of freight between rail and water carriers.

Treating the subject of Machinery for Cargo Handling, J. A. Shepard, vice-president of the Shepard Electric Crane & Hoist Co., outlined the development of devices for moving cargo in and out of the holds of ships, indicating the limitations which the necessity of stowing away cargo by hand power imposed and discussing some types of pier machinery. Mr. Shepard made a plea for the development of smaller but more efficient terminal units, thoroughly equipped with mechanical apparatus giving efficient results and large output per unit.

E. Logan Hill, of Heyl & Patterson, Inc., in discussing Car Loading and Unloading Machinery, confined his remarks to apparatus suitable for handling miscellaneous package freight from box and open-type cars to platforms, piers, lighters, and steamships.

Mr. Hill traced the progress in the manner of unloading such material from cars, through the steps of hand labor and hand-operated derricks, steam locomotive cranes, to specially designed electrically operated cranes. Three distinct types of electric cranes were mentioned as satisfactory for this work. These are, in the order of their efficiency and first cost:

1 A steel gantry structure, spanning one or more tracks and having mounted thereon apparatus which to all effects and purposes is the same as the locomotive crane without the boiler and steam engine, the motive power for hoisting the load, rotating the crane and luffing the boom being supplied by one motor with a multitude of clutches, brakes, brake bands, gear levers, etc.

2 The so-called straight-line crane, which consists of a tower structure and a boom which in operating position is held in a horizontal plane and has no provision for working at any other angle and is incapable of being rotated about a central point.

3 The full-arch or semi-portal traveling revolving jib crane.

The speaker then went on to discuss a typical installation of an open-type railroad pier approximately 1000 ft. long and 80 ft. wide, on which were placed a number of parallel tracks. Eight steam locomotive cranes were replaced by four traveling full-arch revolving jib electric cranes having separate motors for each of the several movements such as hoisting, rotating and traveling. The maintenance charge of the eight locomotive cranes for twelve months was practically $34,000. The four electric cranes which replaced the locomotive cranes had a maintenance charge of $7500 after they had been in service for nearly four years. The four electric cranes actually handle more material than was ever handled by the eight locomotive cranes. They require 14 less men, which, taken into consideration with the increased amount of material handled, resulted in a total saving per annum of approximately $45,000.

The portal structures of these cranes are designed so as to span two railroad tracks, their movement up and down the pier is entirely independent of any switching movement, and their booms are of such length that they can reach any car on any one of the five tracks of the pier.

In concluding the discussion, R. S. Parsons, general manager of the Erie Railroad, called attention to the great importance of coöperative action on the part of the people of New Jersey in the development of a port of New Jersey. He contrasted the action in New York, where three counties are combined under one specific head, with the situation in New Jersey, where some 15 separate municipalities are struggling with jealousies and petty problems and the great problems are ignored.

Between the presentations of the papers reels of moving pictures of New York Harbor and of Newark Bay were shown.

Four Test Codes for A.S.M.E. Spring Meeting

A.S.M.E. Codes must be presented for adoption by the Society at a regular meeting. A feature of the Chicago Meeting will be a session devoted to the consideration of the proposed Power Test Codes on General Instructions, Reciprocating Steam Engines, and Evaporating Apparatus. This session will be in the nature of a public hearing, and every one who is interested in these Codes or in any one of them is invited to be present and take part in the discussion. The Code on General Instructions appeared in the December issue of Mechanical Engineering; the Code on Reciprocating Steam Engines in the January issue, and the Code on Evaporating Apparatus in the March issue. Written discussion on all of these Codes is also invited from those who are unable to attend the Power Test Code session, and should be addressed to C. B. Le Page, Secretary to the Committee, 29 West 39th Street, New York.

The Elimination of Waste in Industry

Purpose and Plan of Work of Committee Appointed by Herbert Hoover, President of The Federated American Engineering Societies

THE membership of The Federated American Engineering Societies consists of national, local, state and regional engineering and allied technical organizations and affiliations. Such national engineering societies as The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and the American Institute of Mining and Metallurgical Engineers, are members of The Federated American Engineering Societies.

The object of the organization, as quoted from the Constitution,

> ...Shall be to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions. ......A comprehensive organization of the community, state and nation.

The Committee on Elimination of Waste in Industry came into existence from a speech in Washington by Mr. Hoover, in November, in which he said:

> It is primary to mention the three-phase waste in production: first, from intermittent employment; second, from unemployment that arises in shifting of industrial currents; and third, from strikes and lockouts. Beyond this elimination of waste there is another field of progress in the adoption of measures for positive improvement in production.
>
> In the elimination of the great waste and misery of intermittent employment and unemployment, we need at once coördination in economical groups ..

In an executive meeting of the American Engineering Council, Mr. Hoover further discussed the need for an intensive study being made of all causes for industrial waste, emphasizing those factors that contribute to labor or man-power waste. He suggested to the Council, which is the governing body of The Federated American Engineering Societies, the advisability of appointing a committee of fifteen carefully selected engineers to undertake a study of waste in industry. The American Engineering Council readily approved the suggestion of Mr. Hoover, whereupon he then formed the Committee on the Elimination of Waste in Industry.

In selecting the personnel of this Committee, care was exercised to secure men of broad experience, of clear concepts, of unbiased attitude toward labor problems and representative of managerial, consultant, educational and editorial activities, as well as having a widely distributed and a varied industrial contact.

At the organization meeting of the Committee in January, its purpose was stated to be—

1 To determine the cause of labor, material and equipment waste in industry. The material and equipment phases of the problem to be studied only in so far as they may cause labor waste.

2 In so far as possible to determine the extent of the waste that arises through each major cause.

3 To suggest means of removing the cause for such waste.

To accomplish the purposes of the Committee, it has been found necessary to make studies along the following lines:

1 Organization—that which assigns responsibilities and relationships, and the discharge thereof.

2 Engineering—which comprises the design, construction and maintenance of plant, machinery and tools and the design of the product.

3 Production Control and Cost Control. Under this division fall all the factors relating directly to production and the proper direction and accounting therefor.

4 Physical Factors. This division relates to the storage and inspection of raw and processed materials and to matters of internal transportation. It also includes consideration of the physical condition of the plant as regards lighting, heating, toilet facilities etc.

The first and third sections, as well as the principal part of the fourth, directly relate to the human element in industry. The Committee is devoting the major portion of its effort to the factors that affect the human element.

The important subdivisions of the major factors—organization, production control and cost control,—to which special attention is directed, are enumerated below.

ORGANIZATION

(a) *Nature of operation:*

1 Contractual. This form presents many problems that affect personal relations. Building operations largely contractual. This form of relationship is quite common in the clothing industry.

2 Repetitive. A large portion of industrial activity is repetitive. This phase of industry makes prominent the question of monotony, and occupational diseases.

3 Continnous. Steel and chemical industries are typical representatives. In this form of operation the question of the number of shifts is considered important.

(b) *Types:*

The type of organization is some index to the quality of the management and as such is an essential consideration.

1 Functional
2 Line and Staff
3 Staff
4 Mixed
5 Committee.

(c) *Personal Relations:*

1 Employment Policies

2 Representation—To what extent each plan has been tried, and with what results:

a Federal plan
b Joint committee
c Employees'coöperative association.

3 Strikes and Lockouts—The case for, the duration of, the man-hours lost, and the total cost.

4 Restrictions by Management and Labor—An investigation of the means employed by management and by labor to restrict production. Such practice produces an unstable condition and hence leads to uncertain labor conditions and disturbed relations.

5 Unemployment
a Quantity of
b Causes of
c Remedy for.

6 Seasonal and Intermittent Employment
a Qnantity of
b Causes of
c Remedy for.

PRODUCTION CONTROL AND COST CONTROL

(a) *Planning:*

All of these factors have a direct influence upon the productivity of the individual worker. If inadequately or ineffectively provided for, the worker loses time and compensation, hence a high morale is not snstained.

(b) *Establishing Standards:*

This is very significant, as many labor disputes have arisen over the method and fairness used in establishing such standards. They have a direct bearing upon the earnings of the worker.

(c) *Maintenance:*

If equipment is not properly maintained, the operator does not accomplish standard tasks, hence dissatisfaction results.

Industries to be Studied. The representative industries which have been selected because of their general importance and interest to the public are as follows:

1 Bituminous Coal	6 Paper
2 Building Trades	7 Metal Trades
3 Transportation	8 Textiles
4 Men's Ready-Made Clothing	9 Shoes
5 Printing	10 Rubber

From three to ten plants of each selected industry are being visited by an experienced engineer, who will secure the information desired by the Committee. A carefully prepared list of questions has been placed in the hands of each field worker. The information obtained by the field investigator is to be supplemented by such authoritative data as may now exist in the form of reports made by reliable parties or agencies. Through this means sufficient information is to be secured to enable the Committee to formulate specific conclusions as to the major causes of industrial waste.

Staff. A small staff is to be maintained at headquarters. This staff plans and directs the work. The field work is to be done by engineering firms carefully selected for their fitness for the work. For example, the investigation of ready-made clothing was assigned to a firm that has had a large experience in that field. Thus the

Committee will obtain the benefit of the experience and knowledge of the firm that has had most intimate contact with a given industry. The firms are doing the work at actual cost to them, all profit being waived.

All authoritative literature upon each general topic is to be carefully searched and digests made by well-qualified firms. The headquarters staff will compile all the data and write the final report, which is to be reviewed by the Committee as a whole. Every effort is to be made to secure authentic and quantitative information, and care will be exercised to prevent any bias or prejudice from influencing any phase of the work.

Progress of Work. The work of the Committee is well under way. Reports on the first investigation in each industry were made on February 21, carrying out the time schedule set February 7. At a meeting of the Planning Board held on March 1, further reports were presented and plans made for continuing the investigations more intensively. These reports were uniformly encouraging and there is every reason to believe that the investigation will yield information that will have an important bearing on the nation-wide movement inaugurated by the engineer to eliminate waste in American industry. In New York, New England and Pennsylvania the fuel investigation is practically completed.

Engineers Asked to Urge Reconsideration of Nolan Patent Office Bill

The following report of the Patent Committee of the American Engineering Council is of importance to all engineers and should receive their immediate attention. The Patents Committee, in submitting the report, asks that every member of each of the constituent societies of The Federated American Engineering Societies immediately write his representative and his senators and the chairmen of the Committees on Patents of the Senate and the House of Representatives, urging the reintroduction and passage of the Nolan Patent Office Bill without the section known as the Federal Trade Commission section.

The bill for the imperatively necessary relief of the Patent Office, after passing the House of Representatives with satisfactory provisions for the Patent Office, failed to pass the Senate at the session just closed with those same provisions, solely because of the presence in it of an unrelated section known as the Federal Trade Commission Section.

The former opposition in the Senate to the Patent Office relief and that which forced the unacceptable reductions in salaries and numbers of examiners and clerks (which the Conference Committee was persuaded to set aside) is largely and seemingly almost wholly overcome. But the opposition in the Senate to the Federal Trade Section is determined and has expressed an intention to prevent the Patent Office from getting the desired relief, unless the Federal Trade Section is removed from the bill.

More than preventing the Patent Office relief, however, the Federal Trade Section is believed to be a dangerous measure in itself, It provides that the Federal Trade Commission may receive assignments of and administer inventions and patents from governmental employees and is an entering wedge for further legislation to empower the Trade Commission to receive patents from non-governmental inventors or owners. An exclusive license would have to be granted, at least for a few years, to induce any one to undertake the almost always necessary development expense, and the Trade Commission would surely be charged with favoritism in granting such a license. In order to protect its licenses, the Trade Commission would have to sue infringers, a most unfortunate activity for the Government. The industries would close their doors to the government employees, fearing to disclose to them their secrets or unpatented inventions, and research by the industries would be discouraged for fear that government employees, using government facilities, might reach the result first and patent it. The Trade Commission, owning a large body of patents, in case that one of its patents was found to be infringed during or at the close of a frequently very expensive development by private interests would be able to dictate in the license the price at which the article, which was the object of the development, could be sold, or to dictate other similar conditions, thus depriving the development of much of its value; and could even require the licensee, as a condition for granting needed license, to practically destroy some of its unrelated patents, as by licensing the trade generally when it would prefer to retain the monopoly for itself.

The foregoing and other objections would result in making patents less desirable to own or to purchase, and consequently would decrease the incentive to produce inventions, which production is the main purpose of our patent system.

The proposed section is unnecessary for the protection of government employees, since they now have all the rights which non-governmental employees have to patent inventions and to sell them. It is therefore believed that the Federal Trade Commission section should not be enacted into law in any form, even as a separate bill.

Award of Kelvin Gold Metal

The first triennial award of the Kelvin Gold Medal has been made to Dr. William Cawthorne Unwin, F.R.S., of London, for his preeminence in the branches of engineering with which Lord Kelvin's scientific work and researches were closely identified. The Kelvin Gold Medal as instituted eight years ago when the leading engineering societies of the world coöperated in securing a memorial to Lord Kelvin, a distinguished engineer and man of science. The major memorial took the form of a window in Westminster Abbey. The Kelvin Medal was established from the remainder of the memorial fund. The Kelvin Gold Medal Fund is administered by the Institution of Civil Engineers. The committee making the award, in accordance with the conditions of the Kelvin Medal Trust, consisted of the presidents of the principal representative British engineering institutions.

Dr. Unwin has been professor of mechanical and hydraulic engineering at the Royal Indian Engineering College and professor of engineering at the Central Technical College of the Guilds of London. He is a past-president of the Institute of Civil Engineers and an honorary member of The American Society of Mechanical Engineers.

Dr. Unwin has done work of great importance in the development of precise methods of testing, in connection not only with materials but also with all types of power plant. The standardization of specifications now being carried on by the British Engineering Standards Association owes much of its success to his pioneer work. In the work of coördinating results of experience in engineering design, in the development of centrifugal pumps and the hydraulic generation of power, in increasing the efficiency of heat engines, and in machine design, the influence of Dr. Unwin, both as a writer and as a teacher, has been far-reaching.

Engineer Appointed to Public Service Commission of Maryland

Governor Ritchie of Maryland has recently announced the appointment of Ezra B. Whitman, civil engineer, and president of the Engineers' Club of Baltimore, as one of the three public-service commissioners of the state. In the announcement emphasis was laid particularly on the desirability of having a trained engineer on this board.

Mr. Whitman was graduated from Cornell University in 1901, and afterward took special courses in chemistry and bacteriology in the Cornell Medical School, New York. From 1902 to 1905 he was a member of the firm of Williams and Whitman, of New York City. From 1906 to 1911 he acted as division engineer for the Sewage Commission of Baltimore, in charge of the design and construction of the sewer systems for that city. From 1911 to 1914 he served as chief engineer and president of the Water Board of Baltimore City, in charge of the maintenance, operation and extension of the system. From May 1914 to May 1916 he was a member of the firm of Greiner and Whitman. Since 1916 he has been a member of the firm of Norton, Bird and Whitman, who have carried on a very extensive practice as consulting civil engineers. During the war he was officer in charge of utilities at Camp Meade, with rank of major, and was responsible for practically the whole of the operation and maintenance of that large camp.

Mr. Whitman is a member of the American Society of Civil Engineers, American Water Works Association, American Public Health Association, New England Water Works Association, American Association of Engineers, and the Engineers' Club of Baltimore. His appointment has been a matter of very considerable gratification to friends and fellow engineering associates in Baltimore, where it is felt that considerable advantages will accrue from the presence of an engineer on the Public Service Commission.

A Correction

A. E. Hall has called attention to the fact that in the discussion of his paper in the February issue of Mechanical Engineering, page 101, the 54 to 60 in. dimensions referred to *circular* saws and that the 3-hp. and 4-hp. should have read 300-hp. and 400-hp.

Engineering and Industrial Standardization

Campaign Against Industrial Accidents

DURING 1921 the members of the National Safety Council are for the first time attempting a unified and intensive accident-prevention campaign. Formerly safety campaigns have been conducted independently in each of the 8000 member plants of the council, and although much has been accomplished by these scattered campaigns, there are still approximately 22,000 workers killed and 600,000 injured in industrial accidents each year.

The plan announced at the headquarters of the council in Chicago calls for a concentrated attack, through all available means, on a different hazard each month. Thus during January, in approximately 8000 industrial plants, mines, railroads and other public utilities throughout the country, a special campaign was conducted against ladder accidents. The February campaign was against neglect of minor injuries and infections arising therefrom, and the March campaign dealt with unsafe clothing. The campaigns announced for the other months are as follows: April, horse play; May, hand-tool hazards; June, standing or sitting in dangerous places; July, machinery hazards; August, inattention; September, fire; October, health hazards; November, careless handling of materials; and December, eye injuries.

Safety Code for Logging and Sawmill Machinery

For a number of months the Bureau of Standards, at the request of the American Engineering Standards Committee, has been organizing a Sectional Committee to formulate a safety code for logging and sawmill machinery. The personnel so far determined is as follows:

Name and Address	Association, Society or Firm Represented
Manufacturers' Organizations:	
W. Graham Cole, director of Safety and Industrial Relations	Southern Pine Association
Frank H. Lamb, president Wynooche Timber Company	Pacific Logging Congress
Dr. Wilson Compton, manager	National Lumber Manufacturers Association
....	West Coast Lumber Association
Individual Manufacturers:	
Kenneth Rushton, chief engineer	Baldwin Locomotive Works
W. G. Hagmier	Allis-Chalmers Company
J. S. Reid, president	Clark Brothers Company
State Authorities:	
H. M. Wolflin, Cal.	International Association of Industrial Accident Boards and Commissions
James C. Cronin, Pa.	
Richard J. Cullen, N. Y.	
C. H. Younger, Wash.	
R. A. McA. Keown, Wis.	
C. H. Gram, Ore.	
Government Bodies:	
Col. W. B. Greeley, Forester	U. S. Forest Service
E. H. Finlayson	Canadian Forest Service
E. B. Rosa	Bureau of Standards
M. G. Lloyd	
J. A. Dickinson	
Safety Engineering Organizations:	
Joseph H. Dickinson, Lidgerwood Manufacturing Company	American Society of Mechanical Engineers
C. W. Price, general manager	National Safety Council
Carl O. Hero, safety engineer, Lumber Mutual Casualty Insurance Company	American Society of Safety Engineers
Insurance Organizations:	
W. H. Cameron, secretary-treasurer	Workmen's Compensation Service Bureau
H. F. Richardson	National Council on Workmen's Compensation Insurance
Carl O. Hero, safety engineer, Lumber Mutual Casualty Insurance Company	National Association of Mutual Casualty Companies
Civic Associations:	
P. S. Risdale, secretary	American Forestry Association
Organized Labor:	
....	International Union of Timber Workers
Dr. Thorfinn Tharaldsen	Loyal Legion of Loggers and Lumbermen
Professional Societies:	
Prof. E. T. Clark, University of Washington	Society of American Foresters

Individual Experts:

Major Swift Berry, Timber Appraisal Section, U. S. Treasury Department
A. R. Lawrence, manager, Virginia State Rating Board
John H. Foster, N. H. State Forester
Robert Stanley, safety engineer, Parker-Young Co., Lincoln, N. H.
W. D. Scruggs, efficiency and safety engineer, Great Southern Pine Company, Bogalusa, La.
David Van Schaack, director, Bureau of Inspection and Accident Prevention, Aetna Life Insurance Co.

Safety Code for the Protection of Head and Eyes

Attention is called to a new publication of the Bureau of Standards, Handbook No. 2, entitled National Safety Code for the Protection of the Head and Eyes of Industrial Workers. This is a set of rules designed to give mechanical and optical protection to the eyes of workers in certain occupations which involve an eye hazard. The rules have been worked up in coöperation with outside conferees representing all points of view and especially with the assistance of an Advisory Committee which has approved the draft of the rules.

A copy of this code may be obtained by addressing the Bureau of Standards, Washington, D. C. If desired in quantity they may be obtained at a small charge from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Industrial Lighting Code

At the March 6, 1920 meeting of the American Engineering Standards Committee the Illuminating Engineering Society was requested to form a Sectional Committee for the development of an Industrial Lighting Code and to assume sponsorship therefor. This society accepted the responsibility and has submitted the names of the members of the Sectional Committee to the A. E. S. C. The interests included in this Committee and the number of representatives assigned to each are as follows: state commissions (1), gas and electric companies (3), insurance interests (2), federal bodies (2), other general interests (3), manufacturers of lamps (2), and consulting engineers (3).

The members of the Sectional Committee are: L. B. Marks (Chairman), W. T. Blackwell, W. F. Little, R. E. Simpson, G. H. Stickney, W. J. Serrill, Prof. C. E. Clewell, Dr. Louis Bell, Dr. A. S. McAllister, G. B. Regar, Dr. M. G. Lloyd, Dr. Thomas C. Eipper, C. L. Law, W. D. Keefer, W. H. Cameron, and Dr. J. W. Schereschewsky.

Copper Specifications

The American Society for Testing Materials has submitted the following copper specifications to the American Engineering Standards Committee for approval:

Specifications for Soft or Annealed Copper Wire (B3–15).
Specifications for Lake Copper Wire Bars, Cakes, Slabs, Billets, Ingots and Ingot Bars (B4–13).
Specifications for Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots and Ingot Bars (B5–13).
Methods for Battery Assay of Copper (B34–20).

Specifications B3–15, B4–13 and B5–12 may be found in the 1918 volume, and Specifications B34–20 in the 1920 volume of A. S. T. M. Standards. Copies of these may also be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York.

News of Other Societies

American Institute of Mining and Metallurgical Engineers

Annual meeting in New York, February 14–17. Iron and steel topics were extensively discussed. Two sessions were held on the breakage and steel treatment of drill steel, at which Benjamin F. Tillson, of the New Jersey Zinc Co., Francis B. Foley, of the Bureau of Mines, and Frank H. Kingdon, of Sullivan Machinery Co., presented papers dealing with the mechanics of failure of materials, and C. W. Burrows, of The Dorr Co., an illustrated report of an investigation on the fatigue of drill steel by magnetic survey and magnetic analysis. The discussion led to a resolution that the Institute establish a board in coöperation with other engineering societies and Government agencies to investigate the breakage and heat treatment of rock-drill steel and other steels subjected to similar stresses. This resolution was passed unanimously and will go to the board of directors for action. Two other sessions were held on iron and steel at which questions dealing with the manufacture and metallurgy of these metals were taken up. Some of the papers presented were: Static and Dynamic Tension Tests on Nickel Steel, by J. J. Thomas and J. H. Nead; Measurement of Blast-Furnace Gas, by D. L. Ward and R. S. Reed; Importance of Hardness of Blast-Furnace Coke, by Owen R. Rice; Manufacture of Ferromanganese in the Electric Furnace, by Robert M. Keeney and Jay Lonergan; Electric Furnace in the Iron Foundry, by Richard Moldenke; Surface Changes of Carbon Steels Heated in Vacuo, by E. H. Hemingway and G. R. Ensminger; and Molybdenum Steels, by John A. Mathews.

One entire session and parts of others were devoted to industrial relations. Among the papers presented were one on the Hiring and Placing of Men, by S. R. Rectanus, and another on Dust Ventilation Studies in Metal Mines, by D. Harrington. Sessions were held also on mining and milling, coal mining, nonferrous metallurgy, non-metallic minerals, and petroleum and gas. The list of papers presented at these sessions included: Relation of Air Pressure to Drilling Speed of Hammer Drills, by H. W. Seamon; Skip Hoisting for Coal Mines, by Andrews Allen and J. A. Garcia; Steel Chimneys and Their Linings in Copper Smelting Plants, by A. G. McGregor; By-Product Expansion in the Non-metallic Mineral Industries, by Oliver Bowles; and Effect of Temperature, Deformation, Grain Size, and Rate of Loading on the Mechanical Properties of Metals, by W. P. Sykes.

The papers by J. J. Thomas and J. H. Nead, H. W. Seamon, and W. P. Sykes are abstracted in the Survey Section in this issue.

At the banquet, Herbert Hoover, retiring president, delivered a brief address in which he reviewed the activities of the Institute during the past year. Edwin Ludlow, New York, the incoming president, spoke on the present labor conditions in the United States.

American Institute of Electrical Engineers

Annual meeting in New York, February 16, 17 and 18. President A. W. Berresford, in his address, reviewed the role of the engineer in modern civilization, calling attention to the rapid growth in magnitude of modern enterprises and the increasing application of science to all phases of life. The complicated civilization of the present day exhibits the process of association at its maximum and the engineer is being forced more and more into closer coöperation with his professional brothers. The day has past when he can grapple alone with the engineering problems of the times. They must now be solved by the profession as a whole, and herein lies the secret of the growth of engineering societies, which represent the concrete answer to the call for coöperation. At the same time, the spirit of association inevitably fosters the substitution for the motive of private interest the noble purpose of unselfish public service.

A notable feature of the meeting was the presentation of the Edison medal to Dr. Michael I. Pupin of Columbia University, "for work in mathematical physics and its application to the electrical transmission of intelligence." Upon receiving the medal, Dr. Pupin gave an address on Wave Transmission, in which he described some of his early experiences in Serbia and various incidents of his life and education leading up to his telephonic inventions. Numerous papers dealing with electrical subjects were presented at the technical sessions.

Taylor Society

Meeting at Springfield, Mass., February 24, 25, and 26. Professor Irving Fisher, of Yale University, explained how the instability of the dollar interferes with efficient industrial management, inasmuch as changes from prosperity to depression cause uncertainty and restriction of management activities. The committee on sales quota of the sales management section of the society submitted a preliminary report. A "sales quota" is a predetermined amount of business to be obtained in a given period by the sales department as a whole, by any branch of the department, by any individual salesman, in the entire country or in any state, county, city, sales district or subdivision of these. The determination of quotas, their apportionment and the results of the system were explained in detail. Meyer Bloomfield, in a paper entitled The Development of our Conception of the Function of Personal Administration, surveyed the progress in industrial management during the period from 1910 to the present year. Symposia were held on storekeeping, planning, layout and standardization of equipment, and analysis and standardization of manufacturing processes.

Engineering Institute of Canada

Annual meeting at Toronto, February 1, 2 and 3. Considerable attention was given to the proposed legislation for the registration of engineers in Canada. Through the efforts of the Institute registration laws have been adopted in each of the Canadian provinces, except Saskatchewan, Prince Edward Island, and Ontario. Work is well under way in these provinces, however, toward the successful passage of such legislation. The committee on international relations reported that arrangements had been completed with The American Society of Mechanical Engineers for an indefinite term and with the American Institute of Mining and Metallurgical Engineers for one year, whereby these societies and the Canadian Institute will mutually exchange privileges of publications; that is, any member of these American societies may obtain the publications of the Institute at the same price as that paid by the members of the latter organization, and vice versa.

National Machine Tool Builders' Association

Meeting at Cleveland, February 24, 25 and 26. Cost accounting of machine-tool plants was the chief topic of discussion. A report by Scovell, Wellington and Co. outlined a plan for standard methods of cost accounting which included such items as interest on invested capital, rent on buildings, cost of drawings, patterns, jigs and fixtures, cost of idleness, normal burden and unearned burden, and other points necessary to know total costs. Fred A. Geier showed by figures compiled from 70 important companies for the ten years prior to 1913 that the net returns averaged 9 per cent on the invested capital. Since that period, careful estimates place the net returns at $10^1/_2$ per cent. E. J. Kearney recommended the use of the budget system for recording expenses and keeping them within the proper limit. Ernest F. DuBrul outlined a program for the association to undertake, in coöperation with The American Society of Mechanical Engineers and other technical societies, along such lines as the standardization of machine tools and the organization of industrial research.

American Boiler Manufacturers' Association

Meeting at Cleveland, February 22. Committee reports on standard specifications for setting return-tubular and water-tube boilers were presented. Charles E. Gorton, chairman of the Uniform Boiler Law Society, reported on the recent Detroit meeting of the National Board of Boiler and Pressure Vessel Inspectors, which resulted in the formulation of valuable plans for bringing about the simplification of the stamping and registration of boilers, the examination and certification of inspectors, and the uniform interpretation of the Boiler Code. Provision was made for closer coöperation with the Boiler Code Committee of The American Society of Mechanical Engineers in the interpretation and revision of the Code and also as to tolerances in its enforcement.

LIBRARY NOTES AND BOOK REVIEWS

THE AIRPLANE. By Frederick Bedell. D. Van Nostrand Co., New York, 1920. Cloth, 6 × 9 in., 257 pp., frontispiece, diagrams, $3.

The first six chapters of this volume contain, in revised form, the material previously published under the titles Airplane Characteristics and The Air Propeller. Seven additional chapters discuss problems of flight, performance and stability. The author's aim has been to present a well-rounded introductory treatment simple in form, but reasonably complete and accurate.

AMERICAN LUBRICANTS FROM THE STANDPOINT OF THE CONSUMER. By L. B. Lockhart. Second edition, revised and enlarged. The Chemical Publishing Co., Easton, Pa., 1920. Cloth, 6 × 9 in., 341 pp., illus., tables, $4.

This book is offered to buyers and users of lubricants as an aid in the intelligent selection of oils and greases. It describes the various commercial lubricants, explains the laws of friction, the conditions met in lubricating various classes of machinery and the methods used to satisfy them. Methods for chemical and physical tests are given, and specifications for oils and other lubricants for a great variety of purposes.

ASPHALTS AND ALLIED SUBSTANCES. By Herbert Abraham. Second edition, corrected. D. Van Nostrand Company, New York, 1920. Cloth, 6 × 9 in., 608 pp., illus., diagrams, tables, $6.

This is a comprehensive treatise for makers, sellers and users of asphalts, tars, pitches and their products. It includes the methods used for testing and analyzing raw and manufactured products, information on blending and compounding mixtures, general information on the scope of the use of bituminous materials and on their limitations, and the principles underlying the use of bituminous products for structural purposes. Topics which have been adequately presented in other books have been purposely subordinated to those concerning which little has hitherto been published.

CAMS, ELEMENTARY AND ADVANCED. By Franklin De Ronde Furman. John Wiley & Sons, Inc., New York, 1921. Cloth, 6 × 9 in., 234 pp., diagrams, $3.

The first five sections of this book appeared previously under the title, Elementary Cams. To these sections three have been added, giving a further development of the subject. The elementary portion gives a classification, an arrangement and a general method of solution of the well-known cams, and also a series of cam factors for base curves in common use. The advanced portion includes the development or use of the logarithmic, cube, circular, tangential and involute base curves, and the establishment of cam factors for those which have general ones.

DIE KOMPRESSIONS-KALTEMASCHINE. By W. Koeniger. R. Oldenbourg, Munich and Berlin, 1921. Paper, 6 × 9 in., 204 pp., plates, tables, diagrams, 30 M.

This book is based on an extensive investigation of sulphurous-acid refrigerating machines by its author. New views resulted, which contribute to a solution of the question why the "wet" process of compression is less efficient than the "dry," and which also led to new methods for the calculation of refrigerating machines. The book is intended for students of the theory of these machines and for designers, and includes both sulphurous-acid and ammonia machines.

ELEMENTARY DYNAMICS; a Text-Book for Engineers. By J. W. Landon. University Press, Cambridge, 1920. Cloth, 5 × 7 in., 246 pp., diagrams, $3.25.

The author of this textbook believes that many of the beginner's difficulties in grasping the fundamental principles of dynamics arise from an overemphasis of mathematics. This difficulty he attempts to avoid by emphasizing the physical ideas, whose meaning he explains partly by definition and description, but mainly by worked examples in which formulas are avoided as far as possible.

ELEMENTS OF MECHANISM. By Peter Schwamb, Allyne L. Merrill and Walter H. James. Third edition. John Wiley & Sons, Inc., New York, 1921. Cloth, 6 × 9 in., 372 pp., diagrams, $3.50.

After sixteen years this textbook appears in a thoroughly revised and expanded edition, embodying the changes suggested by its use for instruction at the Massachusetts Institute of Technology and other colleges. It is intended to provide a systematic, clear, and practical presentation of the subject, suited to the amount of time usually devoted to it in college courses.

ERTRAGREICHSTER AUSBAU VON WASSERKRAFTEN. By Dr. Leiner. R. Oldenbourg, Munich and Berlin, 1920. Paper, 8 × 11 in., 111 pp., diagrams, 40 M.

The author examines the principles which serve as a guide in estimating the probable financial returns from the utilization of a water power; then he studies the most advantageous method of development, depending upon the constancy or intermittency of the power, the possibility of using reservoirs, and similar factors.

GAGE DESIGN AND GAGE MAKING. By Erik Oberg and Franklin D. Jones. First edition, first printing. The Industrial Press, New York, 1920. Cloth, 6 × 9 in., 310 pp., illus., diagrams, $3.

Much, the authors state, has been published on manufacturing practice, but comparatively little on the design and making of the gages used to control manufacturing processes and insure interchangeability in finished parts. Their book is intended to present the principles upon which gage design depends, and to describe the methods of manufacturing, measuring and testing gages.

HYDRO-ELECTRIC DEVELOPMENT. By J. W. Meares. Sir Isaac Pitman & Sons, Ltd. (Pitman's technical primer series.) 90 pp., front., illus., 4 × 6 in., boards, $1.

This little primer, based on the author's experience, aims to set down in logical order the points which require attention in the discovery, reconnaissance and final design of a hydroelectric scheme. It is confined strictly to the hydraulic aspect of the problem, omitting electrical questions and the practical details of plant construction.

KUGELLAGER UND WALZENLAGER IN THEORIE UND PRAXIS. By Paul Haupt. R. Oldenbourg, Munich and Berlin, 1920. Paper, 6 × 9 in., 199 pp., tables, diagrams, 18 M.

This work is a summary and extension of the scattered literature on bearings with rolling friction. Besides a theoretical discussion of the laws underlying the construction of ball and roller bearings, current practice is described, and the commercial types are examined critically.

PERSONAL RECOLLECTIONS OF ANDREW CARNEGIE. By Frederick Lynch. Fleming H. Revell Co., New York. Cloth, 6 × 8 in., 184 pp., portrait, $1.50.

Dr. Lynch's reminiscences cover a phase of Mr. Carnegie's activities that is not so widely known as his beneficences. His love of poetry and music, his religious opinions, interest in international peace, his views on education and similar topics, are set forth as he gave them to his friends.

PROPERTIES OF STEAM AND THERMODYNAMIC THEORY OF TURBINES. B, H. L. Callendar. Longmans, Green & Co., New York, 1920. Cloth 6 × 9 in., 531 pp., diagrams, tables, $14.

This work gives a connected account of the conclusions resulting from the author's extended experimental and theoretical investigations of the problems depending primarily on the properties of steam. It is therefore intended to supplement treatises written from an engineering standpoint, by presenting the thermodynamical aspect of the problem. The book explains the origin of the author's equations for steam, shows how well his theory has fitted with subsequent work, and how his equations and tables may best be applied to more recent developments. A considerable portion deals with the thermodynamical theory of turbines, and here some new methods are introduced which the author believes will be useful to engineers. The book includes his steam tables.

THE ENGINEERING INDEX

(Registered U. S. Patent Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Manufacture. Manufacturing Abrasive Wheels. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, pp. 82–88, 14 figs. Methods of Universal Grinding Wheel Co., England.

ACCIDENTS

Dust Explosions. Some Electrical Causes of Dust Explosions, David J. Price. Elec. Rev. (Chicago), vol. 78, no. 5, Jan. 29, 1921, pp. 179–181, 5 figs. Results of investigations of explosions and fires attributed to electricity at Bur. of Chemistry, U. S. Dept. of Agriculture. Menace of static electricity to grain-threshing and cotton-mill operations.

The Cause and Prevention of Dust Explosions (Ueber die Entstehung von Staubexplosionen und ihre Verhütung), H. Weinmann. Zeit. für das Berg-, Hütten- u. Salinenwesen, vol. 68, no. 3, 1920, pp. 100–114, 2 figs. Results of investigations carried out by author to determine whether disastrous explosions which occurred in a German sugar factory were the result of pure sugar-dust explosions or of such explosions in conjunction with other gases.

AERONAUTICAL INSTRUMENTS

Speed Recorder. A Manometer for Recording Flight Speeds (Ein Manometer zur Aufzeichnung von Fluggeschwindigkeiten), C. Wieselsberger. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 1, Jan. 15, 1921, pp. 4–6, 4 figs. Details of instrument constructed in the workshop of the Göttinger aerodynamic testing station, which is said to have shown good results in trial flights.

Two-Needle. Two-Needle Aeronautical Instruments (Appareils de bord à deux aiguilles), M. Dugit. Vie technique & industrielle, vol. 2, no. 16, Jan. 1921, pp. 323–327, 4 figs. Details of construction and uses in aerial navigation.

Uses. Aeronautic Instruments, Charles E. Mendenhall. Aerial Age, vol. 12, no. 20, Jan. 24, 1921, pp. 512–515, 5 figs. Classification of instruments and methods of using.

AEROPLANE ENGINES

Clearance-Volume Measurements. Instrument for Measuring Engine Clearance Volumes, S. W. Sparrow. Aerial Age, vol. 12, no. 23, Feb. 14, 1921, pp. 583–584, 6 figs. Instrument designed and constructed under direction of Automotive Power Plants Section of Bur. of Standards. Technical note of Nat. Advisory Committee for Aeronautics.

Near-Diesel. A Near-Diesel Engine for the Airplane, Harold F. Blanchard. Sci. Am., vol. 124, no. 4, Jan. 22, 1921, pp. 65 and 79, 3 figs. Engine designed by Prof. Junkers. Advantages claimed are low weight per horsepower, increased reliability, higher fuel economy, greater simplicity, safety against fire, and perfect balance.

Superchargers. Turbine-Driven Aeroplane Engine Superchargers for Flight at High Altitudes (Les surpresseurs pour moteurs d'aéroplanes à commande par turbine, pour le vol aux hautes altitudes). Génie Civil, vol. 78, no. 3, Jan. 15, 1921, pp. 55–56, 2 figs. Economical advantages of supercharging engine at high altitudes. Supercharger constructed by Gen. Elec. Co.

Wright. New Wright Aeronautic Engine Succeeds the Hispano-Suiza, A. Ludlow Clayden. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, pp. 154–156, 4 figs. Machine retains steel sleeve and combination valve stem and tappet, but embodies many changes originally developed by Wright Co., including better cooling and simplified lubrication systems. New magneto mounting provided.

Turbo-Compressors for. The Rateau Turbo-Compressor, H. M. Buckwald. Aviation, vol. 10, no. 3, Jan. 17, 1921, pp. 73–76, 10 figs. Details of construction and results of tests.

AEROPLANE PROPELLERS

All-Metal. The Leitner-Watts All-Metal Propeller. Aerial Age, vol. 12, no. 22, Feb. 7, 1921, pp. 559–560, 3 figs. Structural details, and records of tests.

Reversible Pitch. Hart Reversible Pitch Propeller. Aviation, vol. 10, no. 3, Jan. 17, 1921, pp. 79–80, 6 figs. Experiments of Engineering Division, U. S. Army Air Service.

Variable-Pitch. Parker Variable Pitch Air Screw, Billy Parker. Aerial Age, vol. 12, no. 24, Feb. 21, 1921, pp. 610–711, 2 figs. As machine climbs into higher altitudes and more rarified air is encountered, blades automatically increase their pitch so that constant load is kept on motor.

AEROPLANES

Aerofoils. See Wings.

Design. Aeronautics in 1920—I. Engr., vol. 131, no. 3393, Jan. 7, 1921, pp. 5–7, 9 figs. partly on 2 supp. plates. Survey of developments in aeroplane design.

Aeroplane Design, F. S. Barnwell. Aeronautics vol. 20, no. 379, Jan. 20, 1921, pp. 49–50. Table of airscrews of not more than 8 ft. diameter to absorb 1 hp. (Concluded.) Paper read before Cambridge University Aeronautical Soc.

Fuselage Construction. The Monocoque Fuselage, Lester D. Seymour. Aviation, vol. 10, no. 7, Feb. 14, 1921, pp. 203 and 206, 6 figs. Structural details of one-piece monocoque fuselage invented in France. Advantages of this type of construction.

Passenger. The 1000-Hp. Passenger Monoplane of the Zeppelin Works, Staaken (Das 1000 Ps-Verkehrsflugzeug der Zeppelin-Werke, Staaken), A. K. Rohrbach. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no 1, Jan. 15, 1921, pp. 1–4, 8 figs. Specifications: Engine, four 260 hp. Maybach engines; span, 31 m.; aerofoil surface, 106 sq. m.; gliding speed, 130 km. per hr.; carrying capacity, 18 passengers and 2 pilots; fuel-storage capacity, 6 hl. Duralumin is used for aerofoil, fuselage and empennage.

Stabilizers. The Automatic Control of Aeroplanes. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 178–179, 3 figs. Aveline automatic control apparatus for aeroplanes.

The Aveline "Automatic Pilot." Flight, vol. 13, no. 5, Feb. 3, 1921, pp. 73–75, 7 figs. Patented stabilizer employing inclinometer in which fluid is mercury. Machine is based on slight modifications of pendulum principle and is partly electric, partly pneumatic and partly aerodynamic.

Testing, Railway for. A Railway for Testing Full Size Aeroplanes. II. Bendemann. Aeronautics, vol. 20, no. 380, Jan. 27, 1921, pp. 64–65, 5 figs. Testing tower placed on modification of railway truck which is pulled along by locomotive. On top of tower is placed full-sized aeroplane to be tested. Paper read before German Aeronautical Soc.

Wings. A German Rival of the Handley-Page Wing. Aviation, vol. 10, no. 6, Feb. 7, 1921, p. 179, 1 fig. Wing with peculiarly shaped passages which are said to increase both pressure on under side and suction on upper side. Translated from Flugsport.

The Action of Aeroplane Wings (Die Wirkungsweise der Tragflächen), H. Lorenz. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 1, Jan. 1, 1921, pp. 8–11, 9 figs. Deals with pressure of wings, and the influence of inclination and camber suface.

The Glenn Martin High-Lift Wing. Aerial Age, vol. 12, no. 23, Feb. 14, 1921, p. 585, 1 fig. It is said that Glenn Martin Co. of Cleveland have designed aeroplane wing which can lift greater weight per sq. ft. than any other known type. No description of wing is given.

The Internally Trussed Wing, William B. Stout. Aviation, vol. 10, no. 7, Feb. 14, 1921, p. 200. Comparative study of American and German designs.

The Lachmann Aerofoil. Aerial Age, vol. 12, no. 22, Feb. 7, 1921, p. 560, 2 figs. German design consisting of several separate staggered elements arranged in form of Venetian blind. Translated from Flugsport.

Torsion of Wing Trusses at Diving Speeds, Roy G. Miller. Nat. Advisory Committee for Aeronautics, report no. 104, 1920, 8 pp. 4 figs. Suggestions in regard to methods for analyzing stresses in wing truss in vertical dive at limiting velocity.

[See also SEAPLANES; WIND TUNNELS.]

AIR COMPRESSORS

Membrane. The Membrane Compressor (Compresseur à membrane), H. Corblin. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 1, Jan. 3, 1921, pp. 46–48, 1 fig. Air or gas is compressed by alternative movements of circular membrane held rigidly at edges between two conically shaped hollow disks. Above one of these disks a piston forces air or liquid into and out of disk. Air is compressed by movements of membrane operating suitable valves in other disk.

AIR FILTERS

Radio Type. Air Filters (Luftfilter), K. Reichardt Oel- u. Gasmaschine, vol. 17, no. 12, Dec. 1920, pp. 185–186, 2 figs. Describes the Radio air filter equipped with a chamber in which the admitted air is conducted over a large perforated surface and distributed, after which it passes into the filter proper which is filled with metal rings having lateral openings. The dust-absorbing capacity of filter is said to be much greater than that of cloth or wire filters.

AIR SERVICE, UNITED STATES

United Air Force. United Air Force—Pro and Con. Aviation, vol. 10, no. 7, Feb. 14, 1921, pp. 196–198. Arguments for and against army and navy united air force. (Concluded.)

AIRCRAFT

Anchorage. The Universal Aircraft Anchorage. Flying, vol. 10, no. 1, Feb. 1921, pp. 22–24, 5 figs.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Dock for landing, mooring and storing of airships and aeroplane, invented by E. S. Ullman.

Submarine vs. Aircraft v. Submarines, L. H. Strain. Flight, vol. 13, no. 3, Jan. 20, 1921, pp. 46–48. Their comparative value as weapons of war studied from records of their respective applications in last war. Writer believes that if air force is developed extensively there need not be any fear of the submarine in future campaigns. Paper read before Royal Aeronautical Soc.

AIRCRAFT CONSTRUCTION MATERIALS

Plywood. See PLYWOOD.

Steels. British Standard Schedule of Cold Worked Steels for Aircraft. British Eng. Standards Assn., no. 112, Nov. 1920, 15 pp., 2 figs. Schedule of seven cold-worked steels in form of black bars. Chemical composition, heat treatment and mechanical properties are specified.

British Standard Schedule of Sheet Steels for Aircraft. British Eng. Standards Assn., no. 113, Nov. 1920, 12 pp., 3 figs. Schedule of three sheet steels. Chemical composition, heat treatment and mechanical properties are specified.

British Standard Schedule of Valve and Valve Spring Steels for Aircraft. British Eng. Standards Assn., no. 114, Nov. 1920, 17 pp., 7 figs. Schedule of three valve steels and two valve-spring steels for aircraft engines. Chemical composition, heat treatment and mechanical properties are specified for steel in form of bars, forgings and drop forgings.

British Standard Schedule of Wrought Steels for Aircraft. British Eng. Standards Assn., no. 111, Nov. 1920, 27 pp., 9 figs. Schedule of fourteen wrought steels in form of bars, billets, forgings and drop forgings. Chemical composition, heat treatment and mechanical properties are specified.

AIRSHIPS

Rigid. Speed and Endurance of the Rigid Airship. E. H. Lewitt. Aeronautics, vol. 20, no. 379, Jan. 20, 1921, pp. 43–44, 2 figs. Graphs showing variation between speed, horsepower and capacity. (To be continued.)

Zeppelin. The Zeppelin Airships, L. 64 and L. 71, George Whale. Aeronautics, vol. 20, no. 377, Jan. 6, 1921, p. 9. Classification and description of types.

ALCOHOL

Peat as Source of. See PEAT, Gasoline from.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Electrometric Analyses. The Electrometric Analyses of Special Steels (Analyses électrométriques des aciers spéciaux). Industrie Electrique, vol. 30, no. 686, Jan. 25, 1921, pp. 33–36, 5 figs. Industrial apparatus for determining chromium, vanadium, and manganese.

Uranium Steel. Investigates Uranium Alloy Steel, E. Polushkin. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 413–417, 6 figs. In medium-carbon steel uranium increases elastic limit and resistance to rupture without affecting ductility. No unusual results were obtained than could not be had with other special steels. Translated from Revue de Métallurgie.

ALUMINUM

Castings. Analyze Loss in Aluminum Shops—IV, Robert J. Anderson. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 104–111. Tables showing casting losses in various foundries on different castings. Percentages of losses from enumerated causes are indicated in case and comparisons are made.

ALUMINUM ALLOYS

Aluminum-Iron. Influence of Iron on the Mechanical Properties of Chemical Aluminum (L'influence du fer sur les propriétés mécaniques de l'aluminium brut de coulée), Léon Guillet and Albert Portvin. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 753–756, 4 figs. Addition of iron to chemical aluminum was found to increase hardening and to diminish ductility. With 4 per cent iron alloy is not capable of plastic deformation.

Castings. Castings of Light Aluminum Alloys, Robert J. Anderson. Iron Age, vol. 107, no. 7, Feb. 17, 1921, pp. 433–436, 15 figs. Value of macroscopic examination in foundry practice. Its correlation with microstructure. Methods used and typical structures.

Copper-Aluminum. Mechanism of Solidification of a Copper-Aluminum Alloy, Junius David Edwards. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 217–220, 5 figs. Study of piping, segregation and mechanism of solidification of Cu-Al alloys, especially no. 12 containing 8 per cent aluminum, by means of precision measurements on density at various high temperatures.

AMMONIA

Manufacture. Artificial Ammonia, Jacques Boyer. Sci. Am., vol. 124, no. 6, Feb. 5, 1921, pp. 110, 4 figs. Claude process in successful operation in France.

British Neutral Sulphate Process, E. V. Evans. Gas Age, vol. 47, no. 2, Jan. 25, 1921, pp. 44–46. Methods of neutralizing free acid by ammonia gas at South Metropolitan Gas Co., London. Paper read before Southern District Assn. of Gas Engrs. & Managers.

Saturated, Tables for. Temperature and Pressure Tables for Saturated Ammonia. Power, vol. 53, no. 3, Jan. 18, 1921, pp. 96–99. Tentative tables prepared by U. S. Bur. of Standards.

Synthetic. Manufacture of Synthetic Ammonia at Oppau, Germany—I. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 305–308, 7 figs. Principle of process. Manufacture of producer gas and water gas used in process. Purification of gas mixture. Catalytic oxidation of carbon monoxide. Elimination of carbon dioxide and carbon monoxide. Translated from Technique Moderne.

AMMONIA ABSORPTION REFRIGERATING SYSTEM

Non-Condensible Gases in. Causes and Prevention of the Formation of Noncondensible Gases in Ammonia Absorption Refrigeration Machines. E. C. McKelvy and Aaron Isaacs. Technologic Papers, Bur. of Standards, Dept. of Commerce, no. 180, Oct. 25, 1920, 10 pp., 1 fig. Method for quantitative estimation of carbon dioxide in ammonia is also given.

APPRENTICES, TRAINING OF

Draftsmen. How to Train Drafting Apprentices, S. E. Ferry. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 95–97. Outline of two-year training course.

Methods. Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 230–232, 4 figs. Practice of Brown & Sharpe Mfg. Co., Providence, R. I. Apprentice training has gone on for 70 years. Present school holds classes during working hours. Coöperative students also are employed.

Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 54, no. 8, Feb. 24, 1921, pp. 310–312, 3 figs. Practice of Bethlehem Shipbuilding Corp., Quincy, Mass. Sub-foremen are trained to act as instructors for new men.

School Education. Engineering Education, Charles C. Garrard. Eng. Rev., vol. 34, no. 7, Jan. 1921, pp. 175–178 and 180. Report of City of Birmingham Education Committee on school education of apprentices.

Textile Mills. Standardized Training of Textile Apprentices, Eugene Scepesi. Textile World, vol. 59, no. 6, Feb. 5, 1921, pp. 193 and 295, 298, 305 and 309, 10 figs. Uniform methods of industrial education, a means for reducing waste and loss accruing under present system.

AUTOMOBILE ENGINES

Abell. A High Speed Engine with Positively Operated Valves. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, pp. 157–159, 4 figs. Abell design in which but one poppet valve per cylinder is used, this being put in communication alternately with inlet and exhaust ports by rotary distributor placed lengthwise of cylinder head casting. Yoked rocker levers have two rollers in contact with opposit sides of cam. Cooling of valves by incoming charge makes it possible to use higher compression without knock.

Air-Cooled. A Revolving Air-Cooled Engine. Automotive Industries, vol. 44, no. 5, Feb. 3, 1921, pp. 219–220, 1 fig. Has cylinder axes parallel to axis of rotation and utilizes wobbling-plate principle. Is of four cycle type but has planetary gear so arranged that engine makes one revolution for two revolutions of plate, thus combining high piston speed with low rotative speed. Single sleeve valve of cast iron is employed in each of five aluminum cylinders.

Air-Temperature Regulation. Air-Temperature Regulation Effects on Fuel Economy, Reuben E. Fielder. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 119–122, 7 figs. Tests conducted by Fifth Avenue Coach Co. of New York City to study temperature of air entering into cylinder.

Carburetors. See CARBURETORS.

Design. Fuel Problem in Relation to Engineering Viewpoint, A. L. Nelson. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 101–115, 33 figs. Account of extensive tests conducted with view of studying effect of engine design and correlation of results obtained for undertaking research of fuel problem.

Relation Between Principal Characteristics of an Automobile Engine (Relations entre les principales données constructives d'un moteur), Raymond Bricout. Technique automobile et aérienne, vol. 11, no. 111, 1920, p. 127, 1 fig. Graphs showing relation between cylinder diameter, piston stroke r.p.m., etc.

Eight-Cylinder, Balancing. Balancing of Eight-Cylinder Automobile Engine, and Order of Firing of Cylinders (Etude du moteur à huit cylindres en ligne au point de vue équilibrage et ordre du travail des cylindres). Technique automobile et aérienne, vol. 11, no. 111, 1920, pp. 97–125, 31 figs. Diagrams indicating stresses in crankshaft at various stages of rotation, computation of maxima stresses formulas for inertia forces, etc.

Engine Speed and Air Speed. Diagram Giving the Velocity of an Automobile in Terms of the R.P.M. of a Motor (Abaque donnant la vitesse d'une voiture en fonction de la vitesse de rotation du moteur), R. Bricout. Technique automobile et aérienne, vol. 11, no. 111, 1920, p. 126, 1 fig.

Hot-Spot Manifold. The Volatility of Internal-Combustion Engine Gasoline, Frank A. Howard. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 145–148, 1 fig. Argument for further development, improvement and wider use of hot-spot manifold of automotive engines.

AUTOMOBILE FUELS

Alcohol. Researches on Alcohol as a Fuel for Internal Combustion Engines. Harold B. Dixon. Automotive Industries, vol. 44, no. 5, Feb. 3, 1921, pp. 211–215. Basic data on vapor pressure, ignition temperature, movement of flame through explosive mixtures and detonation of vapor of alcohol, gasoline, benzol and various mixtures of two of these fuels. Authorization of standard alcohol mixtures to be used with present engines is urged.

Naphthalene. The Combustion of Naphthalene Solutions in Internal Combustion Engines. L. S. Palmer. Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 31–34, 6 figs. Naphthalene dissolved in benzole to strength of 15 per cent by weight said to form efficient fuel for ordinary gasoline engines.

Research. Notes on Current Fuel Research. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 31–134. Answers to circular letters sent to members of Soc. of Automotive Engrs., asking them method in which they were studying fuel problm and reasons for policy followed in their studies.

AUTOMOBILE INDUSTRY

Germany. The German Automobile and Aircraft Industries, Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 25–27. There have been no changes in principal designs. In contrast with England, France and Italy there is absence of Americanization in chassis design and construction.

AUTOMOBILES

American-Made. 1921 Passenger Automobiles Listed with Their Technical Specifications. Motor Age, vol. 39, no. 4, Jan. 27, 1921, pp. 78–81. Tabulated data of American-made automobiles with makes of principal parts, including engine, lubrication and ignition systems, etc.

Battery Charging. Electric Vehicle Charging Equipments, E. Austin. Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 22–24, 6 figs. Machine built by Lancashire Dynamo & Motor Co. for working on polyphase circuit.

Body Construction. Some Sheet Metal Body Work. Am. Mach., vol. 54, no. 8, Feb. 24, 1921, pp. 318–320, 6 figs. Operations involved in making metal bodies for Ford cars. Blanking, forming and finishing sheets.

Body Design. Style in Automobile Bodies, George J. Mercer. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 123–126, 1 fig. Prevailing body types and possible developments.

Brakes. Friction Metal for Brake Linings. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, p. 153, 1 fig. Adaptation of European practice facilitated by manufacture in this country of copper-lead alloy said to possess exceptional friction qualities. Tests with V-shape brake on truck promise well. Elimination of brake squeaking said to be effected. High friction coefficient claimed.

Brussels Show. The Brussels Stalon (Le salon de Bruxelles), H. Petit. Vie Automobile, vol. 16, no. 720, Dec. 25, 1920, pp. 476–481, 13 figs. Survey of exhibits. (To be continued.)

Chassis Design. Chassis Design for Fuel Economy, A. L. Putnam. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 167–168. Basis for research.

French. Automobile Production for 1921 (La production automobile pour 1921), Charle Faroux, Henri Petit and André Contet. Vie Automobile, vol. 16, no. 720, Dec. 25, 1920, pp. I-LXXIII, 120 figs. Particulars of types to be constructed during 1921 by leading French automobile works, including also projected designs of motorcycles and automobile accessories.

Friction Drive. Kelsey Friction-Driven Car is Announced. Automotive Manufacturer, vol. 42, no. 10, Jan. 1921, pp. 26–29, 3 figs. Friction drive said to effect loss of 13 and 25 per cent on high and low speeds respectively, as compared to 25 and 30 per cent equivalent for average gear drive.

Gradient Meter. The Tapley Gradient Meter. Autocar, vol. 46, no. 1316, Jan. 8, 1921, p. 54, 2 figs. Needle indicates on gradient scale steepness of hill.

New York Show. Some New Parts Seen at the New York Show, P. M. Heldt. Automotive Industries, vol. 44; no. 4, Jan. 27, 1921, pp. 160–161, 5 figs. Two new axles, one of which uses two cone clutches in place of differential, are shown. New flexible universal of laminated steel, automatic advance magneto coupling, and lubricating system for transmission universals and axle, are among developments.

Transmission Gears. Impact Stresses in the Transmission Gears of Automobiles (Sur les chocs dans les engrenages de changement de vitesse des automobiles), A. Petot. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 1, Jan. 3, 1921, pp. 42–44. Formulas for computing stresses.

AVIATION

City Ordinances. Aerial Ordinance for New York City. Flying, vol. 10, no. 1, Feb. 1921, p. 25. Ordinance governing air traffic over New York City.

Civil. Progress of British Civil Aviation. Aviation, vol. 10, no. 7, Feb. 14, 1921, pp. 207–208. Report of British Controller-General of Civil Aviation on progress of civil aviation covering six months period from April 1 to Sept. 30, 1920.

Commercial. European Recognition of the Possibilities of the Airplane for Commercial Uses, E. A. Dixie. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 233–234, 2 figs. English daily papers publish meteorological reports. There are two lines of air buses between London and Paris.

The Design Requirements of Commercial Aviation, Grover C. Loening. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 135–144, 13 figs. Single-engined versus multi-engined planes. Desirable future developments.

Developments. Review of Aviation in 1920. Aviation, vol. 10, no. 3, Jan. 17, 1921, pp. 83-84. Prepared by Manufacturers' Aircraft Association.

Forest Fire Patrol. A Year of the Aerial Forest Fire Patrol. Flying, vol. 10, no. 1, Feb. 1921, pp. 13-16. Report submitted by air officer of headquarters ninth corps area at San Francisco.

B

BALANCING MACHINES

Turbine-Rotor. Martin's Rotor Balancing Machine. Elec. Rev. (Lond.), vol. 83. no. 2253, Jan. 28, 1921, pp. 101-102, 4 figs. Patented machine for balancing rotors without rotation.

BEARING METALS

Anti-Friction. Anti-Friction Bearing Metals. P. W. Priestley. Metal Industry (N. Y.), vol. 19, no. 2, Feb. 1921, pp. 66-67. Chemical, physical, and thermal review.

White-Metal. High-Temperature Properties of White-Metal Bearing Alloys, John R. Freeman, Jr. and R. W. Woodward. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 149-154 and 162, 8 figs. Preparation of alloys, and table of properties.

BELTING

Leather, Effect of Humidity on. Effect of Relative Humidity on Leather Belts, F. W. Roys. Can. Machy., vol. 25, no. 5, Feb. 3, 1921, pp. 76-78 and 98, 9 figs. Explanation of humidity, relative humidity, testing apparatus, atmospheric control, standard conditions and series of tests. Paper read before Nat. Assn. Leather Belting Manufacturers.

Rubber. Rubber in Mine and Mill, A. M. Oliver, Eng. & Min. Jl., vol. 111, no. 6, Feb. 5, 1921, pp. 258-262, 3 figs. Formulas for computing sizes and plies of belting.

BLAST FURNACES

Combustion Regulation. Regulation of the Combustion in Cupola Furnaces and of Working Process through Measurement of the Blast Capacities (Die Kontrolle der Verbrennung im Kuppelofen und des Arbeitsvorganges durch Windmengenmessung), H. Bansen. Stahl u. Eisen, vol. 41, no. 4, Jan. 27, 1921, pp. 114-115, 2 figs. Gives chart showing comparison of the analysis of flue gas taken from cupola furnace with the combustion curve of coke, and defines measurement of nozzle resistance.

Construction. New Blast Furnace Built at Midland. Blast Furnace & Steel Plant, vol. 9, no. 2, Feb. 1921, pp. 132-138, 1 fig. Construction of 600-ton furnace at Midland, Pa. Furnace stack is 92 ft. high with hearth 18 ft. diameter, stock line 16 ft. and bell 12 ft. diameter.

Developments in 1920. Blast Furnace Developments During 1920, Harvey W. Linhardt. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 20-22. Improvements in design, hot blast stoves, boiler plants, blowing engines, furnace appliances and gas cleaners.

Mechanical Equipment. Mechanical Equipment on Tapping Side of the Blast Furnace (Maschinenarbeit hinter dem Hochofen), F. W. Broy. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 3, Jan. 15, 1921, pp. 57-63, 15 figs. Calls attention to neglect up to present time of mechanical expedients on tapping side of blast furnace. Notes on difficult manual work on the casting beds insufficiency of the pig breakers; development of the pig hammers and charging cranes; high-capacity charging cranes; separation of the breaker and charging cranes. Diagrams showing utilization of the crane installation. Future problems.

Operation. Study of Coke Hardness, Owen R. Rice. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 423-426, 4 figs. Tests made in three stacks of Bethlehem Steel Co. to determine relation of furnace condition to coke hardness. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

Sulphur Content of Charge. The Sulphur Content of an Iron Charge in Cupola-Furnace Melting Process with the First Tapping in Contrast to the Following (Der Schwefelgehalt einer Eisengattierung im Kupolofen-Schmelzprozess beim ersten Abstich gegenüber den folgenden), Paul Liebaldt. Giesserei-Zeitung, vol. 18, no. 1, Jan. 1, 1921, pp. 5-8. Tables giving results of a series of chemical and mechanical experimental investigations demonstrating that the first tapping does not show an enrichment of sulphur nor a greater silicon residue than the following. For special castings it is said to be advisable not to use the first tapping because in most cases it is too dull.

BLOWERS

Power Chart. Notes on the Calculation of Blower Systems, John L. Alden. Power, vol. 53, no. 5, Feb. 1, 1921, pp. 180-183, 2 figs. Power chart for air blowers, and friction chart for air piping.

BOILER EXPLOSIONS

Records. Forty Years of Boiler Explosions. Locomotive, vol. 33, no. 4, Oct. 1920, pp. 101-108, 8 figs. There have been in period 1880-1919 total of 14,281 explosions, 10,638 lives lost and 17,085 persons injured.

BOILER FEEDWATER

Treatment. Saving Money by Water Treatment, Paul M. LaBach. Ry. Maintenance Engr., vol. 17, no. 1, Jan. 1921, pp. 17-20, 3 figs. Water treating plants installed by Rock Island system, and results obtained.

BOILER OPERATION

Coal Saving. Coal-Saving in the Chemical Industry, David Brownlie. Pamphlet published by Brownlie & Green, England, 15 pp. Rules for scientific control of steam boiler plant based on records of performance of 60 typical steam boiler plants of chemical industry of Great Britain. Reprinted from Chem. Trade Jl. & Chem. Engr., Aug.-Sept 1920.

Feedwater Regulation. Scientific Boiler Feed Water Regulation, Roland Moeller. Jl. Am. Soc. Heat. & Vent Engrs., vol. 27, no. 1, Jan. 1921, pp. 19-24, 6 figs. Automatic mechanical device.

Firing. Influence Upon Boiler Economy of Continuous Firing of Highly Volatile Fuel Without Intervening Cleaning. A. B. Reck. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 1, Jan. 1921, pp. 1-5, 3 figs. Results of two tests with bituminous coal one made before and another after fourteen days of continuous firing with same fuel without intervening cleaning.

BOILERS

Bonecourt Gas-Fired. Recent Developments in Gas-Firing Steam Boilers, and in the Utilization of Waste Heat, on the "Bonecourt" System, W. Gregson. Proc. South Wales Inst. Engrs., vol. 36, no. 2, Jan. 21, 1921, pp. 279-314 and (discussion) pp. 488-508, 13 figs. Bonecourt boiler consists essentially of outer shell, forming boiler, fitted with longitudinal fire-tubes which carries special packing, mixture of gas and air being drawn through boiler either by natural draught or by suitably arranged suction fan.

Holdsworth. The Holdsworth Lancashire and Yorkshire Boilers. Practical Engr., vol. 63, no. 1767, Jan. 6, 1921, pp. 8-11, 2 figs. Comparison of two types.

Inspection. A National System for the Inspection and Registration of Steam Boilers. Power, vol. 53, no. 2, Jan. 11, 1921, pp. 58-61. Plea for adoption by all States of Boiler Code of Am. Soc. Mech. Engrs., which was formulated by committee composed of representatives of users, designers and manufacturers of boilers and boiler materials after numerous and exhaustive hearings in which representatives of every interest affected took part. This Boiler Code has been adopted as standard by Boiler Inspection Departments of 17 states.

Körting Universal. A New Boiler Adaptable to Use of Different Kinds of Fuel (Ein neuer Heizkessel für verschiedenartige Brennstoffe), Johannes Körting. Gesundheits-Ingenieur, vol. 43, no. 47, Nov. 20, 1920, pp. 554-556, 2 figs. Describes the Körting universal boiler for central heating constructed along lines of the cast-iron sectional boiler with the difference that the separate heating units are arranged, not back of, but alongside of each other. Its noteworthy features are pointed out and results of tests are given which confirm its feasibility.

Marine. See MARINE BOILERS.

Water Purification Chamber. Builds Water Purifier in Vertical Boiler. Iron Trade Rev., vol. 68, no. 4, Jan. 27, 1921, pp. 293, 1 fig. Locomotive crane boiler equipped with annular scale chamber placed between tubes and shell plate. Feedwater passes through scale chamber and attains temperature at which scale forming impurities are liberated from solution without chemicals.

BOILERS, WATER-TUBE

Mercantile Marine. Advantages of the Use of the Water-Tube Boiler in the Mercantile Marine, James Kemnal. North-East Coast Instn. of Engrs. & Shipbuilders, Advance paper, 9 pp. 8 figs. Advantages of water-tube boiler over cylindrical type.

BORING MACHINES

Horizontal. Recent Machine Tool Developments. Engineering, vol. 111, no. 2873, Jan. 21, 1921, pp. 66-69, 25 figs. partly on supp. plate. Horizontal boring machines.

BRAKES

Kunze-Knorr. The Standardization of Railroad Brakes (Zur Frage einer einheitlichen Eisenbahn-Bremse), C. Wetzel. Schweizerische Bauzeitung, vol. 77, no. 3, Jan. 13, 1921, pp. 29-33, 5 figs. Contains abstract of pamphlet describing and illustrating the Kunze-Knorr brake for freight trains. It is claimed that the Kunze-Knorr brake fulfills conditions required of a continuous freight-train brake as set up by the International Commission in 1909.

Shoe Design. Designing Brake Heads for Uniform Shoe Wear, H. M. P. Murphy. Ry. Mech. Engr., vol. 95, no. 2, Feb. 1921, pp. 107-108, 5 figs. Principle applicable to heads used on wheels revolving in one or both directions.

BRASS

Nickel. Nickel Brasses. Chem. & Mettallurgical Eng., vol. 24, no. 6, Feb. 9, 1921, pp. 261-265, 6 figs. Summary of work of Leon Guillet published in "Revue de Metallurgie" of 1913 and 1920 on important role played by nickel in manufacture of low-copper ternary brasses.

Ternary. Ternary Brasses. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 177-178, 4 figs. Mathematical study of equilibrium diagram, and results of studies made by various investigators, notably L. Guillet in Revue de Métallurgie.

BROACHES

Manufacture. The Design and Manufacture of Broaches. Eng. Production, vol. 2, no. 17, Jan. 27, 1921, pp. 122-126, 3 figs. With special reference to parts having internal splines.

BUILDING CONSTRUCTION

Structural-Steel Standards. Construction Practice (Aus der Konstruktionspraxis), Rud. Kramer. Eisenbau, vol. 12, no. 1, Jan. 18, 1921, pp. 7-18, 10 figs. Writer points to the absence of generally applicable standards in structural steelwork and presents, as result of experience, tables for rivet diameters, distances from center of rivet to outside of angle, distances of rivet from edge of plate, pitch of rivets, lengths of angles, etc.

BUILDINGS

Steel-Frame. See ELECTRIC WELDING, Steel-Frame Buildings.

C

CAR AXLES

Design. Notes on Axle Design. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 494-495, 3 figs. Chart for determining centrifugal force exerted on car axles when turning a curve.

CAR WHEELS

Chilled - Iron. Chilled - Iron Car - Wheels — Their Manufacture, Properties and Uses (Les roues en fonte trempée leur fabrication, propriétés et usages), M. E. Polushkin. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 713-735, 20 figs. European and American practices contrasted. (To be continued.)

CARBURETORS

Asmo. Some Carburation Points, and a New Carburettor—The Asmo. Auto-Motor Jl., vol. 26, no. 2, Jan. 13, 1921, pp. 41-42, 5 figs. Instrument incorporates vacuum-feed fuel-supply.

Kerosene. The "Gaserator." Auto-Motor Jl., vol. 26, no. 1, Jan. 6, 1921, p. 20, 1 fig. Application of vaporization system of carbureting kerosene, especially for variable speeds of automobile conditions.

Reatomizing Device. A Re-Atomizing Device. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, p. 159, 1 fig. Spacer into which is pressed venturi throat carrying four small tubes is placed between carburetor and manifold. Ejector effect on four tubes which extend into throat tends to draw into annulus any liquid gasoline which may be passing up wall of carburetor and to eject it from tubes in atomized condition.

CARS

Container. Container Car in Express Service on N. Y. C. Lines. Ry. Age, vol. 70, no. 5, Feb. 4, 1921, pp. 315-316, 4 figs. Experimental car operated between New York and Chicago by Am. Ry. Express Co. Car is nine-section express car, its sectional cargo space consisting of nine separate containers or steel boxes firmly secured on car to prevent shifting during train movement.

CASE-HARDENING

Bibliography. Review of Case Carbonizing, 1920, O. A. Knight. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 51-54 and 65. Review and synopsis of important articles relative to case carbonizing which have appeared in current technical journals during past year.

Nitrogen and. Nitrogen and Case-Hardening, Henry Fay. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 289-290. Nitrogenizing process which takes place when steel is heated in cyanide.

Steel. A New Method of Case Hardening Steel, William J. Merten. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 270-273, 1 fig. Heated steel is brought into contact with pure nascent gas continuously generated in separate unit, preferably under pressure.

CAST IRON

Briquetting Refuse. The "Boreas" Cast-Iron Refuse Briquetting Machine. Foundry Trade Jl., vol. 23, no. 229, Jan. 6, 1921, p. 20, 1 fig. Manufactured by Colley Engineering & Machinery Co., London, England.

CEMENT

Bauxite. Cast Cements and the Electric Furnace, M. J. Bied. Practical Engr., vol. 63, no. 1767, Jan. 6, 1921, pp. 6-7, 2 figs. Strength of bauxite cement. Translated from Revue de l'Ingenieur et Index Technique.

CEMENT, PORTLAND

"Marque Speciale." "Marque Speciale" Swiss Cement. Cement & Eng. News, vol. 33, no. 2, Feb. 1921, pp. 30-32. Portland cement with properties for developing early strength.

CENTRAL STATIONS

Economical Developments. Policies for Future Power Development, John Price Jackson. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 102-106 and (discussion) pp. 106-107, and 110. Demand for central-station electric power in U. S. is contrasted with situation in England, and physical, public and financial relationships that are essential for relieving present stress and meeting that demand with reasonable economy and conservation of natural resources and labor are set forth.

France. Project of Departmental Distribution of Electrical Energy in Savoie (Projet de reseau départemental de distribution d'énergie électrique en Savoie). Revue générale de l'Electricité, vol. 9, no. 5, Jan. 29, 1921, pp. 147-150, 1 fig. Project for construction of central electric station in French department.

New York Metropolitan District. Heat, Light and Power for the Metropolitan District of New York.

William Barclay Parsons. Power, vol. 53, no. 8, Feb. 22, 1921, pp. 324–326. Economical advantages of constructing central station to supply needs of district. Total installation in district amounted in 1919 to 2,100,000 hp. and it is expected this will increase in 1930 to 4,500,000 hp.

Operation. Operation of Electric Central Stations (Etude des conditions de fonctionnement des centrales électriques), G. Jochmans. Société Belge des Electriciens, vol. 34, Nov.-Dec. 1920, pp. 261–273, 6 figs. Construction of load diagram. (To be continued.)

CHAINS

Testing. Chains and Lifting Gear. Mech. World, vol. 69, no. 1776, Jan. 14, 1921, pp. 36–37. Proving and testing. (Abstract.) Home Office pamphlet, of H. M. Stationery Office, Imperial House, London.

CHUCKS

Magnetic. Magnetic Chucks, Ellsworth Sheldon. Am. Mach., vol. 54, nos. 4 and 5, Jan. 27 and Feb. 3, 1921, pp. 121–124 and 7 figs., 177–180, 8 figs. Principle of operation and structural details of various types; classification of magnetic chucks.

Magnetic Chucks—II. Am. Mach., vol. 54, Nos. 6, 7 and 8, Feb. 10, 17 and 24, 1921, pp. 213–217, 8 figs., 265–269, 14 figs., and 324–329, 12 figs. Feb. 10: History of developments. First magnetic chuck patent issued 48 years ago. Early chucks and their construction. Progress from 1873 to 1914. Feb. 17: Characteristics of various types. Feb. 24: Downes, Patton and Walker types.

CLUTCHES

Ring. The Design of Expanding Ring Clutches, W. A. Milnes. Mech. World, vol. 69, no. 1776, Jan. 14, 1921, pp. 25–26, 4 figs. Computation of dimensions.

COAL

Briquetting. Anthracite Conservation by Briquetting, A. L. Stillman. Coal Industry, vol. 4, no. 2, Feb. 1921, pp. 100–103, 4 figs. Description of briquetting plant.

Distillation. By-Products of Coal Distillation (L'extraction des différents produits de la distillation de la houille), A. Grebel. Génie Civil, vol. 78, no. 2, Jan. 8, 1921, pp. 35–37, 2 figs. Processes and installation of Commentry-Fourchambault et Decazeville Society.

Recovery from Ashes. Fuel Recovery from Ashes. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, p. 99, 1 fig. Typical plant in operation in French works for recovery from ashes unburnt coal in form of coke breeze.

COAL BREAKERS

Concentrating Tables. New Methods are Used for Preparing Small Sizes by Locust Mountain Coal Co., Dever C. Ashmead. Coal Age, vol. 19, no. 4, Jan. 27, 1921, pp. 171–179, 16 figs. At Weston Colliery Breaker sizes below pea are cleaned by concentrating tables and specially designed jig.

COAL HANDLING

Government Yard. How Uncle Sam Handles Coal at Washington, Frederick G. Cottrell. Coal Trade Jl., vol. 52, nos. 4 and 5, Jan. 26 and Feb. 2, 1921, pp. 113–115, 2 figs. and 142–144, 5 figs., Jan. 26: Layout of government yard which delivered 193,278 gross tons to various departments during past fiscal year. Feb. 2: Bin construction for loading of trucks.

Pipe Lines. Pumping Coal from Mine to Seaboard, C. H. Thomas. Sci. Am., vol. 124, no. 7, Feb. 12, 1921, pp. 121, 126 and 139, 7 figs. Scheme for shipping coal through pipe lines.

Scraper Loading. Costs of Scraper Loading and Conditions Under Which It Works Best, A. B. Benedict. Coal Age, vol. 19, no. 5, Feb. 3, 1921, pp. 222–226, 4 figs. Where coal is clean, faces fairly long, top good and above all where cars can be supplied regularly and in adequate number, scraper loader has successfully met widely varying conditions.

COAL MINES

Bituminous, Fire Prevention in. Causes and Prevention of Fires and Explosions in Bituminous Coal Mines, Edward Steidle. Dept. of Interior, Bur. of Mines, Miners' Circular 27, 1920, 75 pp. 117 figs. List of common causes of fires and explosions, prepared from examination of report of State Mine Dept. and of Bur. of Mines.

Electricity in. State Mining Laws on the Use of Electricity in and about Coal Mines, L. C. Ilsley. Dept. of Interior, Bur. of Mines, technical paper 271, 1920, 53 pp., 1 fig. 28 states have regulations prepared by commissions or enacted laws governing operation of coal mines.

COAL TAR

Research. Coal-Tar Research at Shadyside, John Morris Weiss and Charles Raymond Downs. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 150–155, 6 figs. Account of expansion of scope and facilities of research department of Barrett Co. Study of physical properties, methods of testing and development of synthetic products.

COAL WASHING

Experimental Station. Coal Washing at the Northwest Experimental Station, Earl R. McMillan. Elec. Rev. (Chicago), vol. 78, no. 4, Jan. 22, 1921, pp. 142–145, 2 figs. Bur. of Mines plant prepared to recover 150,000 tons of culm in one dump

COKE

Hardness Testing. Importance of Hardness of Blast Furnace Coke, Owen R. Rice. Iron Age, vol. 107, no. 6, Feb. 10, 1921, pp. 380–381, 1 fig. Apparatus used at Bethlehem Steel Co. to determine hardness of coke. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

COKE MANUFACTURE

Demster-Toogood Retorts. Demster-Toogood Continuous Verticals at Hawick. Gas World, vol. 74, no. 1905, Jan. 22, 1921, pp. 64–66, 2 figs. Demster-Toogood patented coking retort.

COKE-OVEN GAS

Composition. Composition of Coke-Oven Gases (Sur la composition de quelques gaz de fours à coke), P. Lebeau and A. Damienn. Comptes rendus des séances de l'académie des Sciences, vol. 171, no. 26, Dec. 27, 1920, pp. 1385–1386. Records of examinations.

COKE OVENS

By-Product. By-Product Coke Oven Plants of Yesterday and Today, J. M. Hastings, Jr. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 10–13, 6 figs. Progress of art in 28 years as illustrated by old and new plants of Semet-Solvay Co. Despite improvements original characteristics still remain.

Jones & Laughlin New By-Products Plant. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 13–17, 1 fig. Plant consists of five batteries of by-product ovens, each battery having 60 ovens of Koppers crossed regenerative type.

The By-Product Coke Oven Industry, 1920, C. J. Ramsburg. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, p. 18. First large battery of triangular-flue-type ovens completed and successfully operated during year. Special construction features of installations of year.

COMPRESSED AIR

Metering. The Metering of Compressed Air, John L. Hodgson. Colliery Guardian, vol. 121, no. 3135, Jan. 28, 1921, pp. 271–272, 10 figs. Types of meters in use. Paper read before Midland Inst. Min., Civil & Mech. Engrs.

CONCRETE

Porous. Secrets of Porete Manufacture, Ernest Walter. Tech. Eng. News, vol. 1, no. 10, Feb. 1921, pp. 5 and 12, 3 figs. Naphthalene or paraffin is mixed with cement in ordinary mixer and mixture poured into moulds of any desired shape. After setting for 24 hrs. slabs are removed and put into large tank to which steam is applied. Chemical melts slowly out of mixture.

Specifications. Some Controversal Points in Concrete Specifications, Frank Barber. Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921, pp. 117–122. Discussion on difficulties in preparing concrete specifications, with particular reference to provision of greater detail in clauses dealing with workmanship.

Strength. How Quantity of Mixing Water Affects Strength of Concrete. Eng. World, vol. 18, no. 2, Feb. 1921, pp. 95, 1 fig. Diagram constructed from tests made at Structural Material Research Laboratory, Lewis Inst., Chicago. Rule derived is to use smallest quantity of mixing water that will produce workable mix.

Tannic Acid, Effect on. Effect of Tannic Acid on the Strength of Concrete, Duff A. Abrams. Structural Matls. Research Laboratory, Lewis Inst., bul. 7, Nov. 1920, 31 pp., 16 figs. Tests conducted under auspices of Am. Soc. for Testing Matls. Strength of concrete was reduced for all percentages of tannic acid, for all mixes and ages used. Less than 0.1 per cent of tannic acid in terms of weight of aggregate may reduce strength of concrete to one-half its normal value. Reprinted from Proc. Am. Soc. for Testing Matls.

CONCRETE CONSTRUCTION

Costs. On the Economics of Building Design, J. Morrow Oxley. Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921, pp. 123–130, 8 figs. Graphs and tables showing relative effect on cost of variations in proportions, dimensions and floor loading for standard types of buildings.

Hessian System. The Hessian Fabric System of Concrete Construction. Concrete & Constructional Eng., vol. 16, no. 1, Jan. 1921, pp. 62–64, 3 figs. Walls are erected in situ by means of wooden molds which are raised course by course until wall is completed.

Stresses. Latest Developments in Concrete, H. C. Boyden. Nebraska Blue-Print, vol. 19, no. 4, May 1920, pp. 72–85. Survey of researches on stresses of concrete structures, and of laws which have been formulated for designing them.

CONCRETE, REINFORCED

Bond in. Bond in Reinforced Concrete. Engr. vol. 131, no. 3395, Jan. 21, 1921, pp. 65–66. Results of tests in which bars were pushed through prisms of concrete. Comparison with tests in which bars were pulled out.

Slabs. The Strength of Reinforced-Concrete Slabs with Cross-Reinforcement (Krydsarmerede Jærnbetonpladers Styrke), N. J. Nielsen. Ingeniören, vol. 29, no. 94, Nov. 24, 1920, pp. 723–728, 8 figs. It is shown that the ultimate stresses in reinforced-concrete can be calculated by means of differential equations. Numerical examples for square and rectangular plates.

Stress Formula. Formula for Computing Compressive Stress that can be Borne by Reinforced Concrete (Formule rationnelle du taux de compression du béton), M. Mougnié. Annales des Ponts et Chaussées, vol. 5, no. 10, Sept.-Oct. 1920, pp. 142–154. Formula involving coefficient which is ratio of theoretical moduli of elasticity of steel and concrete.

CONTRACTORS

Code of Ethics. Proposed Code of Ethics for Contractors. Eng. News-Rec., vol. 86, no. 6, Feb. 10, 1921, pp. 257–258. Submitted at New Orleans convention for consideration of the members of Associated General Contractors.

CORE OVENS

Electric. Electric Heating in the Iron Industry, Wirt S. Scott. Iron Age, vol. 107, no. 6, Feb. 10, 1921, pp. 384–385. Development of electric core ovens for foundry and experiences with heat treating furnaces.

COST ACCOUNTING

Power Plants. Armour System of Power Plant Accounting—II, O. A. Anderson. Power, vol. 53, no. 5, Feb. 1, 1921, pp. 170–174, 11 figs. Report system supplemented by charts and table to eliminate calculations.

CRANES

Control Apparatus. The Bergmann System of Control of Crane Hoisting Gear (Steuerung von Kranhubwerken, System Bergmann), Ernst Blau. Elektrotechnik n. Maschinenbau, vol. 39, no. 3, Jan. 16, 1921, pp. 29–31, 1 fig. Describes arrangement and operation of control apparatus developed by the Bergmann Electrical Works, Berlin, with which it is possible to effect a speed range from 1 to 60, and which has given satisfactory service in workshops, foundries, steelworks, etc.

Floating. Self-Propelled Floating Crane. Steamship, vol. 32, no. 379, Jan. 1921, pp. 177–178, 1 fig. 200-ton floating crane at Mersey Docks and Harbour Board, Liverpool.

CRANKSHAFTS

Crankpin Turning Machine. Rotating-Tool Crank Pin Turning Machine. Engr., vol. 131, no. 3396, Jan. 28, 1921, pp. 102–103, 3 figs. Machine belongs to class in which crankshaft is held stationary while tools for turning up pins and inside surfaces of webs are carried in revolving slide. Manufactured by George Richards & Co., England.

D

DIE CASTINGS

Uses. Application of Inserts to Die Castings, M. Stern. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 284–286, 9 figs. Division of application of inserts into four general groups. Various methods of providing inserts with anchors. Locating points.

DIES

Manufacture. A School for Die Sinkers, J. H. G. Williams. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 36–38. Manner in which die-sinkers' school is conducted by Billings & Spencer Co., Hartford, Conn.

Composition and Hardening Die Blocks, James H. Herron and A. L. Wurster. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 34–36. Physical properties conferred by composition. Tempers at which die blocks are furnished.

The Design and Construction of Press Tools—I. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 148–149, 4 figs. Table of allowances for punch and die for different thicknesses and materials.

DIESEL ENGINES

Armstrong-Sulzer. The Armstrong-Sulzer Marine Diesel Engine. Steamship, vol. 32, no. 379, Jan. 1921, pp. 179–182, 5 figs. Manufactured by Sir W. G. Armstrong, Whitworth & Co., England.

Marine. Marine Diesel Engine of 5,400 Shaft Horse-Power. Motorship, vol. 6, no. 2, Feb. 1921, p. 121, 2 figs. Sulzer two-cycle motor for propulsion of ocean liners.

Nordberg. Nordberg 2000 B. H. P. Two-Cycle Diesel Engine. Motorship, vol. 6, no. 2, Feb. 1921, pp. 114–118, 5 figs. Carels type four-cylinder engine with 500 b.hp. cylinder output.

Shop, Glasgow. Diesel-Engine Works in Glasgow (Dieselmaschinenfabrik in Glasgow), Karl Bernhard. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 4, Jan. 22, 1921, pp. 85–88, 12 figs. Notes on location, arrangement, design, foundation and heating of plant designed by author, work on which was begun under his superintendence in 1913, and greater part of iron construction and machinery was supplied by German firms.

Solid-Injection. New American Solid-Injection Engine. Motorship, vol. 6, no. 2, Feb. 1921, pp. 134–135, 5 figs. Small marine Diesel-motor with mechanical-injection of fuel, built on Pacific coast.

DRILLING

Square Holes. Square Hole Drilling Attachment. Engineering, vol. 111, no. 2872, Jan. 14, 1921, pp. 43–44 and 46, 9 figs. Radbore head for drilling square holes from solid exactly as ordinary drilling machine drills round holes only difference in operation being that feed is put on traversing work instead of traversing drill.

DRILLING MACHINES

Pneumatic Clamps. Pneumatically Operated Clamps for Drilling Machines, J. V. Hunter. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 180–181, 4 figs. Devices developed in locomotive shops of Wabash Railroad Co., Decatur, Ill.

Vertical. A New Vertical Drilling Machine. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, p. 103, 2 figs. Machine is designed for high-speed twist

drills and is capable of drilling holes up to 2 1/2 in. diameter in steel. It is manufactured by Fairbairns & Co., Leeds, England.

DROP FORGING

Industry. The Drop Forging Industry in 1920–1921, L. W. Alwyn Schmidt. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 4–7. Past year was one of general readjustment. Change in business psychology recommended. Effect of readjustment of prices on level of production still in excess of prewar volume.

DYNAMOMETERS

Heenan-Froude. The Heenan-Froude Dynamometer. Flight, vol. 13, no. 4, Jan. 27, 1921, pp. 65, 2 figs. Dynamometer for testing internal-combustion engines.

E

EFFICIENCY, INDUSTRIAL

Olympia Exhibition. The "Efficiency" Exhibition at Olympia. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 176. Machine and methods designed to bring about personal and civic efficiency and efficiency of transport of production and of use of fuel. (To be continued.)

ELECTRIC DRIVE

Industrial Applications. The Electric Drive in Industry. Beama, vol. 8, no. 1, Jan. 1921, pp. 45–54, 15 figs. Applications of electric drive to printing presses, and machine tools.

ELECTRIC FURNACES

Fuel-Fired Furnaces vs. Relative Thermal Economy of Electric and Fuel-Fired Furnaces, E. F. Collins. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 217–227 and (discussion) pp. 227–229, 5 figs. Graphs showing relative efficiency at various temperatures, also relative cost of fuel and fuel heat losses.

Induction. High-Frequency Induction Steel-Furnace, E. F. Northrup. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 309–311, 3 figs. Combination of crucible-melting flexibility with advanced practice of electric melting, manufactured by Ajax Electrothermic Corp.

Iron Foundries. Electric Furnaces in the Iron Foundry, Richard Moldenke. Iron Age, vol. 107, no. 7, Feb. 17, 1921, pp. 437–439. Costs and advantages of duplexing or electric melting of cold scrap. Control of sulphur, manganese and phosphorus. Paper before Am. Inst. Min. & Metallurgical Engrs.

Non-Ferrous Metals. Electric Furnaces for Non-Ferrous Metals. John B. C. Kershaw. Engr., vol. 131, no. 3394, Jan. 14, 1921, pp. 44 and 48–50, 7 figs. Results of tests made under three different systems of operation with two furnaces, one of ordinary brass-melting type, provided with lift-out crucible, and other of tilting type. Systems of operation were (1) continuous operation for 24 hours a day, (2) 10-hr. operation, and (3) special 10-hr. operation, in which sufficient power was maintained during night to keep furnace hot.

Oil, Gas and Coal Furnaces vs. Relative Economy of Oil, Gas, Coal and Electric Heated Furnaces, Seth A. Moulton and W. H. Lyman. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 249–270. Comparative operating costs, comparative annual production, and comparative advantages and disadvantages.

Operation. Operating Details of Electric Furnaces, Edward T. Moore. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 171–176, 7 figs. Excerpt from report of electric furnace committee of Association of Iron & Steel Electrical Engineers based on questionnaire submitted to steel manufacturers operating electric furnaces.

Russ. A New Electric Arc Furnace (Ein neuer elektrischer Lichtbogenofen), E. Fr. Russ. Giesserei-Zeitung, vol. 18, no. 1, Jan. 1, 1921, pp. 3–5, 2 figs. Description of the Russ furnace, said to possess important advantages over former types; it can be used for melting copper, aluminum, other metals and alloys, as well as for the production of pig-iron casting, special steel, ferromanganese, ferrosilicon, etc.

Smelting. Electric Smelting Furnaces—I, F. Rowlinson. Beama, vol. 8, no. 1, Jan. 1921, pp. 14–22, 8 figs. Survey of developments in utilization of electric furnace for steel making.

Steel Manufacture. English and American Types of Electric Iron and Steel Furnaces Compared, John B. C. Kershaw. Foundry Trade Jl., vol. 23, nos. 229, 230 and 231, Jan. 6, 13 and 21, 1921, pp. 5–7, 2 figs., 29–30, 2 figs., and 53–55, 3 figs. Heroult, Ludlum and Renuerfelt types.

The Electric Furnace, E. T. Moore. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 1, Jan. 1921, pp. 5–8. Recent applications, specially in steel manufacture.

[See also STEEL CASTINGS, Electric Melting.]

ELECTRIC LOCOMOTIVES

Comparison of Types. Economic and Constructive Aspects in the Construction of Modern Large Electric Locomotives (Wirtschaftliche u. konstruktive Gesichtspunkte im Bau neuerer Gross-Elektrolokomotiven), Alb. Laternser. Schweizerische Bauzeitung, vol. 77, no. 5, Jan. 29, 1921, pp. 49–51, 6 figs. Description of the 1C + C1 type of the Swiss Federal Railway for high-voltage single-phase current, 15,000 volt, 16 1/3 periods, and the 2 C 2 type Gr. E 332 of the Italian State Railroad for 3-phase current 3000 volt, 16 1/3 periods, both constructed by the Oerlikon Machine Factory; and a comparison of them with recent American types of the Gen. Elec. and Westinghouse Cos.

Design. The Application of the Electric Locomotive to Main-Line Traction on Railways, H. E. O'Brien. Jl. Instn. Elec. Engrs., vol. 28, no. 295, Sept. 1920, pp. 858–869, 9 figs. Elements of design are developed from examination of performance data of C. M. & St. P. Railway and on Italian and Swiss railways.

Freight. Freight Electric Locomotives of the Swiss Federal Railways, Constructed by Oerlikon Works (Locomotives électriques à marchandises des chemins de fer fédéraux suisses construites par les ateliers d'Oerlikon). Génie Civil, vol. 78, no. 2003, Jan. 1, 1921, pp. 1–3, 2 figs. Type, 2–6–6–2; tension, 15,000 volts; maximum grade, 26 per cent; horsepower, 1700.

Operation. Train Handling with Electric Locomotives, W. S. H. Hamilton. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, pp. 227–231, 5 figs. Records of operation in electrified section of C. M. & St. P. Railway.

ELECTRIC WELDING

Seam-Welding, Machines. Electric Seam-Welding Machines, Alfred Gradenwitz. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 128–129, 5 figs. Intermittent process designed by German firm.

Steel-Frame Buildings. Electrically Welded Steel Frame Building. Engineering, vol. 111, no. 2872, Jan. 14, 1921, pp. 55–56, 8 figs. Details of buildings constructed by welding methods in England.

EMPLOYMENT MANAGEMENT

Des Moines Employment Association. Consolidate Employment Study, H. C. Pfund. Iron Trade Rev., vol. 68, no. 4, Jan. 27, 1921, pp. 286–289 and 293, 6 figs. Association formed by employers in Des Moines, Iowa, "to promote harmony and coöperation between employer and employee," and to "encourage continuous employment."

Duties of Manager. The Employment Manager in an Engineering Works. Engineering, vol. 111, no. 2873, Jan. 21, 1921, pp. 65–66. Duties of manager. Technique of hiring men.

Railways. The Functions of a Railway Employment Service. J. C. Clark. Ry. Age, vol. 70, no. 5, Feb. 4, 1921, pp. 329–331. Methods of selecting best men and following up new employees.

Selecting Employees. Simple Tests for Selecting Office Workers, Eugene J. Benge. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 91–93, 3 figs. Suggests method of devising and standardizing clerical tests.

Sizing Up the Qualities of a Man. Walter D. Scott. Can. Manufacturer, vol. 41, no. 2, Feb. 1921, pp. 39–41, 1 fig. Suggested classification of personnel qualifications. Position for which man of known character is best suited.

The Present Status of Industrial Psychotechnology with Special Regard to Foundry Practice (Der gegenwärtige Stand der industriellen Psychotechnik unter besonderer Berücksichtigung des Giessereigewerbes), W. Moede. Giesserei-Zeitung, vol. 18, nos. 1 and 2, Jan. 1 and 15, 1921, pp. 1–3 and 24–27, 8 figs. Brief outline of the present approved methods for the psychotechnical testing of the adaptability of industrial apprentices and discussion of their practical value.

ENAMELS

Iron and Steel. A Reading List on Vitreous Enameling on Iron and Steel, Clarence Jay West. Jl. Am. Ceramic Soc., vol. 4, no. 1, Jan. 1921, pp. 47–64. Bibliography for years 1907 to 1920.

ENGINEERS

Training of. Some Suggestions for the Training of Engineers, Aunson S. J. Hall. Trans. Inst. Mar. Engrs., vol. 32, Dec. 1920, pp. 251–267 and (discussion) pp. 267–277. Combination of technical training and industrial apprenticeship.

EXECUTIVES

Duties of. How to Develop Executive Ability Through Personality, G. Sumner Small. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 115–118. Study of principle underlying good organization. Means whereby executive can definitely, systematically and surely build morale in his subordinates.

EXHAUST STEAM

Utilization of. Utilization of the Exhaust Heat of a 100-Hp. Reciprocating Steam Engine (Die Abwärmeausnutzung einer 100-PSi-Kolbendampfmaschine). Elektrotechnischer Anzeiger, vol. 38, no. 11, Jan. 20, 1921, pp. 49–50. Shows with the aid of an example to what extent the exhaust steam of an engine using superheated steam can be utilized.

F

FACTORIES

Construction. Features of the New Dunlop Factory, Bernard H. Prack. Can. Manufacturer, vol. 41, no. 2, Feb. 1921, pp. 35–38, 5 figs. Construction details, layout and equipment of factory and office building.

Machine Tool Plant of New Design, F. L. Prentiss. Iron Age, vol. 107, no. 5, Feb. 3, 1921, pp. 311–316, 11 figs. Modified monitor roof instead of sawtooth type in plant of Foote-Burt Co., Cleveland.

The "Fordson" Factory—Cork, H. C. Johnson. Concrete & Constructional Eng., vol. 16, no. 1, Jan. 1921, pp. 5–13, 10 figs. Layout and structural details of concrete buildings.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FARM MACHINERY

Electric vs. Steam Drive. Electric Motor vs. Locomobile (Elektromotor oder Lokomobile?), B. Jacobi. Elektrotechnischer Anzeiger, vol. 38, nos. 6, 7 and 8, Jan. 12, 13 and 15, 1921, pp. 25–26, 29–30 and 33–34. Discussion of the relative economy of steam- and electrically-driven farm machinery.

FATIGUE

Industrial. Fatigue in Steel Works. Iron & Coal Trades Rev., vol. 102, no. 2758, Jan. 7, 1921, pp. 6–9. Report of Industrial Fatigue Research Board, England.

Industrial Fatigue, Charles S. Myers. Jl. Royal Soc. of Arts, vol. 69, no. 3558, Jan. 28, 1921, pp. 150–156 and (discussion) pp. 156–159. Method of measuring fatigue.

Output in Boot and Shoe Factories. Eng. & Indus. Management, vol. 5, no. 3, Jan. 20, 1921, pp. 70–72, 9 figs. Investigations carried out by Industrial Fatigue Research Board.

FERROMANGANESE

Electric-Furnace Production. The Electric Furnace for Production of Ferromanganese, E. S. Bardwell. Jl. Electricity & Western Industry, vol. 46, no. 3, Feb. 1, 1921, pp. 120–122. Method of Anaconda Copper Mining Co.

FIRE EXTINGUISHERS

Carbon Tetrachloride. Corrosive Action and Products Formed when Carbon Tetrachloride Extinguisher Liquids are Applied to Fires, A. H. Nuckolls. Nat. Fire Protection Assn., vol. 14, no. 3, Jan. 1921, pp. 221–236, 5 figs. Tests to determine corrosive action and nature of fumes resulting from application of carbon tetrachloride extinguisher liquid to fires.

FIREBRICK

Spalling. A Study of Spalling, Raymond M. Howe and Robert F. Ferguson. Jl. Am. Ceramic Soc., vol. 4, no. 1, Jan. 1921, pp. 32–46, 11 figs. Comparison of laboratory spalling tests of firebricks and behavior in service.

FOREMEN

Duties of. The New Foreman for the New Day—Fred H. Rindge, Jr. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 109–111. Duties and responsibilities of foremen.

FORGING

Drop Hammers. Application of Compressed Air to Drop Hammers and Forging Presses. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, p. 27. Details of work done at U. S. Navy Yard, Norfolk, Va.

Forge Shops. Forge Plant for 75 MM Projectiles, T. W. Towler. Blast Furnace & Steel Plant, vol. 9, no. 2, Feb. 1921, pp. 168–171, 5 figs. Shop designed to turn out from 50,000 to 55,000 shell forgings daily.

Gun-Forging Plant. Armor-Plate and Gun-Forging Plant of the United States Navy. Roger M. Freeman. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 14–26, 10 figs. Description of government-built and operated naval ordnance plant at South Charleston, West Va. "H" type forge and furnace building among features of plant.

Swaging. Swaging Practice—II (Plaudereien aus der Gesenkschmiede), Paul Heinrich Schweissguth, Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 5, Jan. 29, 1921, pp. 109–115, 37 figs. Deals with molding of swages. Working process is exemplified on a shrapnel double fuse. Notes on raw material, swage, swage with several parts, preliminary swaging, losses of material through waste and removing fins; determination of the preliminary swage; errors in design of swages and their prevention; useful possibilities of process.

FORGINGS

Sand-Blasting. Sand-Blasting Forgings and Sand, Blasting Versus Pickling, H. D. Gates. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 72–74, 4 figs. Comparison of costs.

FOUNDRIES

Germany. Shows Trends in German Practice, Hubert Hermanns. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 92–93, 3 figs. Developments in molding and metallurgical practice as featured at annual meeting of German Iron Foundries Assn.

Natural-Gas Melting. Melts Gray Iron with Natural Gas. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 139–142, 5 figs. Experience of company in melting gray iron with natural gas without regenerating either gas or air.

Steel. Combines Steel and Alloys Casting, Hubert Hermanns. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 154–157, 6 figs. Mark Steel foundry of Wengern, Germany.

Dust Removal in. Arrangement and design of Dust-Removal Plants for Foundry Cleaning shops (Anordnung und Bemessung von Entstaubungsanlagen für Gussputzereien), W. Kaempfer. Stahl u. Eisen, vol. 41, no. 4, Jan. 27, 1921, pp. 110–113, 8 figs. Gives average values showing volumes of air to be exhausted per minute for various classes of machines, and describes different methods for the separation of dust and the different types of machines used therefor.

[See also MOLDS.]

FUELS

Oil. See OIL FUEL.

Solid, Patented. Progress in Furnace Installations for Solid Fuels (Neuerungen an Feuerungsanlagen für feste Brennstoffe), H. Pradel. Feuerungstechnik, vol. 9, no. 8, Jan. 15, 1921, pp. 65–69, 10 figs. Quarterly yearly report. Review of recent domestic and foreign patents.

Turf. A New Process of Drying Turf for Fuel in Finland. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, p. 215. Raw turf in swamp is freed from all old roots and changed to thin mud, by powerful jet of water under pressure of 20 atmospheres. Mud is pumped out on drying field and spread in layers from 20 to 30 cm. in depth which are subsequently cut into bricks.

Utilization. The Work of the Committee for the Utilization of Fuels (Travaux de la commission d'utilisation des combustibles), Cornu-Thénard. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 757–764. Committee was appointed by French Ministry of Public Works. First report of Committee deals with results obtained in steel works with mixture of coal and wood in Martin furnace.

[See also COAL; LIGNITE, OIL FUEL; PULVERIZED COAL.]

FURNACES

Recuperative. A New Type of Recuperative Furnace. Foundry Trade Jl., vol. 23, no. 230, Jan. 13, 1921, pp. 32–34, 5 figs. Developed in connection with research work on glass and refractories carried on at National Physical Laboratory, England.

FURNACES, ANNEALING

Continuous. Tunnel Furnace for Continuous Annealing. Iron & Coal Trades Rev., vol. 102, no. 2759, Jan. 14, 1921, p. 49, 2 figs. Advantages claimed for tunnel type of furnace is that by gradual advance of cold material into annealing zone all calorific value of waste gases can be usefully absorbed, leaving only sufficient temperature in outlet to create necessary draft in chimney stack.

FURNACES, BOILER

Lignite-Burning. The Adaptation of Steam-Boiler Furnaces to Lignite Coals (Die Umstellung der Dampfkesselfeuerungen auf Rohbraunkohle), H. Pradel. Braunkohle, vol. 19, nos. 38, 39 and 40, Jan. 1, 8 and 15, 1921, pp. 469–472, 477–482 and 489–492, 7 figs. Impressions from the Furnace Engrs.' Convention in Berlin, Germany. Concludes with summary of author's recommendations.

Turbine. The Turbine Patent Furnace. Elec. Times, vol. 59, no. 1525, Jan. 6, 1921, p. 11, 2 figs. Designed on principle of impulse turbine. Air-trough corresponds to nozzle and fire-bars to blades of turbine.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HEAT-TREATING

Electric. Recent Developments in Electric Heat-Treating Furnaces, H. O. Swoboda. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 83–85. Applications to date. Classification of electric heating furnaces as to resistor construction, resistor material, charging and operating and control. Discussion of cost of operation.

FURNACES, REVERBERATORY

Charging Method. New Method of Charging Reverberatory Furnaces, J. O. Ambler. Eng. & Min. Jl., vol. 111, no. 5, Jan. 29, 1921, p. 226, 1 fig. Experimental machine designed for charging material at practically continuous rate into furnace by mechanical means, without production of dust.

G

GAGES

Developments. Recent Developments in Gauging Apparatus. Eng. Production, vol. 2, no. 15, Jan. 13, 1921, pp. 40–44, 12 figs. Machines recently introduced by Alfred Herbert, Coventry, England, notably gear pitch and concentricity measuring machine and universal gage measuring machine.

Dial. Gauging with Dial Instruments. Engr., vol. 131, no. 3395, Jan. 21, 1921, pp. 76–77, 4 figs. Dial gages for gaging thickness, length, diameters, depth, etc.

GAGING

Limit. Limit Gauging. Jl. Instn. Mech. Engrs., No. 9, Jan. 1921, pp. 1089–1124, 25 figs. partly on 5 supp. plates. Technical considerations on formation of system of limits. Description of gage testing apparatus designed and used at National Physical Laboratory, England.

GAS ENGINES

Steel Works. The Gas Engine in Iron and Steel Works, T. B. Morley. Elecn., vol. 86, no. 2227, Jan. 21, 1921, pp. 99–102, 9 figs. Galloway tandem-cylinder engines.

Testing. The Working and Testing of a Gas Engine, Arthur G. Robson. Practical Engr., vol. 63, no. 1768, Jan. 13, 1921, pp. 20–23, 18 figs. Methods of testing.

GAS TURBINES

Elements. The Gas Turbine. B. Pochobradsky. Beama, vol. 8, no. 1, Jan. 1921, pp. 9–13. Gas turbines are classified into explosion and constant-pressure turbines. Technical elements of each of these types are studied.

French Patent. European Inventions, J. H. Blakey. Power Plant Eng., vol. 25, no. 4, Feb. 15, 1921, pp. 232–234, 4 figs. French patent for internal-combustion turbo-motor. Also patented alloy for internal combustion engine valves. Composition of alloy is nickel, 67 per cent; iron, 1 to 5 per cent; and copper, 28 to 32 per cent.

GAS WORKS

Developments. Gasworks Engineering in 1920. Engr., vol. 131, no. 3393, Jan. 7, 1921, p. 12. Survey of developments.

GASOLINE

Natural Gas. Gasoline by the Charcoal Absorption Process, G. A. Burrell, G. G. Oberfell and C. L. Voress. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 156–160, 7 figs. Description of activated charcoal process for absorbing vapors from natural gas. Comparison with commercial processes; activated coconut shell charcoal; absorption and selection; steam distillation of saturated carbon; yields and quality of products.

Gasoline from Natural Gas. V—Hydrometer for Small Amounts of Gasoline, R. P. Anderson and C. E. Hinckley. Jl. Indus. & Eng. Chem., vol. 13, no. 2, Feb. 1921, pp. 144–145, 3 figs. Apparatus for rapid and fairly accurate determination of gravity of gasoline when quantity is insufficient to float usual type of hydrometer.

Peat as Source of. See PEAT, Gasoline from.

GEAR CUTTING

Hobbing Machines. Automatic Hobbing Machine. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 259–260, 3 figs. Machine designed for rapid production of helical and herringbone gears.

Newark No. 5 Automatic Gear-Hobbing Machine. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 157–158, 1 fig. Machine designed for rapid production of helical gears.

GEARS

Grinding. The Precision Grinding of Hardened Gears. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 158–161, 8 figs. Machine for grinding gears developed by Sulzer Bros., England.

Helical. See GEAR CUTTING, Hobbing Machines.

Worm. Worm Gear Design, S. Bramley-Moore. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 474–480, 20 figs. Study of forces acting, formulas for computing dimensions, and comparison of types of worm gears. Paper read before Instn. Automobile Engrs.

GRINDING

Centreless. Centreless Grinding. Eng. & Indus. Management, vol. 5, no. 2, Jan. 13, 1921, pp. 39–41, 3 figs. Machines which have been developed for grinding straight cylindrical work without centres.

Cylindrical, Speeds for. Work Speeds in Cylindrical Grinding. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 481–483. Importance of using proper speed. Fallacy of idea that the faster the rotation of work, the higher rate of production.

GRINDING MACHINES

Surface. Rotary Surface Grinding Machine. Engineering, vol. 111, no. 2874, Jan. 28, 1921, pp. 100–102, 13 figs. Constructed by Heald Machine Co., Worcester, Mass. Machine is designed for flat grinding of small articles such as can be held by magnetic chuck.

GUN METAL

Tests on. Gun-Metal, J. Arnott. Foundry Trade Jl., vol. 23, no. 229, Jan. 6, 1921, pp. 2–4, 11 figs. Suggests restriction of term "gun-metal" to ternary alloy copper-tin-zinc. Tests on metal of composition 87 per cent copper, 9 per cent tin, 3 per cent zinc and one per cent lead. Paper read before Scottish Branch Instn., British Foundrymen.

H

HACK-SAWING MACHINES

English. A New Hack Sawing Machine. Machy. (Lond.), vol. 17, no. 435, Jan. 27, 1921, p. 524, 2 figs. Designed to cut bars up to 6 in. diameter. Manufactured by Blundstone Engineering Service, Coventry, England.

HANDLING MATERIALS

Electric Power in. Application of Electrical Power to Modern Handling Plants, H. C. Widlake. Chem. Age (Lond.), vol. 4, no. 82, Jan. 8, 1921, pp. 38–40, 5 figs. Survey of developments.

Economies in Handling Materials in Industrial Plants, J. S. Tuthill. Elec. World, vol. 77, no. 4, Jan. 22, 1921, pp. 201–202. Instances of savings effected by electrically operated material handling machinery and examples of adaptation to cover varying needs.

Factories, Germany. Handling Materials in Factories (Werkstättentransporte), W. Dahlheim. Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 187–192, 13 figs. Portable hoisting apparatus. It is claimed that the latest German types of portable elevators are far superior to those of American make. Details of a new patented one-man tipping and elevating truck lifting heavy loads from floors and raising them to proper height for loading on and in railroad cars.

Inter-Floor Transportation. Inter-Floor Transportation by the d'Humy Motoramp System, Harold F. Blanchard. Eng. World, vol. 18, no. 2, Feb. 1921, pp. 105–106, 2 figs. Staggered floor construction.

HEAT TRANSMISSION

Pipe Coverings. Emissivity of Heat from Various Surfaces, V. S. Day. Power House, vol. 14, no. 2, Jan. 20, 1921, pp. 17–23, 11 figs. Tests carried out at experiment station of University of Illinois. Heat loss was greater through asbestos paper-covered pipes than through same pipes uncovered.

HEATING

Catalytic Method. Heating by Catalysis (Le chauffage par catalyse), R. Villers. Nature (Paris), no. 2438, Dec. 25, 1920, pp. 415–416. Apparatus decomposes petroleum by catalysis in steam and carbonic acid by platinum in presence of air.

Systems, Cooling with. Method of Utilizing Heating Systems for Cooling Rooms in Summer, A. M. Feldman. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 1, Jan. 1921, pp. 15–18, 5 figs. Patented heating and cooling apparatus comprising pipe circuit, water radiators connected at top and bottom beater and cooler and valves for cutting heater and cutting out cooler, or vice-versa, flow through system when heater is cut in being in one direction through pipe circuit for heating and in opposite direction for cooling.

HEATING, ELECTRIC

Industrial. Unusual Industrial Heating Developments, Wirt S. Scott. Elec. World, vol. 77, no. 6, Feb. 5, 1921, pp. 307–310, 6 figs. Developments of electric air heating for textile mills. Typical uses to which electric heat can be applied.

HOISTS

Mine. Hoist Designed Specially for Use in Room Work. Coal Age, vol. 19, no. 5, Feb. 3, 1921, pp. 229–230, 2 figs. Six-jaw clutch holds or frees drum from shaft. Oil supply will last three months. Special provision for jack props.

Quincy Hoist—Largest in World, Thomas Wilson. Power, vol. 53, no. 3, Jan. 18, 1921, pp. 90–95, 12 figs. Compound condensing hoist with two high-pressure and two low-pressure cylinders, 38 and 60 x 66 in., with ultimate winding capacity of 13,300 ft. of $1^5/_8$ in. rope in single layer. Hoist operates in balance, raising 20,000 lb. rock per trip at rope speed of 3200 ft. per minute.

HOUSES, CONCRETE

England. Concrete Cottage Building. Housing at Liverpool. Concrete & Constructional Eng., vol. 16, no. 1, Jan. 1921, pp. 22–29, 9 figs. Heavy concrete walling patented by Economic Building Corporation.

HYDRAULIC JACKS

Stella. Hydraulic Jacks (Hydraulische Hebeböcke), H. Berthold. Der praktische Maschinen-Konstrukteur, vol. 54, no. 2, Jan. 13, 1921, pp. 12–15, 9 figs. Describes the Stella lifting jack constructed by the Klingelhöfer-Defries Works, Ltd., Düsseldorf, Germany, consisting chiefly of a water tank equipped with a horizontal pump and a cylinder and plunger. Its advantages are pointed out.

HYDRAULIC TURBINES

Design. Tendencies in Development of Hydraulic Prime Movers, S. L. Shuffleton. Jl. Electricity & Western Industry, vol. 46, no. 3, Feb. 1, 1921, pp. 116–118, 3 figs. Capability of handling increasingly higher heads and involving increasingly large concentration of power in single units.

Installations. New Western Turbine Installations, Lewis F. Moody. Jl. Electricity & Western Industry, vol. 46, no. 3, Feb. 1, 1921, pp. 119–120, 1 fig. Survey of turbine installations now under construction by I. P. Morris Dept. of William Cramp & Sons Ship & Engine Building Co., Philadelphia.

Lubrication. Lubrication of Hydraulic Turbines. Lubrication, vol. 6, no. 11, Dec. 1920, pp. 1–8, 9 figs. Scheme for lubrication of large turbines of Niagara Falls Power Co.

Niagara Falls Power Development. The Hydraulic Turbines for Niagara Falls. Power House, vol. 14, no. 2, Jan. 20, 1921, pp. 24–26, 6 figs. Each of these machines will develop 61,000 b.hp. at $187^1/_2$ r.p.m. They will be coupled to 45,000-kva. vertical generators. Turbine casing weighs 110 tons.

Theory. Contribution to the Theory of High-Speed Hydraulic Turbines (Contributo alla teoria delle turbine idrauliche veloci), Giacomo Büchi. Industria, vol. 34, no. 23, Dec. 15, 1920, pp. 561–567, 17 figs. Comparative examination of design features of leading types, together with records of experiments. (To be continued.)

Wellman-Seaver-Morgan. Hydraulic Turbines for Queenston Development. Can. Engr., vol. 40, no. 5, Feb. 3, 1921, pp. 185–186A, 6 figs. Casings, runners and speed rings of two Wellman-Seaver-Morgan units of 61,000 hp. capacity each.

HYDROELECTRIC PLANTS

France. Making Best Use of French Hydro Plant, Lucien Pahin. Elec. World, vol. 77, no. 7, Feb. 12, 1921, pp. 357–359. Originally designed for railroad electrification, station was utilized for war loads to alleviate loss of coal mines. How station, line and substations were changed to get maximum utilization of water.

The Great Modern Hydroelectric Plants (Les grandes distributions électriques modernes), A. Troller. Nature (Paris), no. 2433, Nov. 20, 1920, pp. 326–332, 7 figs. Tendencies in design and construction as shown in latest installations, notably hydroelectric plant at Eget in the Pyrénées.

Simplon Tunnel. The Termination of the Simplon Tunnel (L'achévement du tunnel du Simplon), J. Boudet. Vie technique & industrielle, vol. 2, no. 16, Jan. 1921, pp. 305–314, 30 figs. Hydroelectric installation at north entrance. (Continuation of serial.)

Surge Tanks. Diaphragm Increases Surge Tank Capacity. Can. Engr., vol. 40, no. 3, Jan. 20

1921, p. 145, 2 figs. Added penstock threatened to overtop tank, but surge is throttled down by plate with small opening.

Water Control. Water Control on Hydro-Electric Systems, R. C. Denny. Power, vol. 53, no. 6, Feb. 8, 1921, pp. 208–212, 10 figs. Operating procedure for hydroelectric system of six plants utilizing combined static head of 2637 ft. Description of storage reservoirs and methods of conveying water to plants. Measurement of evaporation from reservoirs. Evaporation from one reservoir has been as high as 30 acre-feet per day.

Water Supply, Forecasting. Snow Surveying for the Forecasting of Stream Flow, J. E. Church, Jr. Eng. News-Rec., vol. 86, no. 6, Feb. 10, 1921, pp. 244–248, 2 figs. Methods, factors and results in making spring predictions of summer water supply for irrigation and power in streams fed by mountain snows.

I

IMPACT

Duration of. Researches on Duration of Impact (Recherches sur la durée du choc), Georges Moreau. Annales de Physique, vol. 14, Nov.-Dec. 1920, pp. 306–333, 2 figs. Measurements of duration of impact between ball and plain by electrical process, and empirical formula for calculating it.

INDUSTRIAL MANAGEMENT

Budget-Control System. A Budget Control System which is Producing Results, Norman G. Shidle. Automotive Industries, vol. 44, no. 6, Feb. 10, 1921, pp. 269–271, 8 figs. System of management which enables distributors and managers to know which departments are making money and which are not making money. System developed at Packard-Chicago distributors.

Expense Reduction. How to Reduce Expenses without Hurting the Business. Factory, vol. 26, no. 2, Jan. 15, 1921, pp. 167–170 and 198, 2 figs. Suggestions from executives in representative industrial works.

Inspection. The Part Inspection Plays in Good Management, Howell B. May. Factory, vol. 26, nos. 2 and 3, Jan. 15 and Feb. 1, 1921, pp. 175–179, 5 figs., and 335–339, 4 figs. Organization and operation of inspection department and selection of necessary personnel.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 6, Dec. 25, 1920, pp. 44–45. Proposal of the Committee for Economic Production for instruction sheet for the use of tapers.

Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 50–51. Proposal of the Committee for Economic Production for an instruction sheet for the fabrication and use of screw dies.

Nomenclature Systems. Systematic Nomenclature and Factory Organization (Bezeichnungs-systematik und Betriebsorganisation), Eduard Michel. Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 165–177, 6 figs. It is shown that a symbol system composed of letters and numerals is superior to one consisting only of numerals, due to mnemonic simplifications. Writer advocates a comprehensive system of nomenclature and shows how, with the aid of a symbol system, concentration of energy and a considerable saving in mental and clerical work can be effected.

Organization. Organization is Death, James B. M. Clark, Jr. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 141–145. Arguments against and for specialization of work.

Overhead Expense. Distributing Overhead Expense by the Machine Hour Rate Method, Christopher Haigh. Automotive Industries, vol. 44, no. 4, Jan. 27, 1921, pp. 172–177. Advantages of machine hour rate method over four other methods —man rate, man hour, sold hour, and material and labor. Paper read before Am. Gear Manufacturers' Assn.

Planning. The possibilities of Planning, E. A. Pells. Eng. & Indus. Management, vol. 5, no. 3, Jan. 20, 1921, p. 69. Functions of planning office and its place in management administration.

Production Systems. An "I am Producing More" Contest that Doubled Output, C. W. Ferguson. Factory, vol. 26, no. 3, Feb. 1, 1921, pp. 332–334, 4 figs. Experience of company of plan which gave each worker that phrase as slogan.

Economics of Workshop Practice—Mass Production (Die Wirtschaftlichkeit der Werkstattarbeit. Massenfertigung), K. Jung, Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 4, Jan. 22, 1921, pp. 93–95. Author claims that present highly developed economic and industrial life calls for educated practitioners without whom no progress can be made, and points out that engineering students should be taught the value and necessity of practical work and practical education.

Economy in Single-Unit Manufacture (Wirtschaftlichkeit bei Einzelfertigung), J. Hanner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 2, Jan. 8, 1921, pp. 29–35, 12 figs. Contrasts between mass and single-unit production; relationship between construction and production; assignment and distribution of work; measures for improvement in economical operation; superintendence; working plan and machine layout; conveyance equipment, etc.

Less Wages, or More Work? Maxwell Droke. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 103–105. Writer holds that 20 per cent increase in production is safer and saner than 20 per cent decrease in wages.

Modern Production Methods—XIV, W. R. Basset. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 187–191, 8 figs. Method of analyzing labor costs and their relation to final cost of manufactured article.

Why Increase Production? J. H. H. Boyd. Eng. & Indus. Management, vol. 5, no. 3, Jan. 20, 1921, pp. 73–76. Writer questions whether call for increased production is justified under present-day conditions, and further analyzes aims and objects of Higher Production Council and deals with their method of applying principle of payment by results.

Routing. Handling and Routing Large Work. Machy. (Lond.), vol. 17, no. 435, Jan. 27, 1921, pp. 501–507, 17 figs. Methods for routing of work through factory.

Routing Considered as a Function of Up-to-Date Management—IV, H. K. Hathaway. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 126–134, 8 figs. Evolution of progress sheet into assembling route sheet.

Safety Departments. What is the Business of a Safety Department? Henry Landesman. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 260–264. Significance of safety department in industrial plants. Advantages of safety departments.

Statistics, Compiling of. Making Statistics Talk —III, M. C. Rorty. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 119–125, 9 figs. Mathematical and semi-mathematical uses of graphics.

Stock Records. Accurate Methods in Keeping Stock Records, Fred J. Huntley. Automotive Industries, vol. 44, no. 3, Jan. 20, 1921, pp. 125–128, 6 figs. System at plant of Cadillac Motor Car Co., Detroit.

Tool Repairing. "Repairing Tools—One Hour." Factory, vol. 26, no. 2, Jan. 15, 1921, pp. 172–174, 5 figs. Time records for checking idle machines and men.

[See also EFFICIENCY, INDUSTRIAL.]

INDUSTRIAL RELATIONS

Arbitrating Disputes. When You Arbitrate, Chesla C. Sherlock. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 130–132. Three kinds of arbitration recognized by law.

Collective Bargaining. Tyrannous Labor Leaders, Parlor Socialists and So-Called Collective Bargaining, Henry Herbert Squire. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 138–140. Protest against "tyranny of labor leaders."

Incentive Plans. How Rewards Help Workers at Their Jobs. Iron Age, vol. 107, no. 5, Feb. 3, 1921, pp. 317–320. Report of Committee on Labor Relations of Cleveland Chamber of Commerce.

Open Shop. Open Shop Wins at Golden Gate, Don Partridge. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 418–422, 5 figs. Works council system reported to be working satisfactorily in shipyards, commercial shops and manufacturing plants of San Francisco Bay District.

The Philosophy of the Closed Shop in Action, James A. Emery. Open Shop Rev., vol. 18, no. 1, Jan. 1921, pp. 3–24. Arguments in favor of adopting open-shop principle in U. S. Address delivered before Nat. Founders Assn.

Strikes. See STRIKES.

INDUSTRIAL TRUCKS

Railways. Electric Vehicles for Railway Purposes—II. Ry. Gaz., vol. 34, no. 3, Jan. 21, 1921, pp. 67–69, 6 figs. Device adopted by British railway companies.

INSULATORS, HEAT

Magnesia. Characteristics of 85 per cent Magnesia as a Non-Heat-Conducting Covering, Edward R. Weidlein. Heat. & Vent. Mag., vol. 18, no. 2, Feb. 1921, pp. 30–34, 11 figs. Results of tests, with curves showing most economical thickness of pipe covering for different conditions.

Conservation of Heat in Power and Heating Systems, Edward R. Weidlein. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 295–300, 10 figs. Discussion of 85 per cent magnesia insulation, showing low depreciation rate under wetting and drying and high-temperature conditions. Chart for determining economical amount of insulation. Amounts of coal, heat and money saved by insulation. Paper read before Am. Inst. Chem. Engrs.

INTERCHANGEABLE MANUFACTURE

Machined Fits. An Analysis of Machined Fits. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 132–133 and 144, 12 figs. Questionnaire being sent to manufacturers by Subcommittee on Standards and Tolerances for Manufactured Material, and sectional committee on Plain Limit Gages for General Engineering Work, a sectional committee which is working under Rules of Procedure of Am. Eng. Standards Committee and is sponsored by Am. Soc. Mech. Engrs.

INTERNAL-COMBUSTION ENGINES

Drayton. The Drayton Two-Stroke Engine. Automobile Engr., vol. 11, no. 146, Jan. 1921, pp. 14–15, 7 figs. Experimental supercharging unit.

Fatigue of. Criterion for Determining Fatigue of Internal-Combustion Engines (Au sujet de la détermination d'un critère de fatigue générale des moteurs à combustion interne), M. Dumanois. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 1, Jan. 3, 1921, pp. 44–46. Coefficient of general fatigue is expressed in terms of variations of temperature of inside wall of cylinder.

Fuels for. Oils for Internal Combustion Engines, J. L. Chaloner. Trans. Inst. Mar. Engrs., vol. 32, Dec. 1920, pp. 215–232, 8 figs. Comparative study of suitability of fuels used.

Testing of Oils for Internal Combustion Engines, Tom McKenzie. Trans. Inst. Mar. Engrs., vol. 32, Dec. 1920, pp. 232–247 and (discussion) pp. 247–250, 6 figs. Tests required in specifications of internal-combustion engine fuels.

Marine. Six-Cylinder Petrol or Paraffin Marine Motors. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 168–169, 13 figs. on supp. plate. Gleniffer motors built with 1, 2, 4 or 6 cylinders, cylinder dimensions in each case being 6 in. bore by 8 in. stroke.

[See also DIESEL ENGINES; DYNAMOMETERS; GAS ENGINES; GAS TURBINES; MOTORCYCLES, Engine for; OIL ENGINES; TRACTOR ENGINES.]

IRON

Electrolytic. Some Aspects of Electrolytic Iron, W. Albert Noyes, Jr., Thirty-Ninth General Meeting Am. Electrochemical Soc., April 21–23, 1921, 7 pp. Experimental measurement of minimum potential at which electrolytic deposition of iron can be carried out.

L

LABOR

Three-Shift vs. Two-Shift System. The Three-Shift System in the Steel Industry, Horace B. Drury. Bul. Taylor Soc., vol. 6, no. 1, Feb. 1921, pp. 2–49. Survey of conditions in some 20 American steel mills where change from two-shift to three-shift has been introduced, with notes on introduction of three-shift system almost exclusively in European and English steel works. Paper read at joint meeting of Taylor Soc., Metropolitan and Management Section of Am. Soc. of Mech. Engrs. and New York Section, Am. Inst. Elec. Engrs.

LABORATORIES

U. S. Navy. The New U. S. Naval Experimental and Research Laboratory, Havelock C. Hislop. Compressed Air Mag., vol. 26, no. 2, Feb. 1921, pp. 9973–9974. Laboratory under erection at Belleville, D. C. where civilian scientists and engineers, represented through Naval Consulting Board will have opportunity to engage in research work for benefit of navy.

LADLES

Drying. Drying 100-Ton Ladles, Alan E. Dynan, Iron Age, vol. 107, no. 6, Feb. 10, 1921, p. 394. 1 fig. Swinging-type burner using preheated tar without artificial air supply.

LATHES

Automatic. The Hartness Automatic Lathe. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 273–275, 7 figs. Machine intended for large production. Head placed at angle. Groups of tools carried by two bars. All movements controlled by single cam-drum.

The Hartness Automatic Lathe. Iron Age, vol. 107, no. 6, Feb. 10, 1921, p. 386, 1 fig. Designed to handle boring, turning and facing cuts in pieces under 12 in. in diameter and 6 in. in length.

Turret. Turret Lathe Applications, J. H. Moore. Can. Machy., vol. 25, no. 6, Feb. 10, 1921, pp. 38–41, 15 figs. Tooling necessary for machining engine cylinder, clutch cone, clutch cone gear, and peculiar-shaped tractor driving-axle arm.

LIGHTING

Factory. Present Day Illumination Standards, George C. Cousins. Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921, pp. 105–109, 7 figs. Relations between good lighting and increased efficiency, with tables showing results of better lighting in factory.

LIGNITE

Combustion. Combustion of Lignites and High-Moisture Fuels, T. A. Marsh. Combustion, vol. 4, no. 2, Feb. 1921, pp. 39–44, 7 figs. Methods of burning these fuels and results in their combustion. Paper read before Stoker Manufacturers' Assn.

LOCOMOTIVES

Design. Locomotives and Rolling Stock of 1920. Engr., vol. 131, no. 3393, Jan. 7, 1921, pp. 10–12 and 14, 6 figs. Survey of recent developments in design.

Electric. See ELECTRIC LOCOMOTIVES.

Feedwater Treatment. Railway Water Treatment Pays Large Returns, Paul M. LaBach. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, pp. 247–248, 2 figs. Results obtained by Rock Island system.

Manufacture. Methods in a Locomotive Works. Eng. Production, vol. 2, no. 15, Jan. 13, 1921, pp. 55–64, 34 figs. Practice of Midland Railway Co., England.

Oil-Burning. Experience of a French Railway with Oil Burning Locomotives (Note sur les premiers essais a la compagnie d'orléans du chauffage des foyers de locomotives au "fuel oil"), Louis Bigourat. Revue generale des Chemins de Fer, vol. 40, no 1, Jan. 1921, pp. 9–32, 10 figs. Apparatus employed and results obtained. Comparison with coal burning locomotives.

Reconstruction. Practical Reconstruction of Old Locomotives. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, pp. 237–240, 6 figs. Typical examples of reconstruction work.

Squaring Valves. A Short Cut in Squaring Locomotive Valves, William Ulrick. Ry. Mech. Engr., vol. 95, no. 2, Feb. 1921, pp. 123–124, 4 figs. Squaring valves without applying main rods and afterwards removing them.

LUBRICANTS

Tests. Flash and Fire Tests, their Importance. Lubrication, vol. 6, no. 11, Dec. 1920, pp. 9–12, 1 fig. Standard instruments for testing lubricants and methods of operation.

Viscosity. Tentative Lubricant Viscosity Progresses. Sci. Lubrication, vol. 1, no. 1, Jan. 1921, pp. 9 and 32. Tentative test for viscosity of lubricants adopted by Am. Soc. for Testing Matls.

Worm-Gear Efficiency. The Effect of Lubricants Upon Worm-Gear Efficiency, J. H. Hyde. Eng. & Indus. Management, vol. 5, no. 2, Jan. 13, 1921, pp. 46–48. Report of Lubricant & Lubrication Inquiry Committee of British Department of Scientific & Industrial Research.

LUBRICATING OILS

Carbonization. Carbonization of Lubricating Oils. Dept. of Commerce, Circular of Bur. of Standards, no. 99, Nov. 12, 1920, 44 pp. 4 figs. Nature of effects of deposits formed in internal combustion engines. It is known that term "carbon" is a misnomer, because deposits consist largely of asphaltic matter. Accounts are given of nature of petroleum oils and of theories concerning formation of deposits.

The Carbonization of Lubricating Oils in Internal-Combustion Engines, Frederic H. Garner. Petroleum Times, vol. 5, no. 107, Jan. 22, 1921, pp. 93–95. Requirements of lubricating oils which will reduce carbonization in cylinder of internal-combustion engine to minimum. (Abstract.) Paper read before Instn. Petroleum Technologists.

Cold Test. A Cold Test Apparatus for Oils, G. H. P. Lichthardt. Jl. Indus. & Eng. Chem., vol. 13, no. 2, Feb. 1921, pp. 145–146, 1 fig. Apparatus used for lubricating oils at laboratory of Southern Pacific Railroad Co.

Testing Machine. Friction and Lubrication, R. Mountford Deeley. Engr., vol. 131, no. 3395, Jan. 21, 1921, p. 78, 1 fig. Deeley's oil-testing machine. Preliminary report communicated to Lubricants & Lubrication Inquiry Committee of Dept. of Sci. & Industrial Research.

M

MACHINE CONSTRUCTION

Economics. The Relationship between Design, Construction and Economics in Machine Construction (Der Zusammenhang von Gestaltung, Fertigung und Wirtschaftlichkeit im Maschinenbau), G. Schlesinger. Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 177–187, 10 figs. Introductory address to lecture on machine construction in the Technical Academy, Charlottenburg.

MACHINE TOOLS

Alignment. Correcting the Alignment of Machine Tools, F. Horner. Can. Machy., vol. 25, no. 4, Jan. 27, 1921, pp. 33–37, 12 figs. Methods of correcting alignment of spindles, slides, heads, cylindrical bearings, clamping devices, turrets and other parts of machine tools.

British. Notes on Improvements in British Machines, J. William Chubb. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 141–145, 12 figs. Ten new types produced in last ten years. Changes in machine details. Special vs. general-purpose machines. Unusual planer drive.

Clamping Devices. Design, Fabrication and Use of Clamping Devices (Ueber Konstruktion, Herstellung und Verwendung von Spanneisen), Guido Dierauer. Werkstattstechnik, vol. 15, no. 2, Jan. 15, 1921, pp. 33–39, 26 figs. Deals with various types of devices for clamping work in boring mills, lathes, milling machines, etc.

Manufacture. Tool Plant Reflects New Ideas, Dann O. Taber. Iron Trade Rev., vol. 68, no. 5, Feb. 3, 1921, pp. 344–349, 11 figs. Description of machine tool plant in Cleveland, noting arrangements of equipment and facilities for handling materials.

Performance Record. Apparatus for Recording the Performance of Machine Tools (Ueber Kontrollschreibapparate für Arbeitsleistungen an Werkzeugmaschinen), F. Breitling. Werkstattstechnik, vol. 15, no. 2, Jan. 15, 1921, pp. 43–44, 5 figs. Details of the work-recording clock originally designed and employed by Dr. Poppelreuter in his nerve clinic for wounds in the head; curves recorded with this clock are said to give an excellent presentation of the efficiency of a workman as well as of the useful scope of a machine tool. Description of Harms control apparatus for recording operations of machine tools, etc.

Repetition Work. Machining Operations on Repetition Work—Part I. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, pp. 76–81, 15 figs. Examples of modern practice in construction and operation of machine tools.

Safeguards. Guarding Machine Tools. Mech. World, vol. 69, no. 1775, Jan. 7, 1921, pp. 4–5. Forms and types of safe guards. (Abstract.) Paper read before Industrial Safety Conference organized by the Home Office and British Industrial "Safety First" Association.

The Safeguarding of Machinery. Foundry Trade Jl., vol. 23, no. 230, Jan. 13, 1921, pp. 34–35. Forms and types of safeguards. (Abstract.) Paper read before Industrial Safety Conference organized by Home Office & British Industrial "Safety First" Association.

Working Speeds. Standardized Calculation of Working Speed (Einheitliche Laufzeitberechnung), A. Winkel. Werkstattstechnik, vol. 15, no. 1, Jan. 1, 1921, pp. 5–10, 10 figs. Reduction of the working-speed equation for the different machining operations to a uniform equation, correction of this equation for planing based on diagrams for planers, its use for the design of a slide rule, and the development and manipulation of described slide rule.

MALLEABLE IRON

Cupola-Melted. Experiments on Cupola Malleable, F. H. Hurren. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 135–138, 6 figs. Comparative study of cupola melted metal and air furnace product. Paper read before Birmingham Branch, Instn. British Foundrymen.

Metallography. American Malleable Cast Iron—III, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 5, Feb. 3, 1921, pp. 353–357 and 361, 9 figs. Metallography of malleable iron.

Properties. American Malleable Cast Iron—IV, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 7, Feb. 17, 1921, pp. 485–488, 7 figs. Tensile properties of malleable iron.

MANGANESE STEEL

Magnetic Mechanical Analysis. The Magnetic Mechanical Analysis of Manganese Steel, Robert Hadfield and S. R. Williams and I. S. Bowen. Proc. Royal Soc., vol. 98, no. A692, Jan. 3, 1921, pp. 297–302, 3 figs. Correlation of magnetic and mechanical properties of manganese steel.

MARINE BOILERS

Return-Tube. Cylindrical Return-Tube Boilers, W. F. Carnes. Gen. Elec. Rev., vol. 24, no. 2, Feb. 1921, pp. 110–114, 7 figs. Their manufacture by Bethlehem Shipbuilding Corp.

Water-Tube. Water Tube Marine Boilers, W. M. McFarland. Gen. Elec. Rev., vol. 24, no. 2, Feb. 1921, pp. 115–119, 4 figs. Evolution and adoption of Babcock & Wilcox stationary boiler to render it suitable for use on board ship.

[See also BOILERS, WATER-TUBE.]

MEASURING INSTRUMENTS

Tolerances. Weights and Measures. Dept. of Commerce, Bur. of Standards, miscellaneous publications, no. 43, 1921, 200 pp. Specifications and tolerances of measuring instruments. Thirteenth annual conference of representatives from various states held at Bur. of Standards, Washington, D. C., May 24–27, 1920.

METALS

Calorizing. Calorizing as a Protection for Metals, Arthur V. Farr. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 251–253, 9 figs. General Electric Co. process of protecting methods at high temperatures. Process consists in placing material to be calorized in retort and heating in reducing atmosphere, retort being filled with mixture containing finely divided aluminum. Treatment infuses aluminum into exposed portion of metal so as to form homogeneous aluminum alloy for certain depth.

Finish. Finish of Metallic Materials, Sidney Cornell. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 209–212. Quality given by heat treatment contrasted with durability and appearance. Finish of metallic materials discussed as essential detail in modern manufacturing, with brief notes on cleaning, polishing, lacquering, coatings, slushes and wrapping.

METRIC SYSTEM

Arguments Against Adoption in U. S. Metric Bugaboo Again in Congress, C. C. Stutz. Am. Industries, vol. 21, no. 7, Feb. 1921, pp. 19–21, 2 figs. Criticism of bill for adoption of Metric system in U. S. introduced into Senate. Map of the world is presented and "commanding position of the English system" is indicated.

MILLING CUTTERS

Standards. British Standards for Milling Cutters and Reamers. British Eng. Standards Asso., no. 122, July 1920, 67 pp. 46 figs. Standards for non-relieved cutters, end mills, form-relieved cutters and reamers, determined as result of conference, research and coöperation between small tool makers, machine-tool makers and users of these tools in Great Britain.

MILLING MACHINES

Manufacture. Making One Thousand Milling Machine Saddles, Donald A. Hampson. Can. Machy., vol. 25, no. 6, Feb. 10, 1921, pp. 33–37, 15 figs. Equipment necessary to produce one thousand saddles every year. Pattern work is taken up, also various machining operations, cost of machine tools and other vital points.

Profile. Profile Milling. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 170–172, 8 figs. Automatic profile-milling machine.

MOLDING MACHINES

Hand-Power. Hand-Power Moulding Machine. Engineering, vol. 111, no. 2876, Feb. 11, 1921, pp. 164–166, 16 figs. Designed to be easily adjusted to take boxes and pattern plates of any size within comparatively wide range.

Suspended-Type. Inventor Installs His Own Devices. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 98–103, 12 figs. Adaptation of molding machine through suspending it and carrying it along molding floor. Installation at foundry of Standard Malleable Iron Co., Muskegon, Mich.

MOLDS

Foundry, Drying. The Drying of Foundry Molds and Cores Through Electrically Preheated Air (Trocknung der Formen und Kerne in der Giesserei durch elektrisch vorgewärmte Luft). Zeit. für die gesamte Giessereipraxis, vol. 42, no. 4, Jan. 22, 1921, pp. 50–51. Describes electric-hot-air apparatus of the Oerlikon Machine Factory, advantages of which over other heating methods with solid fuel are pointed out.

MONEL METAL

Properties. Monel Metal—II, Adolph Bregman. Metal Industry (N. Y.), vol. 19, no. 2, Feb. 1921, pp. 64–65, 4 figs. Summary of properties, methods of melting and casting, uses, handling and working in up-to-date practice of this natural nickel alloy.

Notes on Monel Metal, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 291–294, 3 figs. Physical properties of this natural alloy, and commercial uses to which it has been adapted. Its resistance to corrosion and its strength at high temperatures are perhaps most useful properties.

MOTOR TRUCKS

American-Made. Complete Mechanical Specifications of All Makes of 1921 Gasoline Motor Trucks. Motor Age, vol. 39, no. 4, Jan. 27, 1921, pp. 90–105. Details of 527 gasoline and one steam motor-truck chassis as produced by 176 American truck manufacturers.

New York Show. Observations at the New York Truck Show, P. M. Heldt. Automotive Industries, vol. 44, no. 3, Jan. 20, 1921, pp. 119–123, 13 figs. Few changes of radical nature in evidence. Influence of war designs seen in fitting of bumpers and tow hooks on many models.

Steam. Steam Waggon Construction. Eng. Production, vol. 2, no. 18, Feb. 3, 1921, pp. 162–168, 15 figs. Methods at Sentinel Waggon Works, England.

The Application of Steam Power to an Automotive Truck, Lewis L. Scott. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 155–160 and 162, 9 figs. Steam engine used on two-ton truck. Characteristic torque curves of 40-hp. internal-combustion engine and steam engine developing same power.

Three-Point-Mounted. Three Point Chassis Mounting Feature of New Speed Truck. Automotive Industries, vol. 44, no. 5, Feb. 3, 1921, pp. 204–206, 6 figs. Midwest engine with two-bearing crankshaft and full electrical equipment is rigidly mounted on two forward points but has flexible connection with frame at rear supports. Rigid frame designed to prevent weaving of bodies.

MOTORCYCLES

Engine for. An Aluminum Motorcycle Engine. Automotive Industries, vol. 44, no. 6, Feb. 10, 1921, p. 258, 1 fig. V type with two-cylinders cast together with top half of crankcase of aluminum. Translated from Motorwagen.

MOTORSHIPS

Economical Advantages. Motorships, Charles Edward Lucke. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 140–141. Economical advantages of motorship. Construction of motorships by European shipbuilding nations and its continued adoption in U. S.

Europe. A Review of Motorship and Marine Diesel Engine Building in Europe. Mar. Eng., vol. 26, no. 1, Jan. 1921, pp. 49–54, 4 figs. During 1920 about 20 large motorships were completed and orders in hand in European yards at beginning of 1921 amount to between 180 and 190 ships, varying from vessels of 14,000 tons deadweight capacity to craft of 3,500 tons, total deadweight capacity being estimated at 1,500,000 tons.

United States. Motorship Building in the United States. Mar. Eng., vol. 26, no. 1, Jan. 1921, pp. 46–48. Nineteen motorships, totalling 143,850 deadweight tons, under construction in U. S. at beginning of 1921, total shaft horsepower of vessels amounting to 44,520.

N

NICKEL

Properties. Chemical Properties and Metallography of Nickel, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 197–200, 4 figs. Data on solubility and magnetic transformation of pure nickel; also on effect of common impurities such as carbon, oxygen, manganese, sulphur, cobalt, iron and silicon upon various physical properties.

NICKEL-CHROME STEEL

Properties. Nickel-Chrome Steels. Machy. (Lond.), vol. 17, no. 433, Jan. 13, 1921, pp. 465–467. Chart showing tensile strength of nickel-chrome oil-hardening steel.

NOZZLES

Steam, Tests of. German Tests on Steam Nozzles and Diffusors. Steam, vol. 27, no. 1, Jan. 1921, pp. 8–9, 1 fig. Experiments carried out in laboratory of machine design of Technical High School, Charlottenburg, Germany. Translated from Zeitschrift des Vereines deutscher Ingenieure.

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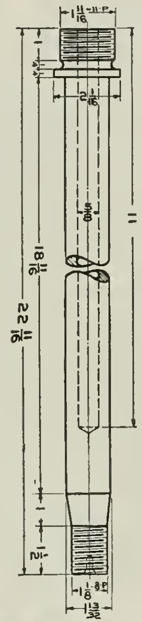

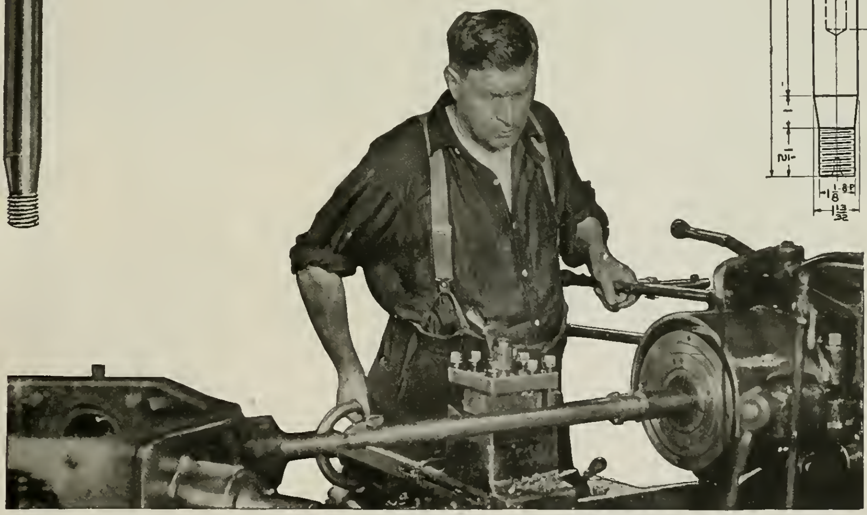

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Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong

ENGINEERING INDEX (Continued)

O

OFFICE MANAGEMENT

Correspondence Filing. Some Suggestions on Office Correspondence Filing, Grant Gibson. Ry. Age, vol. 70, no. 7, Feb. 18, 1921, pp. 413–416, 5 figs. General, unit and sub-files and file book for cross reference facilitate locating letters.

OIL

Crude. Properties of Typical Crude Oils from the Eastern Producing Fields of the United States, E. W. Dean. Reports of Investigations, Dept. of Interior, Bur. of Mines, serial no. 2202, Jan. 1921, 57 pp. Specific gravity at 60 deg. fahr., sulphur percentage, water percentage, distillation at atmospheric pressure, vacuum distillation of residuum at 40 mm. absolute and Conradson carbon residue percentages.

[See also PETROLEUM.]

OIL ENGINES

Ingersoll-Rand. A New Development of the Heavy Oil Engine, F. A. McLean. Can. Machy., vol. 25, no. 3, Jan. 20, 1921, pp. 37–40, 4 figs. Principle of operation and structural details of Ingersoll-Rand, Price Rathbun type of heavy-oil engine.

Marine. 130-B. H. P. Bolnes Marine Oil Engine. Engineering, vol. 111, no. 2873, Jan. 21, 1921, pp. 70–72, 7 figs. Two-cycle hot-bulb Dutch-type engine resembling in general arrangement a steam marine engine.

Pistons. Casting and Machining Oil-Engine Pistons, Piston Rings and Cylinders, Samuel Rosswell. Am. Mach., vol. 54, no. 4, Jan. 27, 1921, pp. 137–140, 2 figs. Selection of materials. Vertical casting preferable. Heat treatment after rough-machining. Fitting piston pin. Assembling rings. Reaming vs. grinding cylinders.

Solid-Injection. Effect of Fuel Consumption on Oil-Engine Reliability, Ralph Miller. Power, vol. 53, no. 7, Feb. 15, 1921, pp. 272–273, 1 fig. Diagram from solid-injection engine.

OIL FIELDS

Exploitation by Shafts and Galleries. The Exploitation of Petroleum by Shafts and Galleries (De l'exploitation du pétrole par puits et galeries), N. A. Lykiardopoulo. Revue universelle des mines, vol. 8, no. 1, Jan. 1, 1921, pp. 38–45 Methods followed in exploitation of oil at Béchelbronn, Alsace.

The Exploitation of Petroleum by Shafts and Galleries (Exploitation de pétrole par puits et galeries), Paul de Chambrier. Pamphlet published by Dunod, editor, successor to H. Dunod & E. Pinat, 47 & 49, Quai des Grands-Augustins, 1921, 106 pp. 4 figs. Economical and technical advantages over drilling methods.

OIL FUEL

Coal vs. The Use of Fuel Oil as Compared with the Firing of Coal by Means of Mechanical Stokers, F. H. Daniels. Steam, vol. 27, no. 1, Jan. 1921, pp. 5–8, 1 fig. Urges prohibiting use of oil fuel on land and restricting it to ships. Graph giving comparative fuel costs of coal and oil fuel.

Installations. Unusual Efficiencies in an Oil Fuel Installation, Joseph Poke and Frank G. Philo. Universal Engr., vol. 33, no. 1, Jan. 1921, pp. 29–33, 3 figs. Oil-burning tests results obtained at plant of Savannah Electric Co. From Stone & Webster Jl.

Locomotives. Experimental Study of Oil-Fuel Burning in Locomotive Boilers (Resultati degli esperimenti e delle prove di trazione eseguite con alcune locomotive attrezzate per bruciare la nafta nei forni delle loro caldaie), Alessandro Mascini. Rivista tecnica delle Ferrovie Italiane, vol. 18, no. 4, Oct. 1920, pp. 117–126, 5 figs. Adoptation of locomotives to oil burning by Italian State Railways. (To be continued.)

Uses. Fuel Oil, W. A. White. North-East Coast Instn. Engrs. & Shipbuilders, Advance paper, 23 pp. 4 figs. Uses of oil fuel, particularly in ships, notes on fire precautions and appliances, with data on world oil deposits and probable resources.

OIL SHALES

Industry. A Review of the Progress of the Oil Shale Industry in 1920, Victor C. Alderson. Am. Gas Eng. Jl., vol. 114, no. 4, Jan. 22, 1921, pp. 69–71 and 79–81. Progress in utilization of oil shale.

Retorting. American vs. Scotch Methods in Retorting of Petro-Shales, J. B. Jenson. Salt Lake Min. Rev., vol. 22, no. 20, Jan. 30, 1921, pp. 17–23, 12 figs. Pumpherston and Henderson types of retorts.

Experimental Shale Oil-Retorting Plant. Chem. & Metallurgical Eng., vol. 24, no. 7, Feb. 16, 1921, pp. 312–313, 3 figs. 15-ton commercial unit installed by Shale Oil Refining Corp. at Denver, Col., using Johns eduction process.

OPEN-HEARTH FURNACES

Controlling Valve for. A New Type of Controlling-Valve for Supplying Air and Gas Mixtures to Open-Hearth Furnaces, W. H. Wharton. Iron & Steel of Canada, vol. 4, no. 1, Feb. 1921, pp. 18–20, 3 figs. Reversing valve combined with air-pressure and volume-controlling mechanism.

P

PAINTING

Spray. Recent Developments in Spray Painting, Henry A. Gardner. Paint Manufacturers' Assn. of U. S., circular no. 114, Jan. 1921, 18 pp. 20 figs. Paper read before Pennsylvania State Assn. of Master Painters.

PATTERNMAKING

Shop Organization. New England Pattern Shop is Unique, Herbert R. Simonds. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 127–132, 13 figs. Plant is arranged as series of producing units each with its equipment complete. Progress of work is recorded by special system.

PEAT

Deposits. Classification and Formation of Peat and Related Deposits, C. C. Osbon. Jl. Am. Peat Soc., vol. 14, no. 1, Jan. 1921, pp. 37–44, 4 figs. Distinction between peat and muck. Theory of formation of deposits.

Gasoline from. Easy Money from Peat. Chem. & Metallurgical Eng., vol. 24, no. 5, Feb. 2, 1921, pp. 213–215, 1 fig. Apparatus and supertechnical process used for extracting methyl alcohol and gasoline out of peat.

Industry. News of the Industry in Foreign Countries. Jl. Am. Peat Soc., vol. 14, no. 1, Jan. 1921, pp. 31–36. British Empire, Denmark, France, Germany, Russia and Sweden.

News of the Domestic Industry. Jl. Am. Peat Soc., vol 14, no. 1, Jan. 1921, pp. 15–30. Developments of peat industry in different states.

Production in 1919. Production of Peat in 1919, K. W. Cottrell. Jl. Am. Peat Soc., vol. 14, no. 1, Jan. 1921, pp. 7–14. Total production in U. S. in 1919 was 69,197 short tons valued at $705,532.

PETROLEUM

Products, Testing. Use of the MacMichael Viscosimeter in Testing Petroleum Products, W. H. Herschel. Reports of Investigations, Bur. of Mines, Dept. of Interior, serial no. 2201, Jan. 1921, 12 pp. Conditions under which MacMichael torsion viscosimeter may be used to advantage in petroleum laboratory. Methods of operation and calibration.

PIPE LINES

Steam. Long Distance High-Pressure Steam Line. Power Plant Eng., vol. 25, no. 3, Feb. 1, 1921, pp. 157–159, 9 figs. Lines carry steam on pressure of 175 lb. per sq. in. total distance of about 3000 ft.

PLANERS

Toolroom. Gorton Toolroom Planer, J. V. Hunter. Am. Mach., vol. 54, no. 7, Feb. 17, 1921, pp. 257–259, 3 figs. Especially designed for work on dies, jigs and fixtures. Built in two sizes. Furnished with side head. Special features and specifications.

PLYWOOD

Screw Fastenings. Strength Tests of Screw Fastenings of Plywood, H. S. Grenoble. Aerial Age, vol. 12, no. 21, Jan. 3, 1921, pp. 535–536. Tables showing screws required for maximum strength, based on tests carried out at Forest Products Laboratory, Madison, Wis.

POLES, STEEL

Latticed. Calculations of Latticed Poles of Minimum Weight (Calcolo rapido dei pali a traliccio di peso minimo), Marco Semenza. Elettrotecnica, vol. 7, no. 36, Dec. 25, 1920, pp. 640–645, 3 figs. Design equations and graphs.

PORTS

New York, Reorganization of. Proposed Reorganization of the Port of New York. Ry. Age, vol. 70, no. 4, Jan. 28, 1921, pp. 269–274, 3 figs. Special automatic-electric subway recommended by New York-New Jersey Port and Harbor Development Commission.

POWER GENERATION

Gas vs. Electricity. Note on the Thermal Efficiency of the Generation and Use of Gas and Electricity, Dugald Clark. Jl. Instn. Elec. Engrs., vol. 28, no. 295, Sept. 1920, pp. 765–767 and (discussion), pp. 767–779, 1 fig. Ratio of utilized heat units by electricity into utilized heat units by gas for power purposes was found in experiments to be 1.6. This ratio was 4 for heat production and 0.84 for light.

Thermal Springs. The Utilization of Thermal Springs as Source of Energy (L'emploi des eaux thermales comme source d'énergie), P. Caufourier. Génie Civil, vol. 78, no. 2, Jan. 8, 1921, pp. 37–39, 2 figs. Installation at Hammam-Meskoutine, Algiers.

POWER PLANTS

Accounting. Armour System of Power-Plant Accounting, O. A. Anderson. Power, vol. 53, no. 4, Jan. 25, 1921, pp. 128–131, 1 fig. System of records and accounting from which cost figures are deduced and analyses made of plant operations. Motive-power department has under its supervision 72,000 hp. in boilers burning nearly 900,000 tons of coal and 700,000 bbl. of oil per year.

POWER TRANSMISSION

Hydraulic. Hydraulic Transmission of Power (La transmission hydraulique), A. Raudot. Revue généralé de l'Electricité, vol. 9, no. 5, Jan. 29, 1921, pp. 143–147, 4 figs. Technical study of principles of transmission of power by means of fluid, and survey of mechanisms which have been developed for this purpose. (To be continued.)

PRESSES

Feeding Devices. Littell Automatic Punch-Press Feeding Devices, J. V. Hunter. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 209–212, 9 figs. Automatic feed to increase output and safeguard workmen. Construction of attachments for feeding from roll. Dial, slide and hopper feeding mechanisms.

PRESSWORK

Universal-Joint Covers. Making a Sheet-Steel Universal Joint Cover, W. A. Flumerfelt. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 171–173, 9 figs. Methods of drawing and forming articles of comparatively thick sheet metal. Flanging and closing-in by means of sectional dies.

PROFIT SHARING

England. A History of Profit Sharing in the British Isles, W. Wallace. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 85–89. Analysis and summary of recent report by English Ministry of Labor.

Experiences. Promoting Efficiency in Industrial Plants. Iron Age, vol. 107, no. 4, Jan. 27, 1921, p. 267. Cleveland Chamber of Commerce publishes results of survey of 600 companies and study of profit sharing in various forms.

Legislation. Profit Sharing in France (La participation ouvriére aux bénéfices de la production), Paul Razous. Génie Civil, vol. 78, no. 3, Jan. 15, 1921, pp. 59–61. Survey of legislation and practices in Government establishments. (To be continued.)

PULVERIZED COAL

Boiler Firing. Engineers Afforded Latest Information on Powdered Coal and Briquets, R. Dawson Hall. Coal Age, vol. 19, no. 1, Jan. 6, 1921, pp. 16–17. Results of boiler trials made at pulverized fuel plant, Lykens, Pa.

Some Comments on Pulverized Coal for Power Plants, Frederick A. Scheffler. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 1, Jan. 1921, pp. 7–13, 3 figs. Typical applications of pulverized coal to Babcock & Wilcox boiler and to Stirling boiler.

Heating Furnaces. Experience with Powdered Coal for Heating Furnaces, Charles Longenecker. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 86–88, 4 figs. Advantages of powdered coal for heating and forging furnaces.

Quigley System. Pulverized Coal, Ralph H. Cridge. Elec. Times, vol. 59, no. 1526, Jan. 13, 1921, pp. 25–28, 7 figs. Quigley system of burning pulverized coal.

Tests. Actual Performance of Powdered Coal, Chas. Longenecker. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 59–61. Results obtained in number of recent tests.

PUMPING PLANTS

Argentina Naval Port. The Dock Pumping Plant in the Argentine Naval Port, Puerto Militar (Die Dockpumpenanlage im argentinischen Kriegshafen Puerto Militar), H. Wiegieb. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 4, Jan. 22, 1921, pp. 89–92, 6 figs. Notes on general arrangement, main and bilge pumps, steam-boiler plant, electric and hydraulic powerhouse, operating results and comparison with other plants. Plant with all auxiliary equipment was installed by Haniel & Lueg, Düsseldorf, Germany.

PUMPS

Automatic Valves for. Investigation of Automatic Pump Valves and Their Effect on Pumping (Untersuchung selbsttätiger Pumpenventile und ihrer Einwirkung auf den Pumpengang), Ludwig Krauss. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 5, Jan. 29, 1921, pp. 116–122, 23 figs. With a view to eliminating the loud beating of pump valves and securing perfect flow conditions, writer made investigation of six modern valves under widely different working conditions, results of which show that the valve construction exercises less influence than size. Determination of values of discharge and resistance of four valves.

PUMPS, CENTRIFUGAL

Submersible. The Submersible Pump, R. C. Hill. Managing Engr., vol. 7, no. 9, Jan. 1921, pp. 165–172, 6 figs. Submersible electric motor pump used by British Admiralty Salvage Section during war.

Wilfley. The Wilfley Centrifugal Pump. Engr., vol. 131, no. 3396, Jan. 28, 1921, p. 96, 1 fig. Also in Eng., vol. 111, no. 2874, Jan. 28, 1921, p. 116, 4 figs. Impeller is formed with large hollow trunnion, through which suction water flows on its way to impeller passages.

R

RAILS

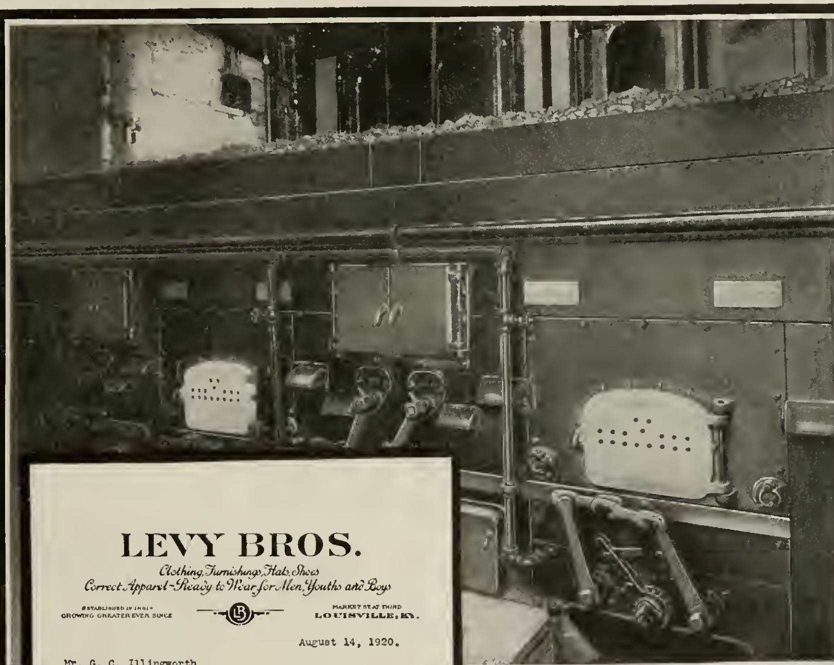
Failures. Report of Committee IV—On Rail. Bul. Am. Ry. Eng. Assn., vol. 22, no. 231, Nov. 1920, pp. 197–215, 13 figs. Report of rail failures, with statistics and conclusions as to costs. Suggestions for improvements in rail steel.

Shallow-Head vs. Deep-Head. Shallow-Head and Deep-Head Rails Compared, George H. Tinker. Ry. Maintenance Engr., vol. 17, no. 2, Feb. 1921, pp. 52–53. Service records show longer life of 14 months for shallow-heads than for deep-head rails.

RAILWAY ELECTRIFICATION

Illinois Central. The Illinois Central Electrification Project. Elec. Traction, vol. 17, no. 1, Jan. 1921, pp. 1–5, 4 figs. Ordinance regarding elec-

$35.00 Maintains 2 Stokers For 10 Years



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ENGINEERING INDEX (Continued)

trification of Chicago terminals of Illinois Central Railroad has been passed by Chicago city council and accepted by Illinois Central Railroad Co.

India. The Electrification of Indian Railways. Ry. Engr., vol. 42, nos. 492 and 493, Jan. and Feb. 1921, pp. 12–16, 7 figs. and 56–59, 7 figs. Advantages of electric locomotives as compared with steam locomotives on heavily-graded sections of North Western Railway of India.

Sweden. Electrification of the Stockholm-Saltsjobaden Railway (L'électrification du chemin de fer de Stockholm à Saltsjobaden (Suède). Revue générale de l'Electricité, vol. 9, no. 4, Jan. 22, 1921, pp. 115–117, 2 figs. Direct current of 1200 volts used.

Switzerland. Electrification Work in Switzerland. Engr., vol. 131, no. 3396, Jan. 28, 1921, pp. 95–96. Notes on projects under consideration.

RAILWAY OPERATION

Accounting. How a Railway Simplified Its Disbursements Accounting, C. O. Price. Ry. Rev., vol. 68, no. 4, Jan. 22, 1921, pp. 134–140, 7 figs. Labor-saving devices.

Train Control. Auto-Train Control Gear, Great Eastern Railway. Ry. Gaz., vol. 34, no. 1, Jan. 7, 1921, pp. 20–21, 2 figs. Explanation of regulator and brake operating and control connections.

RAILWAY SHOPS

Safety Devices. Railroad Shop Safety Devices, Frank A. Stanley. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 184–186, 9 figs. Common sources of accidents on erecting floor. Use of safety screens. Saw bench and boring bit guards.

RAILWAY TIES

Reinforced-Concrete. A New Reinforced Concrete Railroad Tie. Eng. & Contracting, vol. 55, no. 7, Feb. 16, 1921, p. 164, 1 fig. Patented rail fastener is feature. Bolts are removable.

Steel. Service Tests of a Substitute Tie. Ry. Age, vol. 70, no. 3, Jan. 21, 1921, p. 252, 4 figs. "Peerless" steel tie.

Steel Sleepers on the North Eastern Railway. Ry. Engr., vol. 42, no. 493, Feb. 1921, p. 55, 3 figs. Inverted U-shaped plates supporting rails fit into channel-shaped steel ties.

RAILWAY TRACK

Concrete. Device for Holding Down Rails to Concrete Foundations. Engr., vol 131, no. 3397, Feb. 4, 1921, pp. 131–132, 6 figs. Wooden templates fitted in conical coal.

RAILWAYS

Trans-Australian. The Trans-Australian Railway, J. J. Poynton. Ry. Gaz., vol. 34, no. 1, Jan. 7, 1921, pp. 15–19, 9 figs. Notes on construction and operation.

World Mileage. Railway Mileage of the World. Ry. Age, vol. 70, no. 6, Feb. 11, 1921, p. 367. Grand total is 706,730 miles. From Archiv für Eisenbahnwesen.

REAMERS

Ball-Joint. Tools for Locomotive Steam Pipe Joints, Frank A. Stanley. Am. Mach., vol. 54, no. 6, Feb. 10, 1921, pp. 218–220, 8 figs. Type of ball-joint reamer for steam-pipe work on locomotives.

REDUCTION GEARS

Design. New Geared Turbine Set. Power, vol. 53, no. 5, Feb. 1, 1921, p. 187, 2 figs. Turbine element is mounted directly on gear housing making one rigid frame for turbine and gear.

REFRACTORIES

Tests. Refractories and Their Relation to Furnaces. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 53–54 and 78. Tests of refractories under various conditions of slag penetration.

REFRIGERATING MACHINES

Ethyl Chloride. The Ethyl Chloride Refrigerating Machine, Charles Bishop. Cold Storage, vol. 24, no. 274, Jan. 20, 1921, pp. 5–8, 4 figs. Its design and efficiency. Paper read before Cold Storage & Ice Assn.

Rating. Rating of Household Refrigerating Machines, R. F. Massa. A.S.R.E. Jl., vol. 6, no. 6, May 1920, pp. 432–436. Survey of practices.

REFRIGERATION

Standard Unit of. Standard Unit Adopted by the Refrigerating Industry, F. E. Matthews. Power, vol. 53, no. 5, Feb. 1, 1921, pp. 184–187, 1 fig. Am. Soc. of Refrigerating Engrs. has adopted recommendations of joint committee fixing "Standard Unit of Refrigeration" as equivalent of absorption of 288,000 B.t.u. of heat.

[See also AMMONIA ABSORPTION REFRIGERATING SYSTEM, Non-Condensible Gases in.]

RESEARCH

Coördination in. Research Laboratory Adopts Modern Management, C. V. Maudlin. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 98–102, 5 figs. Plan of record and control adopted at Forest Products Laboratory, U. S. Forest Service.

Government-Operated. Scientific and Engineering Work of the Government, E. B. Rosa. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 111–118, 6 figs. Survey of government research work and its economical significance and cost.

Industrial and Scientific. A Reading List on Scientific and Industrial Research and the Service of the Chemist to Industry, Clarence Jay West. Reprint & Circular Series of Nat. Research Council, no. 9, April 1920, 45 pp. Articles on industrial and scientific research.

Industrial Research, Frank B. Jewett. Reprint and Circular Series of Nat. Research Council, no. 4, 16 pp. Urges promotion of industrial research. Paper read before Royal Can. Inst.

Research Laboratories in Industrial Establishments of the United States of America, Alfred D. Flinn, A. J. Porskievies and Ruth Cobb. Bul. Nat. Research Council, vol. 1, part 2, no. 2, March 1920, pp. 45–130. Classified list with information on staff, work and equipment.

Research in Industrial Conservation, H. E. Howe. Gas Age, vol. 47, no. 2, Jan 25, 1921, pp. 42–44. Importance of research in securing increased production, conservation of supplies and selection of best materials and methods.

Machinery. Completes Laboratory for Research in Machinery. Iron Trade Rev., vol. 68, no. 2, Jan. 13, 1921, pp. 152–153, 4 figs. Mechanical laboratory designed for research work in machinery, installed at Nat. Lamp Works of Gen. Elec. Co., Cleveland.

Organization of. An Industrial Research Association, Arthur W. Crossley. Chem. Age (Lond.), vol. 4, no. 83, Jan. 15, 1921, pp 73–74. Advantages of coöperative laboratory research in industry.

The Organization of Research, William Morton Wheeler. Science, vol. 53, no. 1360, Jan. 21, 1921, pp. 53–67. Deprecates organization of research because research, to be successful, must be carried out in a manner to permit full development of personality and individual initiative, manifestations which cannot take place if investigator is merely a part of an organized mechanism.

RIVETING MACHINES

Electric. The Influence of Electrotechnology on Riveting (Das Nieten unter dem Einfluss der Elektrotechnik), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 38, no. 12, Jan. 22, 1921, pp. 55–58, 4 figs. Details of modern types of electric riveting machines, electrohydraulic riveting machines, electric rivet forges, etc.

RIVETS

Electric Heaters for. Electric Rivet Heaters. Ry. Engr., vol. 42, no. 492, Jan. 1921, pp. 23–24, 1 fig. Data on power consumption.

The Lecfur Automatic Electric Rivet Heaters, Practical Engr., vol. 63, no. 1769, Jan. 20, 1921, pp 36–38. Resistance-type furnace.

ROCK DRILLS

Electric. Electric Rock Drills for Mines and Quarries (Elektrische Bohrmaschinen im Betriebe von Bergwerken und Steinbrüchen), Friedrich Ludwig. Elektrotechnischer Anzeiger, vol. 38, nos. 9 and 10, Jan. 18 and 19, 1921, pp. 39–40 and 43–44, 15 figs. Describes types of hand and column machines.

ROLLING MILLS

Efficiency of. The Economics of Roll Trains, A. Dyckerhoff. Iron Trade Rev., vol. 68, no. 4, Jan. 27, 1921, pp. 279–282, 8 figs. Closer study of roll pass design as procedure to increase overall efficiencies of rolling mills.

Electric Drive. Electrical Review Steel Industry for 1920, G. E. Stolz. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 4–5. Steam driven mills rapidly being replaced by progressive application of electricity to steel mill drives. Number of instances shown where steam equipment is being replaced.

Recent Developments in Electric Mill Drive. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 93–94. Practically all new reversing mills built during 1920 are electrically driven mills. Most interesting reversing-mill drive of year built for Tata Iron & Steel Co., at Temshedpur, India.

Plate Mills. Rolls Ship Plates on New Mill, Joseph Horton. Iron Trade Rev., vol. 68, no. 6, Feb. 10, 1921, pp. 410–412, 4 figs. English works where product is transferred from hot bed to shears by movable runout table which controls plate while its ends are being trimmed.

Rotary Side-Cutting Shear for Three-High Plate Mill. Engr., vol. 131, no. 3397, Feb. 4, 1921, pp. 124 and 129–130, 8 figs. partly on supp. plate. Mill has top and bottom rolls 36 in. diameter and middle roll of 24 in. diameter, all 9 ft. long on barrel and is designed to roll plates from $^1/_8$ in. to $1^1/_2$ in. thick up to length of 60 ft. and maximum shearing width of 8 ft. 6 in., maximum weight of finished plate being 5 tons.

The Dominion Iron and Steel Company's New Ship Plate Rolling Mill, Barton R. Shover. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 80–84, 4 figs. Electrically driven mill in which electric motors are used for practically all work in plant.

Variable-Section Shapes. Continuous Die Forming, G. R. Norton. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 104–106, 4 figs. Also in Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 30–32. New process designed to roll variable section shapes at Neville Island plant of Witherow Steel Co. Products to be manufactured in alloy and special steels.

ROPES

Winding. Deformation in Winding Ropes, H. Herbst. Quarry, vol. 26, no. 287, Jan. 1921, pp. 17–21, 6 figs. Formulas for determining stresses. Translated from Glückauf.

S

SCREW MACHINES

Automatic. The Automatic Stopping of Screw Machines (Das selbsttätige Stillsetzen von Automaten), H. Bauer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 5, Jan. 29, 1921, pp. 122–123, 11 figs. Points out desirability of automatic stopping and describes certain release devices for different makes of machines.

The "Empire" Full Automatic Screw Machine. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 492–493, 3 figs. English designs of automatic and pin and stud machines.

Circular Forming Tools. Design of Circular Forming Tools. Machy. (Lond.), vol. 17, no. 435, Jan. 27, 1921, pp. 517–520, 6 figs. Calculations for designing circular forming tools having top rake.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SEAPLANES

Design. Conditions of Flight of a Hydroplane (Etude sur les conditions d'envol de l'hydravion). Aérophile, vol. 28, nos. 23–24, Dec. 1–15, 1920, pp. 359–360, 6 figs. Technical determination of forces acting.

SHAFTS

Bending of. Theoretical Consideration of Bending in Shafts, Charles W. Good. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 138–139. Computation of pressure distribution of loads and reactions, and effect of various distributions

Critical Speeds. The Calculation of Critical Torsional Speeds (Beiträge zur Berechnung kritischer Torsions-Drehzahlen), Fr. Sass. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 3, Jan. 15, 1921, pp. 67–69, 9 figs. Describes method said to greatly simplify the tedious calculation of the critical torsional speed of multiple-crank engines. It is based on the combination of any number of small masses into a single equivalent mass of a given magnitude varying with the number of oscillations. Numerical tables are given for the rapid determination of the reduced length of cranked portion of shaft.

The Critical Speed of a Turbine Spindle, Richard Gardner. Engineering, vol. 111, no. 2874, Jan. 28, 1921, pp. 99–100, 1 fig. Method of obtaining formula for motor which is roughly symmetrical about its middle, taking common case of rotor formed by wheels carried on spindle, diameter of which is stepped.

Multiple-Splined. Torsional Strength of Multiple-Splined Shafts, C. W. Spicer. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 129–130 and 199, 4 figs. Comparative torsional tests of splined shafts and full round shafts.

SHIPBUILDING

1920. Naval Construction in 1920. Engr., vol. 131, no. 3393, Jan. 7, 1921, pp. 16–18. Statistics of shipbuilding throughout world.

The World's Mercantile Shipbuilding in 1920. Shipbuilder, vol. 24, no. 126, Feb. 1921, pp. 151–157, 1 fig. Statistics by countries.

United States. American Shipbuilding—Present and Future. Mar. Eng., vol. 26, no. 1, Jan. 1921, pp. 24–30, 2 figs. It is expected that by July 1, 1921 American merchant marine will aggregate 19,000,000 gross tons. Present tonnage is over 16,000,000 gross tons.

World Statistics. The World's Shipbuilding. Engineering, vol. 111, no. 2874, Jan. 28, 1921, pp. 102–103. Lloyd's statistics for 1920. Total production of world amounted to 7259 ships, making 5,861,666 gross tons as compared with 2483 ships and 7,144,549 tons in 1919.

SPRING MOTORS

Manufacture. Manufacturing Spring Motors—I. Machy. (Lond.), vol. 17, no. 436, Feb. 3, 1921, pp. 556–560, 10 figs. Time-saving methods used in machining phonograph motor parts.

SPRINGS

Calculations. Derivation of Formulæ for Spring Calculations. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 485–488, 3 figs. Illustrations of procedure in various cases.

STANDARDS

Automotive Industry. Standards Committee Meeting. Jl. Soc. Automotive Engrs., vol. 8, no. 2, Feb. 1921, pp. 169–199, 16 figs. Proposed standards for ball bearings, electrical equipment, engine parts, etc.

STEAM

Properties. The Properties of Steam. Engineering, vol. 111, nos. 2873 and 2874, Jan. 21 and 28, 1921, pp. 63–65 and 93–94, 1 fig. Review of Callender's work. Jan. 21: Thermodynamic theory of vapor and application of vapor conclusions to steam. Jan. 28: Properties of steam near critical point. (Concluded.)

STEAM-ELECTRIC PLANTS

Enlarging. Riverside Station Enlarged by 50,000 Kilowatts. Power, vol. 53, no. 2, Jan. 11, 1921, pp. 50–57, 12 figs. Additions to steam-electric plant in Minneapolis. Features are coal and ash handling, skylight illumination of boiler and turbine rooms, all-steel turbine foundations and truck-type oil switches to facilitate their exchange or removal for inspection or repairs.

ENGINEERING INDEX (Continued)

Germany. The Principal Defects in German Steam Plants and Their Elimination (Die hauptsächlichen Mängel unserer Dampfanlagen und ihre Beseitigung), H. Reischle. Zeit. des Bayerischen Revisions-Vereins, vol. 25, no. 1, Jan. 15, 1921, pp. 1–5. Discussion of main deficiencies in storage of fuel, and in the generation, distribution and utilization of steam. Address delivered at the Thermotechnical Convention in Münich.

Shanghai. Electrical Development in Shanghai, I. V. Robinson. Beama, vol. 8, no. 1, Jan. 1921, pp. 30–35, 3 figs. Steam-electric plant of 28,368 kw. capacity.

STEAM POWER PLANTS

Costs. Effect of Load Factor on Steam-Station Costs, Peter Junkersfeld. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 108–110, 4 figs. Financial loss will result whenever it becomes necessary to operate power station at substantially higher or lower annual load factor than that for which station was properly designed. Load factor should be carefully considered in locating central station as well as in selection of equipment. Curves are given to show relative generating costs and boiler rating as affected by load factor, typical week-day load curves and load factors, and load factor as it occurs from day to day and month to month.

Steel Works. Modern Steam Generating Station, G. C. Emmons. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 65–78, 16 figs. Detailed account of performance of steel generating station of Republic Iron & Steel Co., Youngstown, Ohio.

STEAM TURBINES

Design. A New Graphic Method for the Calculation of Steam Turbines (Om Turbomaskiner), Matts Bäckström. Teknisk Tidskrift (Mekanik), vol. 50, no. 11, Nov. 10, 1920, pp. 149–166, 22 figs. 3 on 3 supp. plates. Author discusses basic formulas and principles for the calculation of turbines and explains diagram developed by him and called the temperature-drop diagram, by use of which it is possible to make calculations in a purely mechanical and simple manner.

Developments. Development of the Steam Turbine, Robert June. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 61–64, 2 figs. Development has taken place not only with respect to design of turbines, but in particular with respect to very great increase in their application to different services.

Specifications. British Standard Specification for Steam Turbines for Electrical Plant. British Eng. Standards Assn., no. 132, Oct. 1920, 8 pp. 3 figs. Technical provisions for supply of machines. Method of measuring temperature of steam.

STEEL

Aircraft Steels. See AIRCRAFT CONSTRUCTION MATERIALS, Steels.

Alloy. See ALLOY STEELS.

Bars, Weight of. Weight Table for Estimating, F. W. Salmon. Am. Mach., vol. 54, no. 5, Feb. 3, 1921, pp. 182–183, 1 fig. Table giving weight of round steel bars per linear inch.

Basic Open-Hearth. The Basic Open Hearth Melting Shop Equipment and Practice in England, George A. V. Russell. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 31 and 38–45, 4 figs. Review of mixer plant and practice, melting furnaces, metallurgical practice, handling of materials and products and layout of plant. (To be concluded.)

Bibliography. Review of Iron and Steel Literature, 1920, E. H. M'Clelland. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 8–10. Also in Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 6–8. List of important publications during 1920, with a few of earlier date compiled by librarian of Carnegie Library of Pittsburgh.

Bluing and Browning. Bluing and Browning Steel Articles, Sidney Cornell. Chem. & Metallurgical Eng., vol. 24, no 7, Feb. 16, 1921, pp. 301–303. Commercial methods of producing oxidized finish on polished steel objects, including analyses of several browning solutions in use in various establishments

Gases in. Gases Obtained in Molten Steel—I, Henry D. Hibbard. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 51–53. Classification of gases and how to deal with them in order to make product sound. (To be continued.)

High-Speed. See STEEL, HIGH-SPEED.

Ingot Production. A Proposed New Ingot Mold of Steel, Robert C. Woodward. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 262–263, 2 figs. Cracks in ingots and their causes. Effect of heavy molds. Advantages of thin walls cooled by water.

Macrostructure. Use of Ammonium Persulphate for Revealing the Macrostructure of Iron and Steel, Henry S. Rawdon. Dept. of Commerce, Sci. Papers of Bur. of Standards, no. 402, Nov. 12, 1920, pp. 715–723, 7 figs. Method of etching.

Magnetic Reluctivity. Magnetic Reluctivity Relationship as Related to Certain Structures of a Eutectoid-Carbon Steel, C. Nusbaum, W. L. Cheney and H. Scott. Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 404, Nov. 26, 1920, pp. 739–757, 7 figs. Changes in physical properties resulting from thermal treatment were studied for one per cent carbon steel and it was found that very rapid rise of maximum and residual induction and even more pronounced decrease in coercive force occur between drawing temperatures of 150 and 250 deg. cent. Such changes very likely mark transformation from martensite to troostite.

Manganese. See MANGANESE STEEL.

Metallography. Metallographic Methods for Determining the Nature of Non-Metallic Inclusions in Steel and Cast Iron (Methodes métallographiques pour déterminer la nature des inclusions non métalliques contenues dans l'acier, le fer et la fonte), M. M. Matveieff. Revue de Métallurgie, vol. 17, no. 11, Nov. 1920, pp. 736–752, 25 figs. Comparative value of different etching reagents.

Microstructure. Notes on the Microstructure of Annealed Soft Steel, with Special Reference to Phosphorus in Tin Plate, Geo. F. Comstock. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 60–63, 16 figs. Interpretation of photomicrograph.

Nickel-Chrome. See NICKEL-CHROME STEEL.

Phosphorus and Sulphur. Effect of Phosphorus and Sulphur on Steel, E. W. Rettew and L. A. Lanning. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 247–249. Phosphorus increases tensile strength without decreasing ductility and increases hardness without lowering electric conductivity. Sulphur increases susceptibility to corrosion.

Tool. High Carbon Open-Hearth Steel Versus Crucible Tool Steel in the Manufacture of Miscellaneous Tools, George Porteous. Trans. Am. Soc. for Steel Treating, vol. 1, no. 4, Jan. 1921, pp. 238–244, 5 figs. Open-hearth high-carbon steel with proper heat treatment gives as good results as are given by higher grade and more expensive tool steel.

Uranium. See ALLOY STEELS, Uranium Steel.

Wrought Iron vs. Single Refined Wrought Iron Versus Steel, V. E. Hillman. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 63–65, 8 figs. Argument in favor of feasibility of substituting soft basic open-hearth steel for single-refined wrought iron.

STEEL CASTINGS

Annealing. Annealing Steel Castings with Fuel Oil, R. R. Hillman. Iron Age, vol. 107, no. 4, Jan. 27, 1921, pp. 247–249, 1 fig. Design and operation of new furnace in plant of Atlas Steel Casting Co. Blast for combustion heated by outgoing gases.

Converter Process of Production. The Small Converter Process and Its Importance in the Production of Steel Casting (Die Kleinbessemerei und ihre Bedeutung für die Stahlgusserzeugung), R. Schmidt. Zeit. für die gesamte Giessereipraxis, vol. 41, nos. 51 and 52, Dec. 18 and 25, 1920, pp. 661–662 and 677–678, and vol. 42, nos. 2 and 3, Jan. 8 and 15, 1921, pp. 17–18 and 35–36. Writer relates his experiences with process in his capacity as inspection engineer for artillery workshops.

Electric Melting. Electricity Shop's Sole Heat Source, H. E. Diller. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 87–91, 8 figs. Equipment installed at foundry of Emery Steel Castings Co., Baltimore, which specializes in light castings of intricate design.

Molding Sand for. Sand Plays Part in Poor Castings, R. J. Doty. Foundry, vol. 49, no. 3, Feb. 1, 1921, pp. 95–97. Clean, smooth steel castings are dependent upon facing and heap sand used. Close heap sand causes blows. Ten parts heap sand mixed with one part new sand in facing. Paper read before Am. Foundrymen's Assn.

Specifications. Meet Steel Castings Specifications, E. R. Young. Foundry, vol. 49, no. 4, Feb. 15, 1921, pp. 152–153. Work done under U. S. Ordinance Departments specifications. Table showing effect of various amounts of titanium on physical properties. Paper read before Am. Foundrymen's Assn.

Strength. Steel Castings of High Strength and Toughness—II, Federico Giolitti. Chem. & Metallurgical Eng., vol. 24, no. 4, Jan. 26, 1921, pp. 161–165, 15 figs. Data on improvement to be expected after properly heat-treating steel castings, with illustrative tests on strong, tough castings which have replaced forgings on gun mounts.

STEEL, HEAT TREATMENT OF

Electric. Electric Heat Treating at Emery Steel Casting Company, F. W. Brooke and Geo. P. Mills. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 45–47, 5 figs. Electrically heated core oven and annealing furnace for small intricate castings. High operating efficiency and low initial cost claimed for electric process.

Heat-Treating Department. Constructing a Heat Treating Department, L. C. Dunn. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 40–45, 7 figs. Commercial heat-treating department built by Montgomery Chemical Works, Detroit.

Hump Furnaces. Recent Installations of Hump Furnaces, G. W. Tall, Jr. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 48–51, 12 figs. Hump method and drawing furnaces as it is proposed to install them at new plant of Cadillac Motor Car Co., Detroit, Mich.

Methods. Metallography and Heat Treating of Steels, Wm. J. Merten. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 114–118, 15 figs. Review of various types of heat treatment. Photomicrographs.

STEEL, HIGH-SPEED

Manufacture. High-Speed Steel Manufacture in Sheffield, Paul M. Tyler. Iron Age, vol. 107, no. 6, Feb. 10, 1921, pp. 371–374. Great expansion in war time. Present practice, costs, prices and raw material sources. Wages much below American.

STEEL INDUSTRY

Germany. Development of the Steel Industry During the War in Germany—II, Hubert Hermanns. Blast Furnace & Steel Plant, vol. 9, no. 2, Feb. 1921, pp. 146–150, 2 figs. Utilization of basic open-hearth slag.

STEEL MANUFACTURE

Basic Open-Hearth Process. Basic Open-Hearth Melting Shop Equipment and Practice, G. A. V. Russell. Iron & Coal Trades Rev., vol. 102, nos. 2759 and 2761, Jan. 14 and 28, 1921, pp. 37–39, 3 figs., and 122–124, 3 figs. Rapid growth of basic open hearth process is attributed to its suitability for dealing with pig irons of widely varying composition. Comparative developments of mixer practice in England and other countries. Metallurgical practice at representative British steel works. (To be continued.)

STEEL WORKS

Power Plants. Recent Developments in Steel Works Power Plants, W. N. Flangaan. Blast Furnace & Steel Plant, vol. 9, no. 1, Jan. 1921, pp. 56–59, 1 fig. Steps taken to reduce labor and consumption of coal.

[See also ROLLING MILLS.]

STOKERS

Automatic. Developments in the Design of Automatic Mechanical Stokers (Note sur quelques perfectionnements des foyers à grille-chaîne tournante), A. Lambotte. Société Belge des Electriciens, vol. 34, Nov.-Dec. 1920, pp. 253–260, 3 figs. Use of automatic stokers for burning low-grade coals.

Reconstruction. Remodeling Stokers and Furnaces Adds to Capacity, T. A. Marsh. Elec. World, vol. 77, no. 4, Jan. 22, 1921, pp. 196–197, 4 figs. Boiler ratings raised 39 per cent by enlarging grate areas and improving arch design. Practical method at minimum cost.

STRIKES

Causes. Strikes—How to Avoid Them, William Leavitt Stoddard. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 77–84. Most important single cause of strikes is lack of common understanding between employer and employee, "generally due to the fact that employer and employee do not get together as they could and should." Secret of avoiding strikes lies in personal contact.

SUBSTATIONS

Automatic. Automatic Substations (Sottostazioni automatiche), I. Prinetti. Elettrotecnica, vol. 7, no. 35, Dec. 15, 1920, pp. 622–625, 3 figs. European and American developments.

SUPERHEATERS

Marine. Steam Superheaters in Merchant Ships, H. B. Oatley. Gen. Elec. Rev., vol. 24, no. 2, Feb. 1921, pp. 121–123, 5 figs. Classification into live-gas and waste-gas types. Location of superheater equipment.

The Sugden Uptake-Type of Superheater for Scotch Marine Boilers. Engineering, vol. 111, no. 2872, Jan. 14, 1921, pp. 37–40, 16 figs. Superheater is accommodated wholly in smokebox and Howden air heater is fitted at base of uptake.

T

TERMINALS, MARINE

Improvements. Marine Terminals and Port Facilities, Floyd T. Smith. Mar. Eng., vol. 26, no. 1, Jan. 1921, pp. 66–71, 5 figs. Survey of port developments contemplated.

TERMINALS, RAILWAY

Toronto. Mechanical and Electrical Equipment of the Toronto Union Station, Walter J. Armstrong. Jl. Eng. Inst. of Canada, vol. 4, no. 2, Feb. 1921, pp. 87–97, 7 figs. General survey of mechanical and electrical equipment for new Union Station, including heating and ventilation, lighting, elevators, power equipment, fire-alarm systems, etc.

TESTING MACHINES

Developments. Recent Developments in Testing Machines, Thorsten Y. Olsen. Forging & Heat Treating, vol. 7, no. 1, Jan. 1921, pp. 66–69, 12 figs. Survey of developments during last 50 years.

Manufacture. The Manufacture of Weighing and Testing Machines. Eng. Production, vol. 2, no. 16, Jan. 20, 1921, pp. 91–95, 11 figs. Methods at works of W. and T. Avery, England.

Universal. The Bradley-Richards 30-Ton Universal Testing Machine. Practical Engr., vol. 63, no. 1768, Jan. 13, 1921, pp. 28–30, 2 figs. Testing force is obtained by fluid pressure, working fluid being mineral oil

TESTS AND TESTING

Stamping Tests. Stamping Tests of Thin Sheets (Essai, à l'emboutissage, des tôles minces), Charles Frémont. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 3, Jan. 17, 1921, pp. 146–148, 2 figs. Value of stamping tests for determining elastic properties of material.

Stop-Watch Uses. The Limitations of the Stop Watch as a Precision Instrument, A. L. Ellis. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 2, Feb. 1921, pp. 104–112, 22 figs. Accuracy to be expected in time measurements by stop watch in scientific and engineering testing.

Tenacity. The Tenacity of Materials as Basis for Calculating Steel Constructions, Especially Bridges

ENGINEERING INDEX (Continued)

(La ténacité des matériaux comme base des calcul de ponts et constructions métalliques en acier doux), N.-C. Kist. Vie technique & industrielle, vol. 2, no. 16, Jan. 1921, pp. 319–321, 1 fig. Theoretical study.

TIME RECORDERS

Types. Time-Recording Devices (Messvorrichtungen für die Zeitbuchführung), Rud. Thun. Betrieb, vol. 3, no. 7, Jan. 10, 1921, pp. 52–56, 8 figs. Means and methods of keeping time-schedule control and notes on different time-recording forms and devices. Address before the Federation of German Works Engrs.

TIRES, RUBBER

Truck, Pneumatic. The Nuttall Tyre and Wheel. Motor Transport, vol. 32, no. 829, Jan. 17, 1921, pp. 60–61. Patented design of pneumatic tire for motor trucks.

TRACTOR ENGINES

Grinding in Valves. Grinding in Valves in Motor Heads, Frank A Stanley. Am. Mach., vol. 54, no. 8, Feb. 24, 1921, pp. 332–333, 6 figs. Machining methods used on Holt tractor valves. Details of grinding-machine mechanism.

TRACTORS

Tests. Twenty-Two More Tractors Undergo Nebraska Tests. Automotive Industries, vol. 44, no. 5, Feb. 3, 1921, pp. 216–218. Nebraska state law requires testing tractor before it can be marketed in state. Details of tests officially conducted under law.

TRACTORS, FARM

American-Made. Detailed Technical Specifications of Gasoline Farm Tractors for 1921. Motor Age, vol. 39, no. 4, Jan. 27, 1921, pp. 106–109. Tabulated data on 76 different makes of American gasoline and kerosene farm tractors produced by manufacturers, with makes of principal parts, including engine, governor, lubricator, ignition system, air cleaner, gearset, clutch and axle.

TRANSPORTATION

Land, Air and Sea. A Comparison of the Cost of Transport and Ton-Miles by Land, Sea, and Air, Lord Montagu Aeronautics, vol. 20, no. 380, Jan. 27, 1921, pp. 58–61. Lecture before Royal Aeronautical Soc.

TUBES

Bending of. A New Method of Bending Tubes. Machy. (Lond.), vol. 17, no. 434, Jan. 20, 1921, pp. 490–491. Method consists of using either oil or water as means of obtaining pressure inside tube to prevent wrinkling, and pushing tube around bend instead of bending it to shape by means of punch or wheel.

TYPEWRITERS

Manufacture. Interesting Operations on Typewriter Parts. Eng. Production, vol. 2, no. 17, Jan. 27, 1921, pp. 127–136, 29 figs. Methods of Imperial Typewriter Co., England.

V

VALVES

Hydraulic. A New Hydraulic Valve. Engr., vol. 131, no. 3395, Jan. 21, 1921, pp. 77, 4 figs. Miter seated type balanced hydraulically.

VIBRATIONS

Machinery. Vibration, Julius Frith Practical Engr., vol. 63, no. 1770, Jan. 27, 1921, pp. 52–53. Laws governing vibrations of machinery and their application to particular cases, such as vibrations of crankshafts, flywheels and alternating-current generators. Paper read before Manchester Assn. of Engrs.

VOCATIONAL TRAINING

Disabled Soldiers. Rehabilitation of Our Disabled Soldiers, Sailors, and Marines and Their Return to Civil Employment. Vocational Summary, vol. 3, no. 8, Dec. 1920, pp. 114–117. Training in business administration as conducted by Federal Board for Vocational Education.

W

WATER MAINS

Construction. Water and Gas Mains (Les conduites d'eau et de gaz). Nature (Paris), no. 2434, Nov. 27, 1920, pp. 338–343, 18 figs. Construction, maintenance and inspection.

WATER POWER

Austria. Power Possibilities of Austria, J. Sidener and A. Gruenhut. Elec. World, vol. 77, no. 6, Feb. 5, 1921, pp. 310–311. Total water power capable of development in that country is estimated at 1,500,000-hp. New republic has 460 stations.

Brazil. The Igassú Waterfall (Las cataratas del Iguassú), Emilio Rebuelto. Ingenieria Internacional, vol. 5, no. 3, March 1921, pp. 143–147, 6 figs. Project for utilization of 225-ft. fall involving transmission of 125,000 kw. a distance of about 700 miles.

Developments in Canada. Power Development in Canada in 1920, Leo Denis. Can. Engr., vol. 39, no. 27, Dec. 30, 1920, pp. 649–650. Both public and private enterprise is active. Ontario hydro-electric power commission's Queenston work most important. Quebec streams commission assists development in Quebec. Keen interest in power from Atlantic to Pacific.

Europe. Revival of Industrial Activity in Europe, L. W. Alwyn-Schmidt. Power Plant Eng., vol. 25, no. 4, Feb. 15, 1921, pp. 205–207. Survey of recent developments and proposed projects for utilization of water power in Europe.

Federal Power Commission. Water-Power Applications, 13,469,181 Hp. Elec. World, vol. 77, no. 7, Feb. 12, 1921, pp. 369–370, 1 fig. Federal Power Commission reports 168 applications for preliminary permits on Jan. 29. Twenty-five applications filed during month of January. Arizona leads all states in total horsepower involved.

Water-Power Applications Filed in 1920, 13,000,000 Hp. Elec. World, vol. 77, no. 3, Jan. 15, 1921, pp. 138–139, 1 fig. Federal Power Commission reports 143 applications for preliminary permits at close of 1920. Net total horsepower exceeds present development by about 4,000,000 hp. Mountain and pacific states lead all other sections.

Water-Power Applications Total Over 10,000,000 Horsepower. Elec. World, vol. 77, no. 1, Jan. 1, 1921, pp. 42–44, 1 fig. Federal Power Commission reports 120 applications for preliminary power permits filed prior to Dec. 18. Total horsepower involved exceeds present total water-power developments of country. New York State leads Union in total horsepower of proposed developments.

New England. Water-Power Development in New England, H. K. Barrows. Jl. Boston Soc. Civil Engrs., vol. 8, no. 1, Jan. 1921, pp. 1–42, 10 figs. Review of present situation in regard to amount and distribution of water power in New England, both developed and undeveloped, basis for its development and use, its relative economy and possibilities of improvement in way of storage projects and redevelopment.

Niagara Falls. Two Novel Plans for Harnessing Niagara, T. Kennard Thomson. Power House, vol. 14, no. 3, Feb. 5, 1921, pp. 17–19, 2 figs. One scheme suggests tunnel through Goat Island and other gigantic dam below falls.

St. Lawrence River. 5,000,000 Hp. Available From St. Lawrence. Elec. World, vol. 77, no. 6, Feb. 5, 1921, pp. 312–314, 2 figs. Joint development of this power and locks around dams will create 30-ft. channel from Great Lakes to sea at 27 per cent of expenditure required for improving navigation alone. Methods of conducting, time required and market for power.

South Africa. Water-Power Schemes for the Union, F. E. Kanthack. So. African Jl. of Industries, vol. 3, no. 12, Dec. 1920, pp. 1131–1141. Possibilities of Vaal and Orange Rivers.

Utilization. Hydraulic Utilization in the U. S. and Other Countries. Water Power, vol. 2, no. 1, Jan. 1921, pp. 12–20. Survey of developments in hydroelectric design.

Studies of White Coal (Généralités sue la houille blanche), G. Acher. Vie technique & industrielle, vol. 2, no. 16, Jan. 1921, pp. 315–319, 9 figs. Technical consideration of utilization of water power for the generation of electrical energy. (Continuation of serial.)

The Technique of the Utilization of Water Power (Généralités sur la Houille blanche), G. Archer. Vie Technique & Industrielle, vol. 2, no. 14, Nov. 1920, pp. 1131–17, 4 figs. Comparative economical study of coal and water power as sources of industrial energy. (To be continued.)

Water-Power Problems, W. J. E. Binnie. Surveyor, vol. 59, no. 1513, Jan. 14, 1921, pp. 25–27, 2 figs. Diagrams expressing relation between reservoir storage and factors effecting water power utilization. Paper read before Liverpool Eng. Soc.

Wind Power vs. Wind and Water Power (Wind- und Wasserkraft), Hans Baudisch. Elektrotechnik u. Maschinenbau, vol. 39, no. 4, Jan. 23, 1921, pp. 42–47. Critical discussion of relative merits of wind and water power. It is pointed out that in the development of wind-power motors as well as water turbines, electrotechnology will have decisive and leading influence.

WELDING

Water Mains. 26-in. Welded Steel Main in Montana. Gas Age, vol. 47, no. 2, Jan. 25, 1921, pp. 53–55, 2 figs. Water pipe line including 26,000 ft. of welded large-size pipe.

[See also ELECTRIC WELDING.]

WELDS

Failure of. The Reason Why Some Fusion Welds Fail, T. D. Sedwick. Ry. Mech. Engr., vol. 95, no. 2, Feb. 1921, pp. 114–118, 14 figs. Hardening effect of welding heat graphically demonstrated and effect of annealing shown. Paper read before Chicago Section, Am. Welding Soc.

Why Some Welds Fail, T. D. Sedwick. Welding Engr., vol. 6, no. 1, Jan. 1921, pp. 26–36, 38 figs. Also in Acetylene Jl., vol. 22, no. 8, Feb. 1921, pp. 431–438, 38 figs. Interpretation of photomicrographs. Paper read before Am Welding Soc.

Tests. Properties of Arc Metal and Arc Welds as Determined by Tests, O. H. Eschholz. Power, vol. 53, no. 7, Feb. 15, 1921, pp. 250–255, 16 figs. Result of tests on electric-arc metallic-electrode welds. Tests included tensile, compression, cantilever, transverse, shear, impact, bending and hardness. Comparisons were made between properties of bulk and layer-deposited metal. Microscopic structure of welds. Fatigue resistance under repeated stresses. Magnetic properties.

WIND POWER

See WATER POWER, Wind Power vs.

WIND TUNNELS

Design. Design of Wind Tunnels and Wind Tunnel Propellers—II, F. H. Norton and Edward P. Warner. Nat. Advisory Committee for Aeronautics, no. 98, 1921, 10 pp. 20 figs. Study of directional variation in wind stream with a view to securing data for designing wind tunnels.

Manometers for. The Tilting Manometer, F. H. Norton and D. L. Bacon. Aerial Age, vol. 12, no. 23, Feb. 14, 1921, p. 585, 1 fig. Apparatus designed by technical staff of Nat. Committee for Aeronautics.

Recording Balances. Design of Recording Wind Tunnel Balances, F. H. Norton. Aerial Age, vol. 12, no. 20, Jan. 24, 1921, pp. 511–512, 9 figs. Design developed at Langley Memorial Aeronautical Laboratory of National Advisory Committee for Aeronautics. Works on parallelogram principle and is self-balancing but not recording.

WINDMILLS

Types. Windmills for the Generation of Electrical Energy (Windmühlen zur Erzeugung elektrischer Kraft), H. Donath. Elektrotechnischer Anzeiger, vol. 38, nos. 1, 2 and 3, Jan, 4, 5 and 6, 1921, pp. 1–2, 5–6 and 9–10, 9 figs. European and American types.

WIRE MANUFACTURE

Hardening and Tempering Plant. Electric Wire Hardening and Tempering Plant. Engineering, vol. 111, no. 2873, Jan. 21, 1921, pp. 76 and 78. Continuous plant incorporating two processes, first heating and quenching to harden wire and reheating and second quenching to give required temper.

WOMEN WORKERS

Accidents. A Study of Accidents Among Women in Industry, Nelle Swartz. Safety Eng., vol. 41, no. 1, Jan 1921, pp. 19–22. Based on statistics gathered by New York State Industrial Commission.

Forewomen. The New Place of Women in Industry—V, Ida M. Tarbell. Indus. Management, vol. 61, no. 3, Feb. 1, 1921, pp. 135–137. Survey of advance of women workers into executive positions.

United States. Women in Industry. Monthly Labor Rev., vol. 12, no. 1, Jan. 1921, pp. 153–158. Results of inquiry finances by War Work Council of Young Women's Christian Assn., begun during war and carried down to 1919. It was desired to secure definite facts with regard to increase during war in number of women in industry, kinds of work in which they were employed and their success or failure in new lines of work.

WOOD PRESERVATION

Zinc Chloride Treatment. Effect of Zinc Chloride Treatment on Strength of Timber, H. B. Luther. Ry. Maintenance Engr., vol. 17, no. 2, Feb. 1921, pp. 57–59. Tests showed that for specimens stored at 75 deg. fahr. there was no appreciable difference in strength between treated and untreated timbers; for those stored at 100 deg. fahr. in compression parallel to grain. there was decrease of 3.5 per cent in treated specimens, and in cross-bending decrease of 17.6 per cent; and for those stored at 150 deg. fahr. in compression parallel to grain, there was decrease of 20.6 per cent in treated specimens, in cross-bending decrease of 49 per cent.

WOODWORKING INDUSTRY

Engineering in. Engineering in the Woodworking Industries, B. A. Parks, H. S. Sackett, Lambert T Ericson, Allan E. Hall, E. S. Park and J. M. Weber and D. W. Edwards. Mech. Eng., vol. 43, no. 2, Feb. 1921, pp. 85–101, 36 figs. Group of papers presented at annual meeting of Am. Soc. Mech. Engrs. dealing with furniture manufacture, freight-car construction, machining of railroad cross-ties, wood-block floors, wood preservation, and electrically driven sawmills.

WORKMEN'S COMPENSATION

Pennsylvania Law. Industrial Accidents and Their Cost, Walter F. Mulhall. Iron Age, vol. 106, no. 27, Dec. 30, 1920, pp. 1766–1767. Operation of Pennsylvania Compensation law.

Rates. A Plea for More Adequate Accident Compensation Rates, Ethelbert Stewart. Monthly Labor Rev., vol. 11, no. 6, Dec. 1920, pp. 1–10. Revision of State Compensation Laws.

Social Insurance and. Workmen's Compensation and Social Insurance, Carl Hookstadt. Monthly Labor Rev., vol. 11, no. 6, Dec. 1920, pp. 135–163, 1 fig. Comparison of compensation insurance systems as to cost, service, and security.

State Laws. Workmen's Compensation and Social Insurance. Monthly Labor Rev., vol. 12, no. 1, Jan. 1921, pp. 167–186. Methods of amending state compensation laws.

Z

ZINC

Corrosion. Corrosion of Zinc of Various Compositions after Exposure to the Air for Five Years (Corrosion de zincs de compositions diverses après cinq ans d'exposition à l'air), Eng. Prost. Revue universelle des Mines, vol. 6, no. 5, Sept. 1, 1920, pp. 353–363, 16 figs. Researches at metallurgical laboratory of Liége University.

MECHANICAL ENGINEERING

Volume 43 May, 1921 Number 5

An Investigation of Oxy-Acetylene Welding and Cutting Blowpipes

By R. S. JOHNSTON,[1] WASHINGTON, D. C.

This paper reports the results of and conclusions from an elaborate series of tests carried out by the Bureau of Standards, Washington, D. C., for the War Department on commercial apparatus for cutting and welding by the oxy-acetylene process, submitted by manufacturers for the purpose of the tests.

The welding tests were performed upon $^1/_2$-in. and $^3/_4$-in. steel plates and the cutting tests upon $^1/_2$-in., 2-in., 6-in. and 10-in. material.

The general conclusions from the tests were that there was a great deal of difference between the characteristics of different designs of cutting blowpipes, and that there was no make of apparatus which was equally proficient and economical for all the thicknesses of metal. Further, one of the prime essentials of a good welding blowpipe is its so-called gas ratio, which should be unity. Not any of the blowpipes tested proved capable of maintaining a gas ratio of unity during welding, although, as the author states, the welds were probably made with greater care than has ever been bestowed upon any like work.

The important problem of "flashback" receives extensive consideration, and the author concludes that a blowpipe designed to be absolutely free from flashback caused by any form of obstruction, under all working conditions, will also be the eminently safe blowpipe and the one which with ordinary care will produce sound welds. Such a blowpipe will be one so designed that, under all conditions of operation even to complete blocking of the gas exit at the tip end, there will be maintained a one-to-one volume delivery of each gas, at identical pressures.

In addition to the particulars regarding welding tests here presented, the complete paper gives full details of the series of cutting tests.

In the war the increased use by the American Expeditionary Forces of oxy-acetylene welding and cutting equipment necessitated large purchases by the Government. In discussions concerning the relative merits of procurable apparatus it became evident that no authentic data were available as to the relative merits of the various blowpipes. The Bureau of Standards was therefore requested by the Chief of Ordnance to make a test for the determination of "efficiency, safety and workmanship entering into the several makes of apparatus" (oxy-acetylene).

Of necessity, the emergency of the investigation limited its proposed scope. The manufacturers of welding and cutting blowpipes were invited to conference and were circularized in regard to methods of test. From a study of the results of these conferences and correspondence a tentative scheme of tests was developed. A series of preliminary tests was started, and from the results a set of tests and a method of conducting them were decided upon. Further study made it desirable that a more extended investigation of the oxy-acetylene blowpipe be made. The signing of the armistice relieved the urgency and a much more complete series of tests was proposed. The results of these tests are included in this paper.

In deciding on the final tests S. W. Miller, Mem.Am.Soc.M.E., was engaged as consulting engineer. After securing his suggestions the tests were submitted to the War Department for final suggestions before being submitted to the manufacturers of the apparatus to be tested.

Several weeks of preliminary work were given over to acquainting the expert welders and cutters from the Naval Gun Factory, Washington, D.C., and the New York Navy Yard with their new duties. The knowledge that the tests were to be started, together with the fact that most of the apparatus had been held for test for at least a year, brought forth requests from the manufacturers for the privilege of submitting new and improved apparatus, which were granted.

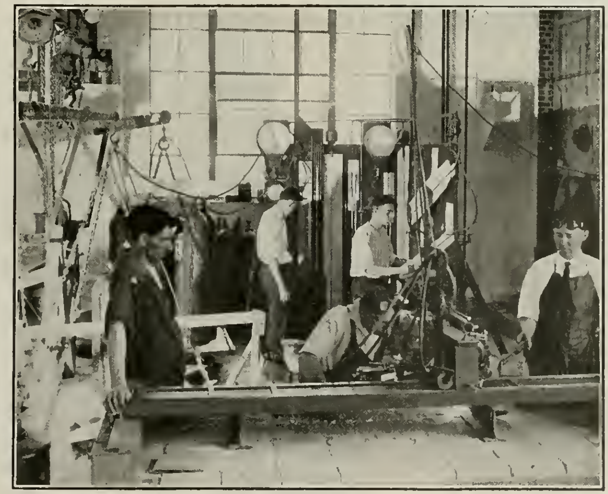

Fig. 1 Entire Testing Equipment

A copy of the tests to which it was proposed to submit blowpipes, accompanied by a circular letter giving the sizes and chemical analyses of the materials to be cut and welded, was forwarded to each manufacturer for him to furnish certain information. Each concern was later also individually notified of the day upon which its apparatus was scheduled to be tested.

The tests occupied about three months.

Acknowledgment

In the development of this investigation the general experience of a number of people was drawn upon that the question might be viewed from its broadest aspects, and its successful completion was largely due to the splendid coöperation received. Appreciation for such assistance is expressed to Col. L. B. Moody, Ordnance, War Department; Lt. Col. Warren R. Roberts, Q. M. C., War Department; Maj. A. B. Quinton, Jr., Ordnance, War Department; Maj. R. F. Carr, U. S. A., War Department; Maj. W. L. Simpson, Ordnance, War Department; Capt. A. L. Willard, Naval Gun Factory, Washington, D.C.; Capt. C. H. Rock, Hull Division, New York Navy Yard; and to the officers of the divisions of the

[1] Engineer-Physicist, U. S. Bureau of Standards, Washington, D. C.

Abstract of a paper to be presented at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper may be had on application. All papers are subject to revision.

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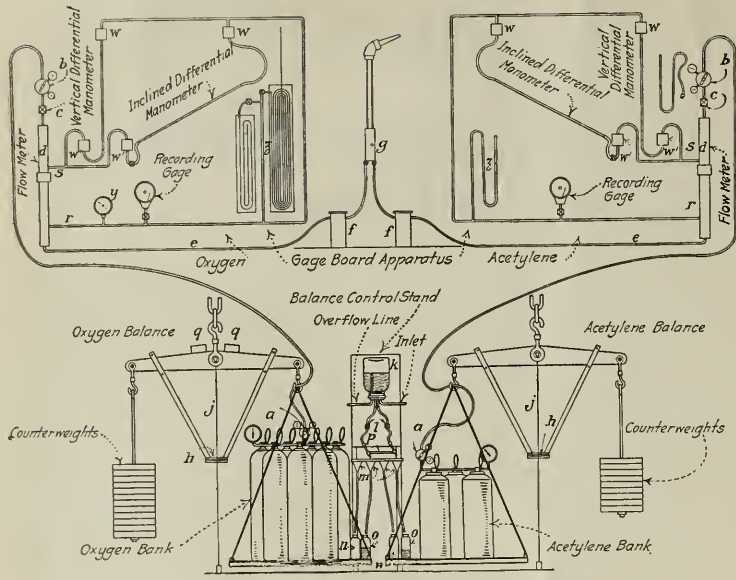

Fig. 2 Diagram of Entire Testing Equipment

Bureau of Standards and the several manufacturers of oxy-acetylene equipment.

The paper presented herewith is the result of a special investigation conducted at the Bureau of Standards for the War Department as represented by Major A. B. Quinton, Jr., Tank, Tractor and Trailer Division, Ordnance Department, through which Department the results of the investigation have been made available for public distribution.

Summary of Results

The results of this investigation would seem to warrant the following statements:

For the Cutting Blowpipes:

a That there is today no generally accepted theory for proportioning, for the cutting of metal of various thicknesses, the volume and velocity of the issuing cutting jet, with the result that none of the apparatus submitted to test proved economical for all thicknesses.

b That there is for any thickness of metal cut a limiting velocity of exit of the cutting jet at which complete utilization of the oxygen takes place, and a limiting value for the amount of oxygen required to produce a cut.

c That an increase in acetylene consumption, or oxygen consumption, or of the velocity of exit of the cutting jet beyond the limiting values, does not produce increased efficiency in commensurate ratio.

d That a large majority of the blowpipes tested were equipped with excessive preheating flames for the thickness of metal the tip is specified for, and that such excessive-sized flames are disadvantageous both from the standpoint of economy of operation and quality of work performed.

e That considerable improvement in economy of operation seems possible in cutting material of 2 in. thickness and that possibly this condition may be found to exist for metal of other thicknesses than those used in the tests.

f That the maximum thickness of metal that may be economically cut with an oxy-acetylene blowpipe of standard design when neither the material nor the oxygen is preheated and the cutting is done only from one direction, is about 12 in.

g That the cutting blowpipes due to their incorrect design are subject to the same "flashback" troubles found in the welding blowpipes.

For the Welding Blowpipes:

a That the blowpipes most subject to the so-called phenomena of flashback are those in which the oxygen is delivered at a pressure in excess of that at which the acetylene is delivered.

b That all the blowpipes tested, including those in which the acetylene is delivered at an excess pressure as well as the so-called equal- or balance-pressure blowpipes, are subject to flashback phenomena on account of inherent defects in their design.

c That the cause of the development of the conditions producing flashback is the setting up within the blowpipe tip and head of a back pressure which retards or chokes off the flow of one of the gases.

d That this back pressure is the result of confining or restricting the volume flow of the issuing gases at the tip end.

e That any cause tending to restrict the flow of the gases sets up a back pressure which immediately causes a change in the amount of each gas delivered to the mixing chamber.

f That a fluctuating gas-volume ratio, due to the restriction of volume flow, from whatever cause, prevents a blowpipe from maintaining constantly and at all times during operation the desired "neutral flame."

g That a blowpipe that cannot maintain under all operating conditions a neutral flame cannot logically be expected to produce sound welds.

h That all the blowpipes tested during this investigation either through improper gas pressures or improper interior design or both are incapable of maintaining a neutral flame (constant-

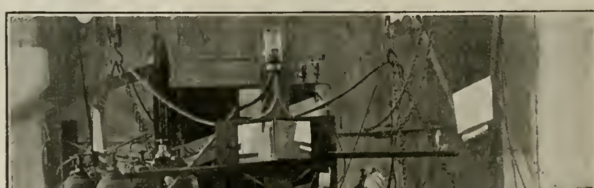

Fig. 3 Operator's Table and Balances

volume gas ratio) under all conditions of restricted gas flow and are therefore incapable of producing sound welds where there is any liability of the gaseous products of combustion being momentarily confined such as occurs in practically all welding operations.

i That the ability of a blowpipe to consume an equal volume ratio of gases when burning freely and undisturbed in air is no criterion that it is capable of producing sound welds, i.e., that it is

not subject to detrimental fluctuations in gas ratio during a welding operation and therefore is capable of maintaining a neutral flame under all operating conditions.

j That whether a blowpipe of present designs will consume an equal volume ratio of gases when burning freely and undisturbed in air depends on how nearly correct the operator sets the so-called "neutral flame," and experience indicates that the average operator checks the acetylene gas flow too much and actually develops an oxidizing rather than a neutral flame.

k That the question of the possible limiting strength and ductility or the efficiency of welds made by the oxy-acetylene welding blowpipe must await the development of a more satisfactory instrument, and that having such an instrument there is no reason to believe that a weld of clean, sound metal cannot be made with assurance during any welding operation and that such welds will or can be made to possess the proper physical properties.

Description of Equipment Used

In general the equipment used for making the tests may be listed as:

a Weighing system for determining amount of gases used during tests by loss of tank weight

b Gage-board system containing necessary pressure gages, regulators and orifice flowmeters

c Welding table

d Cutting table

e Flashback and safety testing apparatus.

Figs. 1 and 2 show the entire equipment. The tanked gases are "banked" and counterpoised on an equal-arm balance. The gas from these tanks passes through a regulator *a*, thence through a flexible hose to the back of the gage board. Passing through

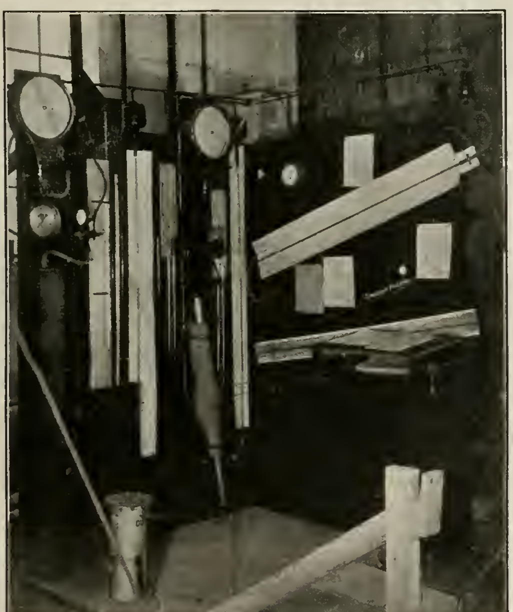

Fig. 4 Gage-Board System

the board the supply line enters a second regulator *b*, thence through a needle valve *c*, to the top of and through an orifice flowmeter *d*. The gas coming from the extreme bottom of the flowmeter is then conducted through a standardized length of flexible hose *e*, containing a safety flashback tank *f*, to the blowpipe to be tested.

Fig. 3 is a view of the operator's table, showing the use of mirrors for taking practically simultaneous readings of the balances.

Fig. 5 Welding Table

Fig. 4 shows the gage-board system. In the center of the board is one of the flowmeters, surrounded by wool-felt insulation.

Accuracy of Tests

Unusual precautions were taken to insure accuracy. If the gas losses through leakage exceeded 0.01 to 0.02 lb. per hour, actual testing of the blowpipes was not continued until the leaks causing such losses were located and stopped.

The values obtained for gas consumption were accurate to 0.005 lb., and in most cases probably much closer.

With the precautions taken with the regulators, it was readily possible to maintain under almost all conditions a pressure varying not more than 0.01 or 0.02 lb. from the desired amount. Autographic records gave visual evidence of the absolute uniformity of the pressure under which the blowpipes were operated during the tests.

Special orifice flowmeters were designed to facilitate securing data on continuous blowpipe action and as a check on the weighing system.

To complete the records the gage board was equipped with a standard calibrated thermometer, a psychrometer, a barometer and a stop watch.

Elaborate precautions were taken to maintain the gas conditions constant during the tests.

The Welding Table

All welding during the tests was performed upon the welding table illustrated in Fig. 5. This was a wooden-frame table approximately three feet square, the top of which was composed of firebricks. On top of the firebricks was placed a heavy casting channeled for a width of about six inches throughout its length. This formed the base upon which all the plates for welding rested during the welding operation. The plates were aligned centrally along this base with the idea that the casting with its grooved surface would permit of better heat radiation along the line of the weld and at the same time form a baseplate or background to prevent possible inconveniences from the blowholes caused by blowing the welded material through the bottom of the V of the test weld plates.

As indicated in Fig. 5, the line of the weld was placed directly in front of the welder and the welding was performed from the back toward the operator, thus giving him a full view of the work as it progressed. The welded plates were cut so that the welds were 1 ft. in length. Where 2 ft. of weld were made continuously, pairs of plates were set in front of each other with a slight space between the individual pairs and with proper allowance for expansion so that the process could be carried from one plate to the other without any interruption. The groove along the baseplate facilitated the preheating of the second pair of plates, so that the start upon the second weld was made under practically the identical conditions which existed when the first pair of plates was finished, a condition that would be equivalent to that which would occur if the weld was made as one of 2 ft. length instead of two of 1 ft.

The Flashback and Safety Apparatus

Flashback-Protection Tanks. The testing equipment also included in the gas lines two flashback tanks (f, Fig. 2, and Fig. 1). These tanks were essentially hydraulically controlled valves which

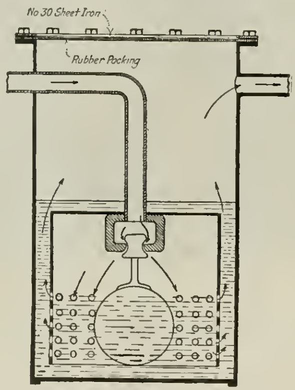

Fig. 6 Flashback-Protection Tank

were intended to prevent the propagation of an explosion in the blowpipe or gas line backward toward the gas supply. They are shown in sectional view in Fig. 6. While it was generally realized that the installation of the water seal of these flashback-protection tanks might be considered detrimental, due to the absorption of moisture by the gas, it became evident that their installation was nevertheless a prime necessity as a means of protecting the rather expensive gage-board equipment. It was believed further that, inasmuch as the oxygen in use generally came from cylinders that contained more or less water, the passing of the gas through the hydraulic seal of the flashback-protection tank would in reality tend to standardize the moisture content in the gas and therefore produce similar effects for all blowpipes.

These flashback-protection tanks proved extremely satisfactory for the purpose intended in that in several explosions they prevented the propagation of the flame beyond the flash tank. They generally ruptured by the blowing off of the head of the tank during the explosion. As furnished the heads were of rather thick sheet metal, fastened on with bolts as indicated on Fig. 6. This construction proved to be somewhat dangerous to the operators making the tests and the tanks were therefore modified in their construction as indicated in the figure by having a rubber packing and a thin sheet of metal fastened to the top with a heavy annulus. By this construction it was expected that if an explosion developed within the flash tank the thin metal sheet would rupture by tearing and thus minimize danger from flying parts.

Materials Used in Tests

Welding Rod. The welding rod used throughout the entire series of tests was secured from the Naval Gun Factory, Navy Yard, Washington, D. C. This rod was purchased in July 1917 under Navy Department Specification 22-W-4. A number of chemical analyses were made and the percentage composition was found to be as follows:

Carbon..........	0.024 to 0.03	Silicon.........	0.002 to 0.004
Manganese.......	0.05 to 0.08	Chromium.....	Trace
Phosphorus.......	0.01 to 0.015	Nickel........	Not detected qualitatively
Sulphur..........	0.023 to 0.024	Vanadium....	Not detected qualitatively

Steel Plates for Welding and Cutting. The steel plates used for welding were $^1/_2$ in. and $^3/_4$ in. in thickness. The material used for cutting was $^1/_2$, 2, 6 and 10 in. in thickness. All the material used in both welding and cutting except the 10-in. was furnished through the Engineer Corps, War Department, and was selected with special reference to uniform quality for any particular thickness. The $^1/_2$-in. material was furnished in plates 3 ft. by 5 ft. in size and was used for both welding and cutting tests. The middle section of each plate was retained as a sample for determining the qualities of the plate. The remaining pieces were used for making welds. During the welding tests it was the practice to use plates that were adjacent to each other in the main or full plate before it was cut into weld specimens, so that as nearly as possible the material used for any particular test would be identical.

The $^3/_4$-in. material for welds was received in plates 12 in. wide by 6 ft. in length. These plates were cut up into sections 9 in. in length, and for the full width of the plate, that is 12 in. All specimens for welding tests were finished with a butt joint of the single V 90-deg. included-angle type.

For the cutting tests the 3-ft. by 5-ft. by $^1/_2$-in. plates were cut into strips approximately $1^1/_2$ to 2 in. in width. The 2-in. material for cutting was furnished in sections 2 in. by 6 in. by 20 ft. These were cut, for convenience in handling, into 5-ft. lengths and in test operations cut lengthwise into sections 2 in. in width. The 6-in. material was shell billet steel furnished in 3-ft. lengths and was cut lengthwise in test operations.

Chemical analyses of a part of these materials indicated that they were of approximately the following percentage compositions:

$^1/_2$-in. Mild-Steel Plate for Welding and Cutting Tests:		*$^3/_4$-in. Plate for Welding Tests:*	
Carbon........	0.14	Carbon........	0.25 to 0.27
Manganese.....	0.32 to 0.36	Manganese.....	0.41 to 0.48
Phosphorus.....	0 012 to 0.013	Phosphorus....	0.011 to 0 013
Sulphur........	0.033 to 0.055	Sulphur........	0.041
Silicon.........	0.006 to 0.012	Silicon.........	0.004

Description of the Tests

The tests were started with the idea of submitting each manufacturer's equipment to the series of tests listed in a circular sent out under date of February 18, 1920. It was found, however, that the proposed series of tests was excessive from the time standpoint. One of the most serious drawbacks as a time-consuming element was the fact that a very large percentage of the blowpipes submitted for test would not operate with the pressures specified by the manufacturers. This condition was probably due to the fact that it is quite a customary practice to recommend setting the regulator pressures three to five pounds higher than the specified blowpipe pressures. By throttling the gases at the blowpipe-handle valves the operator insures having sufficient pressure available at all times to maintain the required velocity of exit of the gases at the tip end. He is therefore enabled to compensate for pressure fluctuations due to irregular action of the regulator, thus tending to minimize the development of flashbacks. The specifications for the tests distinctly stated that at least one of the blowpipe-handle valves must be maintained at full opening during a test. It was only by such a procedure that the gas consumption of a blowpipe could be definitely ascertained. For a great many of the blowpipes the pressures were too high to enable the maintenance of a stable flame with one of the handle valves at full opening.

Another quite serious source of trouble from the standpoint of time consumption was that due to leakage necessitating the dismantling and repacking of valves.

In order, therefore, that the entire investigation might not require an undue length of time it was decided that attention should be devoted only to the so-called primary tests, consisting of the welding, cutting, gas-ratio, and flashback tests. Such proposed tests as the variation of pressure within the blowpipe head, etc.,

TABLE 1 SUMMARY OF TESTS FOR GAS RATIOS

Bureau of Standards Investigation

Torch No. (1)[1]	Test Number: 1a (2)	1b (3)	2 (4)	5a1 (5)	5b (6)	With gratings: 5a1 (7)	5b (8)
1...	1.13	1.16	1.14	1.19	1.08	1.04	1.01
	(1.11)[2]	(1.15)	(1.14)	(1.18)	(1.04)	(1.05)	(0.981)
2....	1.12	1.07	1.08	1.04	1.06	1.04	0.992
	(1.11)	(1.06)	(1.06)	(1.04)	(1.04)	(1.02)	(0.996)
3...	1.21	1.26	1.13	1.10	1.07	1.01	1.04
	(1.18)	(1.23)	(1.19)	(1.07)	(1.09)	(1.01)	(1.09)
4 ...	1.13	1.09	1.41	1.14	1.29	...	...
	(1.13)	(1.09)	(1.16)	(1.15)	(1.10)	...	...
5...	1.07	1.05	1.03	1.02	1.04	1.01	0.999
	(1.05)	(1.04)	(1.13)	(1.02)	(1.10)	(1.01)	(1.03)
6...	1.10	1.11	1.14	1.12	1.17	1.06	1.08
	(1.10)	(1.11)	(1.15)	(1.12)	(1.16)	(1.03)	(1.07)
7...	1.07	1.05	1.03	1.04	1.07	1.05	1.02
	(1.04)	(1.03)	(1.02)	(1.01)	(1.03)	(1.01)	(0.994)
8 ..	1.13	1.12	1.18	1.27	1.43	1.05	1.01
	(1.12)	(1.12)	(1.16)	(1.28)	(1.38)	(1.03)	(0.986)
9. . .	1.15	1.18	1.19	1.14	1.14	1.43	1.19
	(1.18)	(1.24)	(1.17)	(1.14)	(1.15)	(1.39)	(1.15)
10...	1.12	1.15	1.19	1.10	1.04	1.03	1.01
	(1.11)	(1.13)	(1.06)	(1.09)	(1.05)	(0.989)	(0.992)
11..	1.19	1.20	1.26	1.27	1.09	1.21	1.04
	(1.19)	(1.21)	(1.23)	(1.28)	(1.08)	(1.19)	(1.05)
12..	1.21	1.21	1.13	1.02	1.04	1.02	1.02
	(1.17)	(1.20)	(1.11)	(1.01)	(1.02)	(0.998)	(0.979)
13	1.02	1.13	1.09	1.09	1.07	1.02	1.00
	(1.04)	(1.12)	(1.09)	(1.08)	(1.06)	(1.01)	(1.00)
14....	1.07	1.09	1.08	1.08	1.10	0.999	0.956
	(1.06)	(1.08)	(1.07)	(1.08)	(1.10)	(0.992)	(0.964)

[1] Numbers (1) to (8) are column numbers.
[2] Values in parentheses are computed from flowmeter data.

were therefore abandoned. On the basis of the foregoing the following schedule of tests was adopted and all blowpipes tested during this investigation were submitted to them.

Welding Tests. All blowpipes reported upon were submitted to five welding tests, designated respectively as Tests 1*a*, 1*b*, 1*c*, 1*d*, and 2. All the tests numbered 1 were made with $^1/_2$-in. plate. Test 2 was a weld with $^3/_4$-in. plate.

Tests 1*a* and 1*b* were made with the tip sizes and pressures specified by the manufacturer when this was possible. For both of these tests a 2-ft. length of weld was made. These tests were identical in all respects with the exception that an attempt was made to evaluate the personal equation by using different operators. For Tests 1*c* and 1*d* a 12-in. length of weld was made. Both of these welds were made by the operator who made the weld of Test 1*a*, the idea being to maintain as nearly constant a personal equation for this series of tests as possible. Test 1*c* was run with the same size tip as 1*a*, but with pressures (both oxygen and acetylene) 50 per cent in excess of the pressures used for Test 1*a*. Test 1*d* was carried out similarly to 1*c* except that the pressures were 25 per cent below those used in Test 1*a*.

As mentioned above, the pressures specified by the manufacturer very often gave an exit velocity to the gas too high to permit of maintaining a stable flame at the blowpipe tip. In such cases the manufacturer's representative was requested to furnish a modified pressure that would enable the maintenance of a stable welding flame. Very often the modified pressure thus determined upon would not permit of the application of Test 1*c*, that is, a test with a 50 per cent increase in pressure in both gas lines. It was customary, therefore, in such cases to modify the test procedure and incorporate as a test in place of Test 1*c*, Test 1*e*, which was run under identical conditions with the above test with the exception that the pressure on both gas lines was reduced to 50 per cent of the pressure used to make Test 1*a*.

Tests 1*c*, 1*d*, and 1*e* were incorporated to show the effects of increased or decreased pressures on the operation and economy of the blowpipe. Such excess or decreased pressures are found to be quite common in many welding operations, due to carelessness on the part of the operator in setting regulator pressures or to imperfect regulator action. It was felt that a properly designed blowpipe should be capable of adjustment over a considerable range for any specified tip size. It was hoped in the investigation to secure data that would either verify this assumption or prove that it was absolutely essential to maintain exact pressures for satisfactory blowpipe operation.

Test 2 was a 12-in. length of weld of $^3/_4$-in. mild-steel plate. This weld was made in all cases by the operator who made the weld of Test 1*b*. This test was selected as indicating the probable results to be obtained with a blowpipe in heavy welding, and with Test 1 it was felt that it would give a fair idea of the adaptability of the blowpipe for welding purposes. The tips for welding $^1/_2$-in. and $^3/_4$-in. plate were selected as being the tips used respectively for the average-size weld and for the maximum-size weld, and therefore the best general average for determining the blowpipe's efficiency and safety.

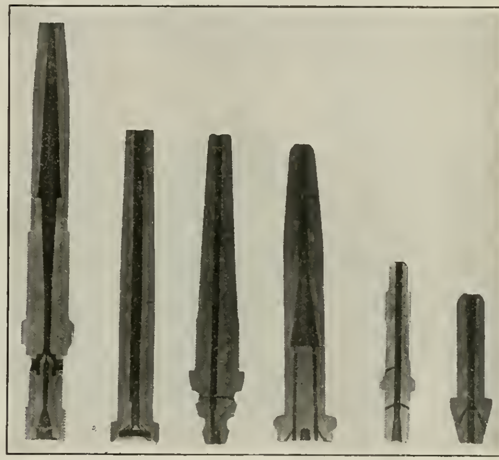

Fig. 7 Cross-Sections of Blowpipe Tips

TABLE 2 SUMMARY OF RESULTS OF TENSILE AND BEND TESTS OF OXY-ACETYLENE WELDS

Bureau of Standards Investigation, Tests 1*a*, 1*b*, 1*c*, 1*d*, 2

(Weld made in Tests 1*a*, 1*b*, 1*c*, 1*d*, 2)

Torch No. (1)[3]	Test Number: 1a Ult. T. S.[1] (2)	1a Incl. angle[2] (3)	1b Ult. T. S. (4)	1b Incl. angle (5)	1c Ult. T. S. (6)	1c Incl. angle (7)	1d Ult. T. S. (8)	1d Incl. angle (9)	2 Ult. T. S. (10)	2 Incl. angle (11)
1.....	39.3	116	44.4	115	33.1	44	42.1	77	43.6	51
	44.9	121	47.4	95	...	...	...	...	...	...
2....	41.2	29	39.4	39	41.2	67	45.8	58	43.7	69
	44.1	56	43.9	67	...	...	...	...	...	...
3	31.9	50	27.9	28	43.0[4]	94[4]	35.3	37	33.2	30
	32.1	36	35.9	20	38.9[5]	62[5]	...	...	...	...
4 ...	36.2	62	41.4	95	40.6	61	39.0	107	53.5	117
	43.0	41	36.7	73	...	...	...	...	...	...
5...	43.0	72	31.1	63	43.6	34	32.1	18	33.0	52
	46.3	25	37.7	63	42.9[5]	42[5]	...	...	...	...
6...	40.6	72	45.8	59	34.4	16	44.3	56	48.6	44
	43.7	69	42.3	65	...	...	...	...	...	...
7...	44.2	33	37.3	56	36.1	73	36.3	53	48.2	49
	46.0	77	40.8	65	...	...	...	...	...	...
8...	43.4	43	39.8	64	32.9	20	39.5	80	41.4	74
	43.8	70	42.6	60	...	...	...	...	...	...
9...	...	...	34.9	38	42.0	67	44.1	71	44.9	57
	46.5	62	45.2	39	...	...	...	...	...	...
10...	41.9	54	35.1	26	47.7[4]	89[1]	45.6	72	39.4	23
	43.1	59	39.6	51	...	...	...	...	...	...
11...	43.8	54	38.7	66	37.9	36	38.4	96	45.1	39
	27.0	51	29.2	57	32.8	38	...	...	...	...
12..	40.4	43	39.0	54	42.3	60	49.4	94	45.8	62
	40.2	32	39.5	56	...	...	...	...	...	...
13...	39.3	51	31.0	83	40.1	61	34.4	82	48.3	58
	52.1	61	41.6	24	...	...	...	...	...	...
14..	40.4	63	45.6	107	39.4	52	42.4	65	38.1	38
	41.0	49	46.5	66	...	...	...	...	...	...
Average:										
1st plate.....	40.4	57	38.0	64	38.6	49	40.6	69	43.3	54
2nd plate.....	42.4	58	40.6	57	32.8	38	...	...	...	...
General Average[6]	41.4	57	39.3	60	35.7	44	40.6	69	43.3	54

Average ultimate tensile strength of all welded $^1/_2$-in. plates.............39.2 lb. per sq. in.
Average ultimate tensile strength of unwelded $^1/_2$-in. plate.............54.9 lb. per sq. in.
Efficiency of welds in $^1/_2$-in. plate.............71.4 per cent
Tests 1*a* to 1*d*, inclusive, were welds made with $^1/_2$-in. plates; Test 2 with $^3/_4$-in. plate.

[1] Ultimate tensile strength in thousands of pounds per square inch.
[2] Included angle of bend, cold-bend test. Bottom of V in compression. Pin diameter equal to thickness of metal. Included angle for unwelded plate = 180 deg.
[3] Numbers in parentheses are column numbers.
[4] Weld made at — 50 per cent pressure instead of at + 50 per cent pressure.
[5] Weld made at normal pressure instead of at + 50 per cent pressure.
[6] Welds referred to in [5] and [6] are not included in the general average.

Gas-Ratio Tests. One of the prime essentials of a good welding blowpipe is its so-called gas ratio, that is, the ratio of the volume of oxygen to the volume of acetylene consumed. Theoretically a properly adjusted blowpipe requires equal volumes of both gases, giving the ratio of 1 : 1. In order to establish the ratios of the blowpipes under test each one reported upon was submitted to a series of gas-ratio tests, numbered *5a*1 and *5b*.

For these tests the blowpipe was allowed to burn freely in air with the same tip sizes and pressures as were used in the welding tests mentioned above. The blowpipe was supported upon a bracket stand with the tip in horizontal position. All gas-ratio tests were made upon the tips used for welding and no attempt was made to clean them before making the tests other than to blow them out with a rather high oxygen pressure. These tests might be expected to indicate the gas consumption of the blowpipe with the flame burning undisturbed from accidental obstructions, such as slag adhesions to the ends of the tips., etc., which occur in actual welding practice. The discussion of the welding blowpipe furnishes additional interesting information concerning the gas-ratio tests.

Flashback Tests. In order to determine the probable safety of operation of a welding blowpipe and, further, to secure information concerning the permanency of construction of the tip and blowpipe head, the blowpipes reported upon were submitted to two types of flashback tests.

One series of tests designated *3a* and *3b*, flashback tests on the tips used for welding 1/2-in. metal and 3/4-in. metal, respectively, consisted of the standard series of tests used by the Underwriters' Laboratories for determining the freedom from flashback and the safety of the welding blowpipe. Each of these tests consisted of four distinct operations. The first three of these operations were carried out as follows: After being properly adjusted to neutral flame the blowpipe was tested for flashback by drawing the tip at varying angles across the surface of, and finally pressing the tip end firmly against, certain materials. For this test a cold steel plate, a firebrick, and a piece of wood were used. Finally the tip was used to make a pool of molten metal in a cast-iron block, flux being used to assist in maintaining the fluid condition of the metal, and the tip suddenly plunged into the pool of metal.

Another series of tests intended to determine the permanency of construction and designated as the Severe Flashback Test, Test 4, was carried out by supporting the blowpipe on a vertical sliding carriage in such a manner that at the proper instant the ignited and carefully adjusted blowpipe could be lowered so that the end of the tip was directly over the center of a hole 2 in. in diameter and 2 in. deep, drilled in a heavy cast-iron block.

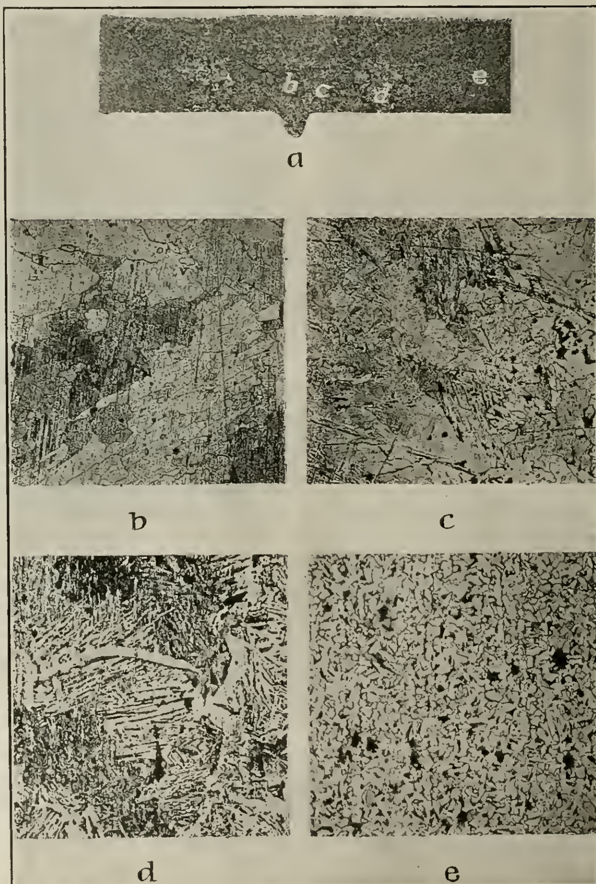

Fig. 8 Photomicrographs of Typical Weld

a Location of photomicrographs
b Fused-in metal of weld
c Junction of weld and plate
d Overheated metal of plate
e Initial or unchanged condition of metal of plate

Etched with 2 per cent alcoholic nitric acid. Magnification, × 50

Discussion of Test Results

The Welding Blowpipe. It is universally accepted that outside of the mechanical features of design that affect weight, balance and convenience of operation, the prime essentials of a strictly satisfactory piece of apparatus are:

a Safety under all operating conditions

b Freedom from the so-called phenomena of "flashback" or sustained backfire

c The quality of maintaining under all operating conditions a welding flame that is neither oxidizing nor carbonizing, one technically known as a "neutral flame," which in the process of combustion consumes, as nearly as possible, equal volumes of oxygen and acetylene; that is, maintains as nearly as possible the theoretical gas-volume ratio of unity.

The tests of this investigation were decided upon with the idea of furnishing data that would enable blowpipes to be compared with respect to these essentials.

A study of the data obtained at the completion of the prescribed tests showed so many apparent inconsistencies that it was evident that there was a governing factor that was not understood, and that was, so far as test data were available, not in evidence. Irrespective of the fact that particular attention had been paid to insuring identical working conditions and gas-pressure control, and that especial care was taken to secure exceedingly competent and unbiased operators, the results obtained from the welding tests seemed extremely unsatisfactory. Gas ratios obtained during actual welding operations were extremely high. Those obtained when the blowpipe was burning freely in air were also higher than was to be expected. In tests for flashbacks there seemed to be a difference in the ease with which they could be developed in blowpipes of different manufacture, but there appeared to be no criterion that would enable one to say just why such phenomena could be caused more easily in some pieces of apparatus than in others, or why with some pieces of apparatus flashbacks could be produced at times quite readily and at other times with difficulty. Finally the general quality of the welds produced during test, although executed with the greatest care and shown by tensile tests to be of a higher strength than is generally secured in most welding shops, was far from satisfactory.

(*Continued on page 359*)

The Design of Large Locomotives

Features Which Keep an Engine in Service a Maximum Length of Time, Reduce Maintenance and Repair Costs, and Increase Revenue-Earning Power

By M. H. Haig,[1] Topeka, Kan.

After discussing various restrictions and limitations in the design and construction of large locomotives due to the inability of existing bridges and tracks to carry the necessary weight and because dimensions must be governed by clearances of bridges and structures, the author expresses the opinion that the physical conditions of a road should be adjusted to the requirements of the locomotive, and that the only controlling factors should be the size of train and the traffic of the territory.

Leading features of locomotive construction such as relative size of cylinders, total heating surface, grate area, principal dimensions, etc., have been treated at length by various writers. Features which have not been so discussed, however, are those which keep a locomotive in service a maximum length of time, reduce engine failures to a minimum, reduce cost of maintenance and repairs, and increase revenue-earning power. And it is in order to arouse interest in those details which are not always given the attention to which they are entitled, and in the quality of material entering into the construction of locomotive parts, that the author proceeds to their consideration. These, in the order of their treatment, are: Counterbalance, crossheads, driving wheels, crosshead pins, piston rods, cylinders, frame braces, boiler cracks, back flue sheet, grate rigging, water columns, cab equipment, and tender capacity. The author's opinions on these topics are presented in the hope that discussion will bring out the experience of others not only on these but on additional details of locomotive design and construction.

The design of a large locomotive depends on the service to which it is to be assigned. The service varies with the weight of the train to be hauled and the number of cars in the train, and is affected by the topography of territory on which it is to operate, ruling grades in each direction, length of grades, average speed between terminals, method of dispatching, whether single or double track between terminals, etc. This information being available, it is a reasonably simple matter to determine upon the leading features of a locomotive to meet the requirements.

Restrictions and Limitations Imposed

For a locomotive to give practically 100 per cent service, its design and construction must not be restricted by personal opinion or by physical limitations of the road. If the weight needed for adhesion in starting a given train is restricted by an opinion that certain wheel loads should not be exceeded or because bridges and track are not capable of carrying the necessary weight, then the capacity of the locomotive is restricted and the train must be adjusted to the locomotive, instead of the locomotive being built to suit the train. This in turn has a tendency to limit a division or a railroad as a whole. Limitations such as these, together with clearances of bridges and structures, obstructions along the right of way, etc., affect the locomotive design and construction. The locomotive as a whole is dwarfed, or some of its vital or essential parts are so dwarfed as to cripple the machine as a whole.

A railroad is a plant, establishment or organization for manufacturing transportation. The locomotive is a very important part of the plant and is one of the most direct earners of revenue from which the transportation-manufacturing plant obtains its income. As such, it is a matter of business and economical principle to adjust some of the physical conditions of the road to meet the requirements of the locomotive, to prevent dwarfing it and to prevent sacrificing its power. Meeting these requirements of the locomotive amounts to meeting the necessary requirements of traffic. No turntable installed at a principal roundhouse should be less than 100 ft. long, and in many cases the length should be 125 ft. The distance between the walls of a modern roundhouse should be great enough to permit closing the door behind the tender of a Santa Fe or Mikado type locomotive and have ample room for trucking between the locomotive pilot and the outer wall of the roundhouse. Passing tracks should be long enough to take trains justified by the business and traffic of the division or territory. Bridges, rail and roadbed should be capable of carrying a static wheel load of at least 65,000 lb. per pair and of permitting the additional stresses resulting from a freight speed of at least 45 miles per hour. In meeting the requirements of rail stresses particular attention should be given to the employment of heavy rails on curves.

Unless these physical conditions are provided, a locomotive cannot be designed and constructed without restriction and proper power cannot be furnished to meet requirements. The only governing factors should be the size of train and the traffic of the territory.

Leading Features of Locomotive Construction

Leading features of locomotive construction such as relative size of cylinders, length of stroke, total heating surface, superheating surface, grate area, etc., have been well covered by handbooks and pamphlets issued by locomotive builders and by reports to the various associations, as well as by articles in the technical press. Tables of principal dimensions of large locomotives are obtainable from the same sources, together with detailed descriptions of features of design and construction which have met with general favor and some which have been short-lived. A discussion or comment on these features would therefore be largely a repetition of facts already presented and easily available.

Features which have not been so generally discussed and exploited are those which keep a locomotive in service a maximum length of time, reduce engine failures to a minimum, reduce cost of maintenance and repairs, and increase revenue-earning power. Among these, durability of material and accessibility of parts are important factors. The latter implies arrangements by which a locomotive is made free from complicationsin construction, inexpensive to repair, easy to maintain, and so put together that needed repairs can be made handily and quickly.

Almost as important as providing a locomotive that will meet the requirements of trains to be hauled and traffic conditions, is providing one that requires minimum repairs—a locomotive that after one trip is ready to be turned for the next trip.

A locomotive is in revenue-earning service only when it is hauling trains. Any road can make a study and determine what proportion of its locomotives are unserviceable and what percentage of the time its serviceable locomotives are on the road. Such information will show what percentage of the time its engines are earning revenue.

To maintain the advantages of designs already existing and to develop these still further requires the unlimited coöperation not only of the mechanical, civil-engineering and operating forces of the railroads, but also of the locomotive builders, and particularly of the manufacturers of material.

The necessity for unlimited coöperation by manufacturers of material is evident from the study of failures of parts both large and small. On the principle of encouraging further consideration of such coöperation by all concerned and for the purpose of arousing interest in those details of locomotive construction which are not always given the attention to which they are entitled, a number of details which seldom appear among "leading dimensions" will be discussed.

Counterbalance

Important among such details and one which is affected particularly by designers and manufacturers of material, is the counterbalance. The blow from the counterbalance is caused by the differ-

[1] Mechanical Engineer, Atchison, Topeka and Santa Fe Railway Company.

Abstract of a paper to be presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper may be obtained upon application. All papers are subject to revision.

ence between the weight of the revolving parts carried by the pins and the total weight in the wheel to balance both the revolving and reciprocating weights. In other words, it is the weight in the wheel to balance reciprocating weight that causes the hammer blow.

Weight of reciprocating parts therefore affects hammer blow of driving wheels, riding qualities of locomotives, possible damage to track and bridges and total weight of locomotive. It is particularly essential to make these parts as light as possible, and to make them light the material must be durable.

Due to the increase in weight of locomotives and to the hammer blow on rails when reciprocating parts are heavy, the 1915 Committee of the American Railway Master Mechanics' Association made the following recommendation:

> Keep total weight of reciprocating parts on each side of locomotive below $^1/_{160}$ part of total weight of locomotive in working order and then balance $^1/_2$ weight of reciprocating parts.

An attempt to counterbalance large locomotives in both freight and passenger service according to this recommendation has demonstrated its merit, but has further demonstrated that the durability of both cast and forged steel must be improved if the method is to be continued.

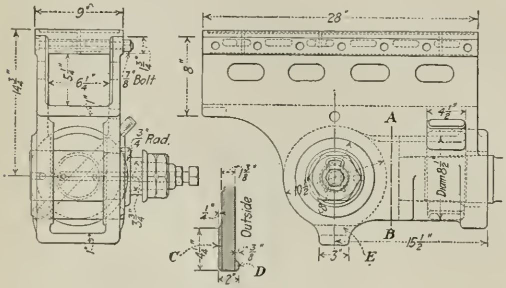

Fig. 1 Laird Crosshead Used on Various Types of Large Locomotives

Crossheads

The Laird type of crosshead is lighter than several other designs, its performance is very satisfactory in service, and it therefore has advantages in designing for light reciprocating parts. A crosshead of this type used interchangeably on large freight and passenger locomotives is shown in Fig. 1.

The construction originally employed is shown by the figure, with the exception of later reinforcement at *C*, *D* and *E*. After about a year's service these crossheads began to break, the weakness appearing in the relatively thin wall between the hub around the piston rod and the lighter hub around the crosshead pin. The same weakness developed in crossheads of similar general design among locomotives of three or four different classes. The defects which proved common to these different crossheads are shown in Fig. 2.

By breaking up these crossheads in order to investigate the nature of the metal, it was found that in most cases each fracture had its origin in a shrinkage crack. The metal in most of the broken crossheads was found to be porous and to contain blowholes or gas holes, or shrinkage cracks, cold shuts or pipes. In some cases all of these defects were present.

Fig. 2 shows very clearly the difference in cross-section of the metal at and near the break. This difference is no doubt largely responsible for the defects in the metal which have caused an epidemic of failures. Crossheads of this general design have been used for many years, and as it appears impossible to modify the shape to advantage, the question, then, is whether foundries can adjust their practices to cast such irregular sections without blowholes, shrinkage cracks and other defects. This is one of the opportunities for manufacturers of material to coöperate with the locomotive designer.

Driving Wheels

Another irregular section which causes shrinkage cracks is the cast-steel driving-wheel center. Rims and spokes are of much lighter section than the hub and counterbalance, and shrinkage cracks are not unusual at the juncture of these light and heavy sections. Foundries which cast locomotive parts have these conditions to meet and it is believed that foundry practices can be adjusted to meet them.

Crosshead Pins

In the development of locomotive construction within recent years the union link of outside valve gears has been connected direct to the crosshead pin. This reduces weight by eliminating the crosshead arm and by shortening the length of the combination lever, thus lessening reciprocating as well as total weight. A further advantage is in eliminating the bolted connection between the crosshead and arm.

In eliminating the crosshead arm the duty of the crosshead pin is increased. A broken crosshead pin is more serious than a broken crosshead arm. When a pin breaks there is a possibility of something else being broken and a very great probability of a cylinder head being knocked out and carrying a part of the cylinder wall with it. It is therefore absolutely necessary that the material in the crosshead pin shall be of a good quality, and the steel used should contain about 0.50 per cent carbon and have a tensile strength of 80,000 lb. per sq. in.

By reference to Fig. 1 it will be observed that the diameter of the union link shank of the crosshead pin is $3^3/_4$ in. This is believed to be considerably larger than usual in locomotive design. Even

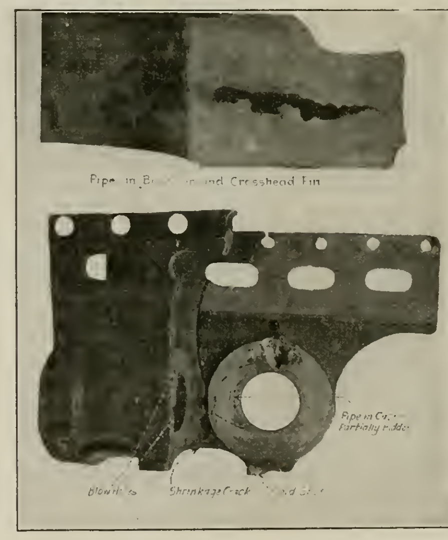

Fig. 2 Location and Nature of Defects in a Poorly Cast Crosshead

though the stresses in the crosshead pin are low, this large size appears to be a necessary precaution against the uncertainty in quality of material. As a further precaution there is a $^3/_4$-in fillet at the end of the shank.

Piston Rods

The greater number of breaks in piston rods of at least one railroad have been through the keyway. Next in order is the location in the crosshead fit adjacent to the collar. Breaks in the body are usually adjacent to the collar at the crosshead fit and occasionally at the collar adjacent to the piston-head fit.

The mechanical fit between the rod and the crosshead is often responsible for the breakage of the former. If there is not a good bearing throughout the length of the fit or at both ends of it, there is opportunity for a slight movement of the rod in the crosshead. This starts a crack which gradually progresses into a fracture. To facilitate making a good bearing at both ends of a piston-rod fit

greater than the keyway and about midway between ends of the fit. To prevent cracks starting in sharp corners at edges of the keyway, these edges are chamfered at both ends of the keyway and entirely around.

Rods with comparatively low stresses sometimes fail in such a manner that it is difficult to attribute a cause unless quality of material is responsible. This is true of rods of ordinary carbon steel as well as those of specially refined steel and of alloy steels. In this is another opportunity for the assistance and coöperation of manufacturers of material.

Cylinders

Failures of parts such as those described in preceding paragraphs, quality of material, uncertainty of cylinder cocks being operated, extreme variation in temperature due to use of superheated steam, foundry practices, etc., all affect the design of cylinders. Consideration of these and other features has resulted in the development of the design shown in Fig. 3, which is that of the cylinder of a Mikado locomotive. Except for modifications in dimensions this represents cylinders used also on Santa Fe, Mountain, Pacific and other locomotive types. The principal features of this cylinder are:

The steam and exhaust channels are free from obstructions and restrictions which will interfere with free flow of steam. The exhaust channels are gradually reduced in area from valve bushing to base of exhaust pipe in such a manner that the cross-sectional area of any point in the channel is not larger than any area through which exhaust steam has previously passed.

A weakness in castings of some large cylinders has been in the wall around the live-steam port. As shown in Fig. 3, this wall is made 2 in. thick and the distance across the port below the valve bushing is 24 in. To reduce stresses in this wall it has been made thicker than most other walls of the casting and, compared with former practice, width across port has been reduced about 4 in. The bridges in the live-steam port are 2 in. thick. They were formerly but 1 in. in thickness and it was not unusual to find them cracked clear through. The change was made to increase the cross-section of the bridges in relation to the adjacent walls and thereby reduce tendency to shrinkage cracks.

To obtain a good cylinder casting from any design, it is necessary to have proper coöperation of the pattern shop and the foundry. Patterns must be well built and carefully checked. The checker should exercise especial care to see that patternmakers apply all the fillets called for. The foundry should so arrange the mold

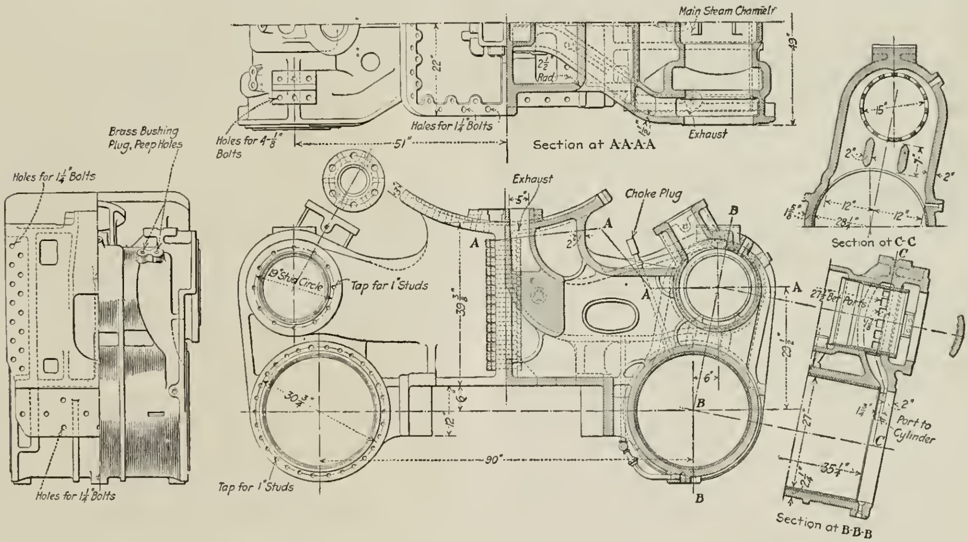

Fig. 3 Cylinder for Large Locomotive

- Simplicity in construction
- Uniform thickness of metal
- Absence of heavy metal sections at junctions of walls
- Walls and parts of ample thickness for strength, well ribbed, well braced and arranged with easy curves and generous fillets
- Uniform sectional area throughout length of steam and exhaust passages
- Short steam ports
- Small steam clearance
- Sections of metal, fillets and other features arranged to eliminate internal stresses set up in metal when cooling
- Double row of splice bolts holding halves of cylinder saddle together
- Double row of bolts at smoke arch
- Triple row of horizontal bolts securing cylinder casting to frame
- Depth of saddle casting directly above frame forming a box section and providing strength where shallow castings used with double-frame rail failed in the past
- Location of valve close to cylinder, permitting short ports, straight valve gear without offsets, and application of nearly straight steam pipe
- Large openings to cylinder cocks.

as to obtain uniform sections of metal. To insure this, careful measurements should be taken when cores are being set and a drop light should be let down into the mold when taking measurements.

Frame Braces

Locomotive frames are subjected to repeated lateral and twisting stresses, as well as to various other stresses, which will gradually break a single frame, but which can be withstood indefinitely by the application of substantial braces. An example of a pair of strong frames substantially braced is shown in Fig. 4, the arrangement illustrated being for a Santa Fe type locomotive. Bracing in the manner shown has been used for a number of years very successfully, and with very little modification is applicable to any locomotive class with outside valve gear.

Braces must be bolted to frames securely. Where braces or castings of other parts are bolted to a frame, the bolts should be applied with the head end bearing in these parts and not the thread end. This will provide for bearing on the bolt through the full thickness of the part bolted to the frame.

Boiler Cracks

In using the boiler to supplement the frames in forming a backbone or foundation from which to brace machinery parts, the boiler

shell is subjected to additional stresses which result in cracks in the sheets. The most frequent causes of these cracks are guide-yoke braces, valve-motion braces and the ordinary belly braces to frames. Guide-yoke and valve-motion braces are often very stiff and are bolted securely to the frames and studded to the boiler. When the boiler expands the braces and connections are held rigidly by the frame and there is a tendency for the boiler to tear itself loose from these fastenings. This sets up strains in the metal which are aggravated by the vibration and pounding to which braces are subjected.

In an effort to overcome these cracks, outside welt plates have been riveted to the boiler to reinforce it where the brace pads are studded on. Experiments have been made with flexible, or partially flexible, braces, some of which have so far been successful.

On engines where breakage of braces has occurred, some of them are being replaced by braces with a pin connection at the lower as well as upper end. Where the use of pins is not favored, however, a thin plate in connection with a cast-steel brace should provide sufficient flexibility for expansion of the boiler and proper stiffness for bracing machinery parts.

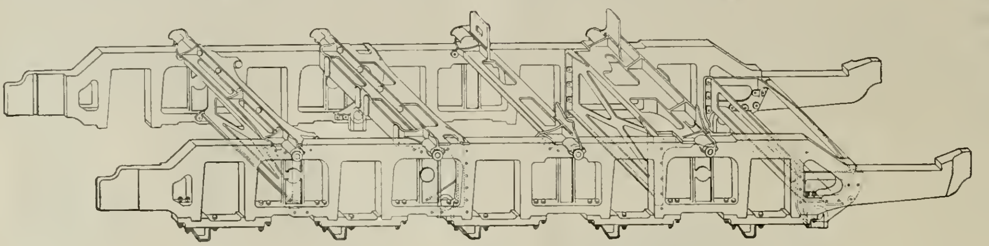

Fig. 4 Frames and Frame Bracing of a Large Locomotive

The Back Flue Sheet

Boiler back flue sheets of large locomotives are renewed and patched more frequently on account of cracks in the knuckle near the top flange than from any other cause. On at least one road the average life of flue-sheet knuckles is 3 years and 3 months, the maximum and minimum varying within rather a large range.

A minimum limit of distance of top flue holes from top of flue sheet that is considered practical is shown in Fig. 5. To omit flues near the top of the flue sheet sacrifices heating surface. To raise the top of the flue sheet above the usual location of flues increases the weight in the firebox, adds to the amount of water necessary to cover the crown sheet, and by requiring increase in diameter of boiler to maintain steam space above the crown sheet, increases the weight of the boiler and consequently the weight of the locomotive as a whole.

Considering the stresses and the peculiar punishment to which flue-sheet knuckles are subjected, it is important to specify this material carefully. The following limits have been demonstrated by experience as practical:

Tensile strength	52,000 to 60,000 lb. per sq. in.
Elongation	Not less than 25 per cent
Carbon	0.12 to 0.25 per cent
Sulphur	Not over 0.025 per cent

The Ashpan

Various details at the rear of a locomotive should be arranged to permit a large ashpan with smooth slope sheets at an angle that will permit cinders to fall to the hopper without obstruction, and its design should be decided on before the designs of surrounding parts have progressed too far. Equally as important is area between the ashpan and mud ring or through parts of the pan, to admit air to support combustion. This area should be at least equal to the area through the boiler flues, and preferably a little greater.

The Grate Rigging

The place for grate rods, which operate the grates, is near the center of the grates and above the deep portion of the ashpan. On locomotives without stokers this arrangement is not difficult to provide for. With some stokers, however, grate rods in this position are interfered with, and this has resulted in some grate rods being located along the sides of pans, in certain cases very close to the flat portion or shelf of the pan under the mud ring. In this position the rods collect cinders close to the air openings and obstruct the admission of air for combustion. With steam grate-shaker equipment and stoker the grate rods can be located near the center of grates by applying a set of intermediate rockers.

Water Columns

A very thorough investigation into conditions affecting the performance of water columns indicates that the most satisfactory serivce is obtained with a column and connections conforming with the following specifications:

Inside diameter of water column ..... $3^1/_2$ in.
Inside diameter of top steam pipe ..... 2 in.
Inside diameter of connection of column to top steam pipe ..... Not less than 2 in.
Inside diameter of bottom connection to boiler ..... $^3/_4$ in.
Top steam pipe as short as possible consistent with required location forward of boiler back head flange
Minimum number of bends in top steam pipe to column. This pipe to be lagged
No valves between water column and boiler either in top steam pipe or in bottom connection
Water-column bottom connection should extend into boiler far enough to clear nearby T-irons or other obstructions, approximately $4^1/_2$ in. from inside of sheet.

Cab Equipment

The back wall of the cab should be far enough away from the boiler back head to give room for a satisfactory seat, for the application of the required equipment, and for a man to pull the throttle open without striking his arm against it. A distance of 46 in. from the face of back head at the center of fire door to the back wall of cab will meet these requirements.

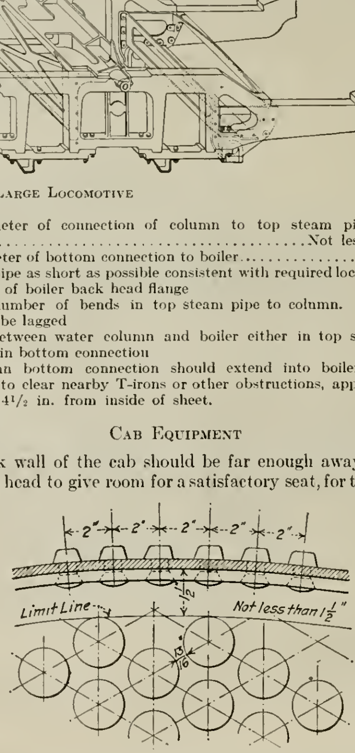

Fig. 5 Minimum Distance Between Top Row of Flues and Flange of Back Flue Sheet

Engineers' and firemen's seats should be located where the men can see ahead and their vision should not be obstructed by air pumps located too high, classification lamps misplaced, running boards too high at the front, or other obstructions that might interfere with their seeing semaphores, switch stands, etc.

(Continued on page 326)

Dry-Vacuum Pump Capacity Tests

Description of New Method Employing the Low-Pressure Nozzle for Air Measurements—Typical Volumetric-Efficiency Curves

By SNOWDEN B. REDFIELD,[1] EASTON, PA.

The method of testing moderate-vacuum pumps described in this paper has a number of advantages. The nozzle used discharges into a back pressure which is greater than the critical. This permits the determination of several values of volumetric efficiency over a range of vacua without changing the nozzle. The method of plotting of results described by the author is a graphic proof of the accuracy of the theory involved and permits ready estimation of approximate performance of a given pump.

CAPACITY tests of dry-vacuum pumps are not common and their actual volumetric efficiency at a given vacuum is usually a matter of conjecture. Furthermore the characteristic curve illustrating the law of the change of volumetric efficiency with vacuum is but little known. It is the purpose of this paper to describe a simple, practical and undoubtedly accurate method of testing dry-vacuum pumps by means of the low-pressure nozzle and to show the characteristic curves of one kind of pump as manufactured by the Ingersoll-Rand Company. The pump illustrated and tested is but one of many similar all-plate-valve pumps tested by the writer. It is not built for extremely high vacua, but is intended for that extensive class of service met with in many industrial and chemical processes calling for what is known as a "moderate vacuum."

Although it is not always appreciated, it is a fact that a dry-vacuum pump is only a compressor working through a range of pressures low down on the scale. Every compressor is really a "booster," that is, it takes in its air or gas at one pressure and compresses and delivers it at a higher pressure. The intake may be at any pressure below atmosphere, exactly at atmosphere, or even a hundred or more pounds above atmosphere. Similarly the discharge pressure may be anything, as long as it is above the intake pressure. In all cases the cycle of intake, compression and discharge is essentially similar, although the weight of material and the power required will vary widely according to the pressures.

Nozzle Tests for Air Measurement

Within the last ten years tests for capacity of air compressors by means of the low-pressure nozzle have become quite common, and the measurement of air has long since passed from the realm of assumption to that of practically standardized methods of determination with considerable accuracy. This being true of the air compressor, it at once becomes true for the dry-vacuum pump, as they have just been shown to be members of the same family, and by methods similar to those standardized for the air compressors we may obtain the exact amount of air handled by a dry-vacuum pump at any vacuum.

Before going further, a word should be said in explanation of the terms "low-pressure nozzle" and "high-pressure nozzle." These are the popular terms to designate whether the back pressure into which the nozzle is discharging is above the critical pressure or below it, respectively. The critical back pressure for air is 0.53 of the upstream, or initial, pressure, and if the back pressure is above the critical, the expansion ratio is relatively low, so the nozzle may be called "low-pressure." If, on the contrary, the back pressure is less than the critical, the total expansion ratio is relatively high, and the nozzle is said to be a "high-pressure" nozzle. The following table gives the class of nozzle for various pressure ratios, assuming a 30-in. barometer:

As explained in many books on thermodynamics, if the back pressure is below the critical, the expansion in the nozzle is only down to the critical pressure in the throat of the nozzle and the rest of the expansion takes place beyond the throat without increasing the quantity of discharge. This immediately fixes the constant quantity of air a nozzle of a given size will pass from a given upstream pressure into any and all back pressures below the critical. For testing compressors with discharge pressures above 13 lb. gage, the nozzle discharging to atmosphere, different quantities of air may be made to flow through a high-pressure nozzle of a given

TABLE 1 CLASSIFICATION OF NOZZLES FOR AIR MEASUREMENT

	Upstream Pressure		Back Pressure		Ratio of Back Pressure to Upstream Pressure	Kind of Nozzle
	Gage	Abs.	Gage	Abs.		
For Pressure Work.....	100	114.7	Atm.	14.7	0.128	High-pressure
	20	34.7	Atm.	14.7	0.424	High-pressure
	12	26.7	Atm.	14.7	0.551	Low-pressure
	2	16.7	Atm.	14.7	0.880	Low-pressure
For Vacuum Work.	Atm.	14.7	2″ vac.	13.75	0.933	Low-pressure
	Atm.	14.7	8″ vac.	10.80	0.733	Low-pressure
	Atm.	14.7	15″ vac.	7.36	0.500	High-pressure
	Atm.	14.7	26″ vac.	1.964	0.133	High-pressure
	Atm.	14.7	28″ vac.	0.982	0.066	High-pressure

size by changing the upstream pressure. This can be accomplished by maintaining the compressor discharge pressure constant in a receiver by means of a throttle which passes the air to the nozzle at some slightly lower pressure. The lower pressure beyond the throttle, at nozzle entrance, will adjust itself automatically to the quantity of air to be passed, so that considerable flexibility may be obtained for compressor testing with this class of nozzle.

Recently some capacity tests have been made upon vacuum pumps using a high-pressure nozzle. This is done by placing a nozzle in the wall of the vacuum vessel, drawing air from the atmosphere, and calculating the flow from well-known formulas. While this has been an assistance in some cases, it is not a flexible method and a different size of nozzle must be used for each vacuum at a given pump speed. This makes it a practical impossibility to test a vacuum pump at a specified vacuum, because one cannot tell just what size of nozzle will be required. With the "low-pressure" nozzle a given nozzle diameter may be used for a very considerable range of vacua and a capacity measurement may be made at any specific vacuum desired.

Due to the excessive noise of a "high-pressure" nozzle and the inaccuracies and difficulty of reading pressure gages of the spring type, the low-pressure nozzle with water-column pressure gage has been adopted by most of the leading compressor builders and is being incorporated into the new test codes of the Society now under revision.

Inspection of the table already given shows that as soon as the vacuum exceeds about 14 in. of mercury, a nozzle discharging from atmosphere into this vacuum is discharging into a pressure below the critical and we have at once a nozzle of the high-pressure class. We have already shown that a high-pressure nozzle of a given size discharging from a constant upstream pressure into a back pressure below the critical will pass only a constant air quantity, irrespective of how low the back pressure may become, and as in this case the upstream pressure remains atmospheric, the quantity of air passed will be constant for a given-sized nozzle for all vacua above 14 in. It then follows that the vacuum obtained with a given-sized nozzle of the high-pressure type, which passes a fixed quantity of air, can be changed only by changing the speed of the pump. If the pump speed is increased, the air must expand after it has passed the nozzle in order to fill the increased piston displacement, and this expansion must be accompanied by a reduction of pressure, which is the same thing as an increase in vacuum. Reduction of pump speed is accompanied by the reverse process and the vacuum will be decreased; but the fact remains that a high-pressure nozzle of a given size will pass only a constant quantity (weight) of air and will produce only one vacuum at a given pump

[1] Engineer in Charge Easton Engineering Dept., Ingersoll-Rand Company, Mem.Am.Soc.M.E.

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speed. Furthermore, it is impossible to select a nozzle of this type to test a given pump at a specified vacuum.

Applying Low-Pressure Nozzle to Vacuum Pumps

As a more flexible and probably more accurate method of testing dry-vacuum pumps, the set-up shown in Fig. 1 lends itself well. In this figure the vacuum pump is drawing from tank A, and any desired vacuum may be produced in A and the pipe connecting it to the pump by adjusting throttle B. Throttle B is a globe valve provided with a long handle for close adjustment. Its stuffing-box gland is liberally daubed with heavy oil to insure against leakage. The running vacuum is observed on mercury column E, and, as said, this vacuum may be adjusted by B to anything desired. Tank C has in its end the nozzle D, taking air from atmosphere, and the pressure drop through D is shown by the water column F. A thermometer G shows the temperature of intake to vacuum-pump cylinder and thermometer H shows the temperature of the air entering the nozzle.

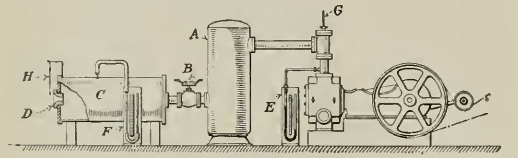

Fig. 1 Apparatus for Low-Pressure Nozzle Test of Vacuum Pump

We now see that the apparatus is composed of three parts: the pump to be tested; tank A and piping in which any desired vacuum is to be maintained, measured by mercury column E and thermometer G; and tank C, which by means of nozzle D, water column F, and thermometer H measures the amount of air handled. As B is adjusted, the quantity of air handled will change. This will change the vacuum as shown on gage E, and water column F will also change to measure the new quantity of air passing through nozzle D. As the drop through D is small, the pressure in C is well above the critical at all times and the quantity of air passed will change with the slight vacuum in C, as measured by water column F. Thus there is a wide range of air quantities which can be made to pass through a low-pressure nozzle of a given size, and by proper adjustment of throttle B any number of test points may be obtained as close together or as far apart as desired, independent of the speed of the pump. Furthermore, any specified vacuum may be secured at will, up to the limit of the machine.

Formulas for Calculating Flow Quantities

For calculating the flow of a gas through an orifice or nozzle, the best-known formula for the case where the back pressure exceeds the critical is that which equates the energy on the two sides of the nozzle and assumes adiabatic expansion in the nozzle. This formula is given in all books on thermodynamics and most handbooks. As given by R. J. Durley[1] it takes the form—

$$W = A\sqrt{2g\,\frac{\gamma}{\gamma-1}\times\frac{P_1}{V_1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}}-\left(\frac{P_2}{P_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$$

where W = weight of gas discharged per second, lb.
A = area of cross-section of jet, sq. ft.
P_1 = pressure on upstream side of orifice, lb. per sq. ft.
P_2 = pressure on downstream side, lb. per sq. ft.
V_1 = specific volume of gas on upstream side of orifice, cu. ft. per lb.
γ = ratio of specific heat at constant pressure to that at constant volume.

By transposition and substituting 1.406 for γ and $53.4T/P_1$ for V_1, we obtain a workable formula for air, namely,

$$W = \frac{2.04\,AP_1}{\sqrt{T}}\sqrt{\left(\frac{P_2}{P_1}\right)^{1.425}-\left(\frac{P_2}{P_1}\right)^{1.712}}$$

where T is the absolute temperature (deg. fahr.) on the upstream side of the nozzle.

This formula assumes frictionless flow and for practice a coefficient must be applied. This coefficient for a nozzle having a well-rounded entrance should be 0.97 for diameters below 1 in., 0.98 between 1 in. and 3 in., and 0.99 for nozzles over 3 in. in diameter. With larger nozzles the coefficient will remain very close to 0.99. This coefficient has been very carefully determined by Dr. Sanford A. Moss, as described in his paper on the Impact Tube.[1]

As P_1 is the upstream pressure and P_2 the downstream, the expression P_2/P_1 is less than unity and to raise this to a power is an awkward job. Also, as P_1 and P_2 are very nearly alike with a low water-column pressure, it is necessary to get the ratio to at least five places of decimals. Unless this is done the difference of the powers will not be correct and the air quantity will not be exact.

To avoid using numbers less than unity, it is more convenient to call $P_1/P_2 = R$, which is greater than unity; then raise the R's to the required powers and subtract their reciprocals. By this procedure we obtain a more convenient formula, namely,

$$W = \frac{2.04\,CAP_1}{\sqrt{T}}\sqrt{\left(\frac{1}{R}\right)^{1.425}-\left(\frac{1}{R}\right)^{1.712}}$$

where C = coefficient = 0.97 to 0.99
R = ratio of absolute pressure on upstream side of nozzle to absolute pressure on downstream side of nozzle: P_1/P_2, expressed to at least five significant figures.

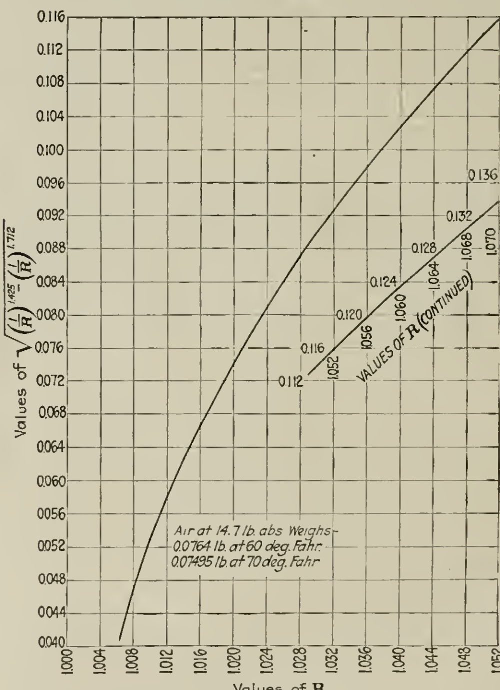

Fig. 2 Factors for Calculation of Air Flow by Rational or Energy Formula

Even with this modification it must be admitted the formula is cumbersome and for that reason the writer plotted the curve shown in Fig. 2. The abscissæ are values of $R = P_1/P_2$, which are therefore greater than unity, and the ordinates represent values of the complete radical $\sqrt{[(1/R)^{1.425} - (1/R)^{1.712}]}$. By means of this curve the process of figuring the weight of air handled is very greatly simplified.

After obtaining the weight per second, or per minute, of the air flowing, this should be changed to the volume handled by the pump so as to express it as a percentage of the piston displacement. To be perfectly logical, it should be expressed in cubic feet at the temperature of pump-cylinder intake as shown by thermometer G,

[1] Trans.Am.Soc.M.E., vol. 27, p. 195.

[1] Trans.Am.Soc.M.E., vol. 38, p. 761.

Fig. 1, and at the pressure of the cylinder intake, which is the vacuum shown by mercury column E. The cubic feet at this condition will be obtained by dividing the weight of flow calculated from the nozzle readings—water column F and temperature at H, Fig. 1—by the weight per cubic foot of air at the absolute pressure of vacuum read on U-tube at E and temperature measured at G, Fig. 1. The specific weight of dry air at any temperature may be calculated from the formula—

$$w = 0.1874 \frac{P}{T}$$

where w = specific weight at the pressure P and the temperature T, lb. per cu. ft.

P = absolute pressure at which the specific weight is to be found, lb. per sq. ft.

T = absolute temperature (deg. fahr.) at which the specific weight is to be found.

Slide-Rule Formula

For those preferring to use a slide rule for calculation, the following formula, based upon the principles of hydraulic flow, but modified empirically, will yield values very close to the longer formula already given, provided the nozzle water column is not over 18 or 20 in. Below this limit the agreement is quite close at most points, but varying about one half of one per cent, being that much high around 8 or 10 in. and that much low around 20 in. water column. The formula, however, is so easy to use that it is preferable to the longer one, and at low water columns—around 4 in.—it is certainly more accurate, as the ratios in the longer formula then become too small for accurate calculation. The formula is—

$$Q = 3.64\, Cd^2 \sqrt{\frac{HT}{P_m}}$$

where Q = cubic feet flowing per minute at absolute pressure of *downstream* side of nozzle and temperature shown by thermometer on *upstream* side of nozzle

C = coefficient of flow = 0.97 to 0.99 as before

d = diameter of nozzle throat (smallest section), in.

H = observed nozzle water column, in.

T = absolute temperature (deg. fahr.) shown by thermometer on upstream side of nozzle

P_m = absolute mean pressure: that is, the average between the pressures on upstream and downstream sides of nozzle, lb. per sq. in.

As Q will be expressed at pressure of downstream side of nozzle and temperature shown by nozzle thermometer on upstream side, it must be recalculated into volume at the vacuum shown by mercury column at E and temperature shown by thermometer at G, Fig. 1, as before. This is, of course, done by changing the volume inversely as the absolute pressures and directly as absolute temperatures. It should be noted that this formula expresses Q at downstream nozzle pressure, which is below atmospheric pressure by the amount of the nozzle water column observed.

Plotting Test Results

So much for methods of test and calculation. The next important step is the plotting of the results, and here we meet a fact which is very convenient for the experimenter. This fact is, that if the quantities of air at various vacua handled by a pump at constant speed are calculated into volumes at *atmospheric* pressure and the temperature of the intake to the pump cylinder (thermometer G, Fig. 1), and if these are expressed as percentages of the elapsed piston displacement of the pump cylinder, we obtain what may be termed "atmospheric volumetric efficiency" and this will be very nearly a straight line when plotted against vacuum. In Fig. 3 is such a curve, as shown by the diagonal line marked Atmospheric Volumetric Efficiency. This was taken from a small pump designed for moderate vacuum. In this diagram abscissæ represent vacua in per cent of the observed barometer and ordinates represent percentage volumetric efficiency.

Having arrived at this very simple form of volumetric-efficiency curve, the ease with which points along the entire line may be read will be noted. This should be compared with the difficulty of reading the true volumetric-efficiency curve, expressed at conditions of pump-cylinder intake, especially at the higher-vacuum points. In this part of the curve the line becomes so steep that close reading is very difficult, and correct plotting is almost impossible. The slightest deviation to the right or left in drawing the high-vacuum part of the curve may make a difference of several per cent.

It should be noted that the volumetric efficiencies shown by both lines in the diagram, Fig. 3, are expressed at the temperature of pump-cylinder intake; that is, by thermometer at G, Fig. 1. This is correct because this is the temperature at which the pump receives the air. The only difference between the two curves is the pressure at which the air volumes are expressed. The temperatures being the same, the volumes are inversely as the absolute

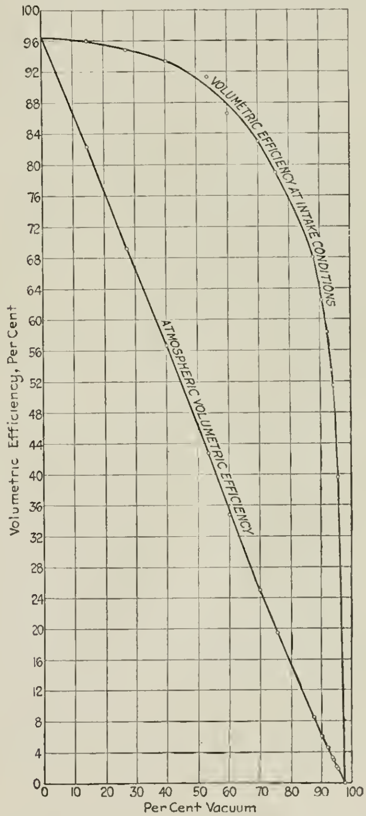

Fig. 3 Method of Plotting Volumetric Results

pressures, and as one of the pressures is atmospheric and the other the absolute pressure of the vacuum, the pressure ratio is simply the ratio of compression of the pump cylinder, provided the discharge is atmospheric. Therefore, with atmospheric discharge and having calculated and plotted the atmospheric volumetric efficiency, as shown by the diagonal, almost a straight line, the curved line of true intake volumetric efficiency may be obtained by multiplying the values on the diagonal line by the ratio of compression. Of course, if the pump discharge is not atmospheric, the values of the diagonal line should be multiplied by the ratio of the atmospheric pressure (barometer) to the absolute pressure of the vacuum at pump-cylinder intake.

Even after the true volumetric efficiency curve is plotted, it is usually easier and more accurate to obtain the true values by picking them from the diagonal line and multiplying these values by the pressure ratios. The steepness of the curve of true volumetric efficiency is too great to read accurately.

Evidence of Accuracy of Nozzle Tests

Right here is an excellent opportunity to say a few words to convince the skeptical of the accuracy of the low-pressure nozzle as an instrument for the measurement of air, as exemplified by these vacuum tests. In such a test we have at the lower right end of the diagonal line, the point showing maximum vacuum with closed intake, that is, with no air handled and no nozzle at all. Following up the diagonal line, the next four points were obtained with a $^5/_8$-in. diameter nozzle with water columns progressing from just under 4 in. to about 13 in. The next three points above these were with a 1-in. nozzle with water columns from approximately $3^3/_4$ in. to about $12^1/_2$ in. After these points follow nozzles of diameters 1.75 in., 2.00 in. and 3 in. with water columns up to just under 15 in., each nozzle being able to handle several different quantities. In such a vacuum test, then, we always have a series of nozzles, beginning in this case with $^5/_8$ in. diameter and ending with 3 in. diameter, with water columns of several heights for each one, and in a very large number of tests which the writer has made, never has there appeared to be any visible break in the curve except what was well within probable experimental errors, showing where one nozzle size left off and the next size began. Considering that each smaller nozzle leaves off with a relatively high water column and the next larger diameter begins with a low water column and furthermore that the smallest nozzle links up with the point of no nozzle and no air, this is also a very good argument that the formula used for calculating the quantity of air expresses the law of nozzle action very well, indeed.

Another point should be noted, and that is that in such vacuum-pump tests the upper left end of the diagonal line which, by the way, is also the upper left end of the true volumetric-efficiency line (the pressure ratio being unity), shows volumetric efficiency around 95 and 96 per cent. As at this point the machine is taking in air with atmospheric intake and also putting it out at atmospheric pressure, under these conditions the pump cylinder really acts as a rough kind of displacement meter checking the nozzle. Of course, with the extra large amount of air being handled under these abnormal conditions, a slight compression takes place inside the cylinder producing a little heating and other small losses which prevent the volumetric efficiency from actually reaching 100 per cent of the cylinder volume. If the nozzle were to show over 100 per cent volumetric efficiency we would know it was inaccurate. So far the writer has never seen a case of this sort, which cannot be said of some other methods of test he has observed and results he has seen reported in all seriousness. Being just under 100 per cent, and sufficiently under to be justified by working conditions, appears to the writer to be a very good argument for those who are skeptical. Other more scientific determinations, notably those of Dr. Moss, prove the result beyond dispute; but these vacuum-pump test curves have always served to quiet the objections of those who lack scientific knowledge, but who require conviction by an obvious, though perhaps approximate, method.

Effect of Valve and Piston Leakage

The effect of valve leakage has been mentioned as a cause for the departure of the atmospheric volumetric-efficiency curve from the straight line. It has been observed that with leaky valves the diagonal line will sag, especially at the high-vacuum or right-hand lower end. With appreciable valve leakage the line coming up and to the left from the closed-intake, maximum-vacuum point, will have a very decided bend in the first two inches of vacuum decrease. This bend in the line will be curved downward, which of course puts the curve lower for a given vacuum. When the points on this sagging diagonal line are multiplied by the ratio of pressures, as described, to obtain the true intake volumetric efficiency, this latter curve will simply lean further to the left. This means that the true volumetric-efficiency curve will not rise as rapidly as the curve corresponding to a diagonal atmospheric volumetric-efficiency line without sag. This again simply means that the true volumetric efficiency at a given vacuum will be lower, which naturally follows for a pump having valve and piston leakage.

With the above-described effect of leakage, it is clear that the true curves of a given pump cannot be drawn without actual nozzle-test measurements at several vacuum points near the maximum, as already described and illustrated in Fig. 3. For this reason any estimates based upon an assumed characteristic curve cannot be considered accurate, and if it is desired to be on the "safe side" without actual capacity tests, it is well to put an appreciable sag in the diagonal line used as a basis of estimation. This refers particularly to the upper two inches of vacuum.

The approved shapes of air-measuring nozzles will be described in the forthcoming air-compressor test codes now in preparation by the Power Test Codes Committee and the latitude to be allowed will be quite broad, just as long as the approach curve is well rounded. Special curves of compound radii have not been found to possess any particular virtue. All this is good news to the experimenter along these lines.

Nozzle Shapes

Something must now be said about the shape of the nozzles used. Coefficients already mentioned were for nozzles having well-rounded approach surfaces. With nozzles of this kind the coefficient has been found to be much more stable than when an attempt is made to use a so-called "sharp-edged" nozzle. It is a practical impossibility to make a nozzle with a perfectly sharp edge and it has been found that with the slightest degree of bevel or rounding or other deviation from the perfect edge, the coefficient may vary widely. With the nozzle having a rounded approach it has been found that the coefficient will not change with change of approach radius within wide limits.

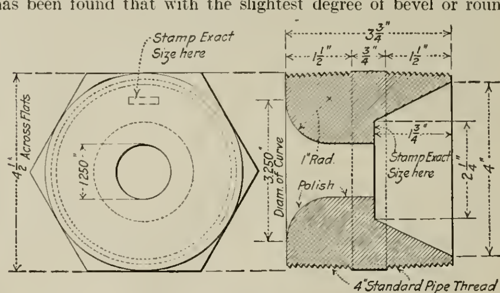

Fig. 4 Convenient Form of Air-Measuring Nozzle

Fig. 4 shows a very convenient form of nozzle. It is made with a pipe thread on both ends so that it can be used at will on the intake side of a vacuum pump, or on the discharge side of a compressor. The approach surfaces may have a radius of anything from 0.6 of the throat diameter, upward, with inappreciable effect upon the coefficient. The throat is followed by a straight or cylindrical portion. It is recommended that this be not less than $^1/_4$ the throat diameter, and it may probably be as long as the diameter without affecting the coefficient. Anything longer might bring in an additional friction influence to reduce the coefficient very slightly. A short straight portion has been found really essential to secure smooth flow.

Nozzle on Discharge Side

In some cases it may be desirable to put the nozzle on the discharge side of the vacuum pump. There are two objections to this, although they are not very serious. First, to eliminate the pulsations of the discharge two tanks will have to be put in series, with the nozzle in the second tank discharging to atmosphere. This aggravates the second objection, namely, the compression ratio, which would necessarily be increased, and therefore reduces the volumetric efficiency of the pump. This back pressure will also be different for different vacua and nozzle sizes. Any throttling between the two tanks to remove pulsation makes this much worse, and if the pulsations are not removed the readings of the nozzle will be incorrect. No throttling or otherwise damping of the pulsations of the nozzle water column will help, as the error comes in the pulsations of the actual air passing the nozzle. Throttling on the intake side is just what is required to get the vacuum, so that, all things considered, the nozzle on the suction side is undoubtedly to be preferred.

The Interpretation of Boiler-Water Analyses

By J. R. McDermet,[1] Jeannette, Pa.

With the increasing use of economizers, higher steam pressures and higher rates of evaporation, it has become as necessary to consider the corrosive effects of a boiler water as its scale-forming properties, if not more so. Because of this the author has prepared the present paper, which discusses briefly the limitations and applications of a technical or mineral analysis; advocates the use of a partial sanitary analysis as forecasting possible trouble due to pollution; and indicates the significance of the analysis for dissolved gases in relation to the conditions under which the water is used. A laboratory-procedure sheet is appended to illustrate and make useful the facts discussed.

The chemist in performing a technical water analysis proceeds along conventional methods and by processes of evaporation, selective solution, precipitation, etc., determines quantities which he may submit for consideration directly, calculate into terms of elemental ions and ion radicals, or hypothesize into various chemical compounds which are assumed originally to have existed in the water. Irrespective of how results are submitted it is possible to calculate back into ion values, to which may be applied certain generalizations—with the reservations, however, that the values are arrived at initially by inflexible methods and are connected with the properties of the water only through deductive relationships.

The dissolved chemical compounds of a water which will ultimately become scale on the boiler surface are relatively slightly soluble in a physical sense. Chemically they are characterized as feebly hydrolyzed salts, and as such they are capable of very little dissociation in water—and then only into a very limited number of ions or electrified particles: namely, those of the salt itself and those of the dissociation with water.

Corrosive salts, on the other hand, are characterized as being both hydrolyzed and highly ionized, one of ions at least being that of a strong acid or base. If the chemist's ionization constants are applied to a group of these salts representative of a natural water, a bewildering series of relationships develops, due to the number of ions and their mutual effect in displacing the equilibria of each other. Such a procedure, however, is irrational for three reasons: (*a*) Ionization constants are experimental factors determined for normal temperatures only and are not necessarily valid at boiler temperatures. (*b*) The water molecule is of the form $(H_2O)_x$, and water in its transition from liquid to superheated steam undergoes a change of molecular grouping from the dihydrol into the monohydrol form. This transition is not abrupt at the change of state but gradual with rise of temperature. The monohydrol form which exists in small proportions at normal temperatures apparently occasions both the hydrolytic and dissociation phenomena. (*c*) Concentration of impurities in a boiler operating at high rating and high circulation velocity varies widely at different points in the circuit, the concentration increasing at regions where the water is abruptly accelerated. The rule of experience alone is applicable to those classes of impurities.

The laboratory-procedure outline appearing later in the paper employs the following basis of distinction: The values obtained in the analyses are computed into those compounds which form scale as far as the analytical values suffice. In this grouping abnormal silica is the only constituent which is capable of causing corrosion and its action is mechanical in permitting local overheating. To the remainder of the impurities limiting values are assigned, either on a percentage or an integral basis, the integral values being reserved for those constituents which are virulent. Sodium is ordinarily a fictitious quantity employed to balance combinations, but if the water analysis indicates a possibility of danger according to the criteria employed, a real value of sodium is determined and compensation is allowed for its presence. Sodium is so strongly basic in its chemical properties that its behavior in solution can be predicted with some exactness, and the hydrolyzed products of sodium salts are themselves inhibitors of corrosion.

It is only the relatively pure waters which produce dangerous conditions, and as the sum of dissolved solids decreases the liability toward corrosion disproportionately increases. Beyond an impurity content of 300 parts per million, corrosive waters are almost invariably of abnormal chemical analysis so that the danger is immediately apparent. Below 50 to 60 parts per million, the technical analysis, even if it shows no unfavorable features, is usually insufficient unless the history of the origin of the water is definitely known. For such waters a sanitary analysis is a distinct contribution.

The Sanitary Analysis

The sanitary analysis is more truly a series of tests in which the reaction of the water is observed as indicative of the pollution which it has undergone, than a determination of foreign constituents. Technique has been so highly developed by the sanitary chemist that it is possible for him to tell from the values obtained in analyses the extent of the pollution and its sources—whether they be industrial, organic vegetable, or wastes from animal or human sources.

Industrial pollution usually manifests itself in the form of some characteristic compound which is a by-product of processes of manufacture. Aside from mine and paper-mill wastes, which usually reveal themselves unmistakably in the technical analysis, this class of pollution may occur in extreme dilution and yet be harmful in pure waters.

Under the heading of organic vegetable contamination may be grouped the products of algal growths, water plants in stagnant bodies of water, and the run-off from uncultivated land, particularly marshes, and deforested or forest fire areas. Chemically such contamination manifests itself either as acidity due to weak organic acids, or as nitrogen compounds. In the power plant the physical damage resulting from organic acids appears principally in the corrosion of saturated-steam lines, turbines, and vapor spaces of condensers; in other words, in apparatus where moisture accumulates from partial condensation. Unlike dissolved-gas contamination, the feed lines and boilers where the dilution of the acids is very great are reasonably exempt, and the corrosion does not exhibit its greatest vigor in a narrow zone of temperature. Undoubtedly the presence of dissolved oxygen accelerates the corrosion, but the organic acids polymerize or change their form rapidly and the action is not indefinitely cyclic as in the case of some mineral acids.

Nitrogen compounds—and in particular ammonia—originating in organic vegetable pollution confine their attacks principally to copper and brass fittings and the iron is exempt in the path of steam flow. In dead-end spaces serious corrosion may occur on both ferrous and non-ferrous metals, but aside from this the damage is usually inconsequential. Dissolved carbon dioxide in appreciable concentration due to bicarbonate alkalinity accelerates corrosion.

Sewage contamination may be classified as recent or remote, and further divided into household refuse and animal or human excrementitious matter. The latter, unless it exists in a quantity that contributes a dangerous chlorine content, sludges in the boiler and may be dismissed without further comment. Oleaginous matter and greases from household wastes if of recent origin contribute to foaming, priming and corrosion much as do organic acids if in considerable concentration. Sewage of remote origin which has been oxidized by aeration and bacteria action shows high nitrate content and sometimes nitrites, depending upon the extent of the natural purification. While the criteria in such cases are the nitrate content and the qualitative presence of nitrites, the introduction of both of these into a boiler water in any concentration is earnestly to be avoided.

The Dissolved-Gas Analysis

The analysis for dissolved gases is confined entirely to the determination of dissolved oxygen. The position of dissolved carbon

[1] Research Engineer, Elliott Company, Assoc.Mem.Am.Soc.M.E.

Abstract of a paper to be presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

dioxide is anomalous. The researches of the author have been concerned with the simultaneous removal of carbon dioxide and oxygen, and are inconclusive; the published results of Speller[1] incline to the view that carbon dioxide in the absence of oxygen is not prejudicial. Cases where corrosion directly chargeable to carbon dioxide has occurred have usually accompanied a high-bicarbonate alkalinity or been complicated by ammonium compounds. It is probable, however, that increased rates of driving will compel an entire reversion of attitude toward boiler-water alkalinities.

Analytical methods for determining dissolved oxygen are available in standard chemical textbooks, and methods of manipulation adapted to the engineer's needs have been discussed in the technical press.[2] Methods for determining dissolved oxygen fortunately and unlike other analyses on water determine definitely and directly the constituent sought, and it only remains to apply the information intelligently to the elimination of corrosion problems. While deterioration of the ferrous metals results at all stages of the water and steam cycle where water and oxygen are present as such, in all but two cases which have developed in the writer's experience alleviation has been sought only for steel-tube or cast-iron economizers, boilers, or hot-water feed lines. The characteristic manifestation is the wasting of cast iron and pitting of steel surfaces, sometimes accompanied in the latter cast by a pseudo-stalagmite formation.

It is impossible with commercial pipe materials to formulate an opinion as to how long a hot-water boiler-feed pipe system will last. It appears, however, that if the oxygen content is kept below 0.7 cc. per liter (0.7 part in 1000 by volume), the gas volume being reckoned under standard conditions, the life of the feed lines will be of such a length as to prevent ascribing the ultimate failure to oxygen. It may be taken as axiomatic, however, that the reduction of oxygen content to the lowest consistent value is always a desirable precaution.

Boilers that operate below rating rarely suffer any damage, whatever may be the oxygen content of the feedwater. As the rating goes up, however, damage appears, but if the concentration is kept below 1.0 cc. per liter the boiler seldom experiences pitting action. Boiler scale is a fairly efficient protective agent against this form of attack. Unfortunately, scales of predominant silicate or pure sulphate composition introduce a different corrosion loss, in that there is an amalgamation at the boundary between the iron surface and the scale through the intermediation of iron oxide. The use of mechanical tube cleaners in removing this scale results in a severe detrition loss from the iron surfaces which may very markedly shorten the life of the boiler. The removal of oxygen from the boiler feed to the extent that existing apparatus is able to accomplish it, does away with this amalgamating action, and these classes of impurities in the absence of heavy carbonate formations become self-scaling.

Boilers rarely present simple corrosion phenomena. Usually trouble arises from a complexity of causes. Corrosive dissolved solids which yield free acid radicals and dissociated acid radicals and dissolved oxygen are mutually accelerants of pitting action. With such boiler waters the removal of dissolved oxygen is a worth-while alleviation and a guarantee against regenerative action with a stable acid ion, but it is not a cure. Chemical treatment of the water is the most logical corrective if it is properly controlled and is not based on excessive alkalinities; but in practice the results obtained are usually far short of the ideal and need to be supplemented. The pitting of the surfaces presents the same general appearance. Where it is directly chargeable to dissolved gases the action is more or less selective, in that the area of greatest virulence is confined to parts where the circulation is sluggish, and entirely to the water space. In boilers subjected to severe acid corrosion, however, the pitting may extend into the steam space.

The corrosion of a cast-iron economizer likewise presents two aspects. The corrosion of cast iron in its initial stages is more rapid than that of steel, but the adhering residue products from the corrosion—graphitic carbon and silica—immediately form a protective coating which arrests further action. Cast-iron economizer corrosion is due to the continuous removal of the protective coating, has most nearly the appearance of erosion, and takes place in the headers and tube ends where water velocities are changed. This erosive-corrosive action will disappear if the oxygen content of the feedwater is kept below 0.7 cc. per liter, provided that the water does not deposit scale on the economizer surfaces. Economizers in the past have been principally waste-heat adjuncts operating between the extreme temperature limits of 90–250 deg. fahr., and if these limits are extended in future practice it will doubtless be necessary to lower further the oxygen value. Where the temperature and character of water combine to produce scaling on the cast-iron tubes which necessitates the periodical use of mechanical tube cleaners, the safe oxygen limit is automatically reduced to 0.3 cc. per liter. The tube cleaner not only removes the existing protective coating which has formed, but disturbs the surface layer so that a new one is slow in forming.

Jacobus and Speller independently and by different methods have established the value 0.2 cc. as the maximum oxygen content which will prevent accelerated corrosion in a steel-tube economizer. The allowable content which will permit the realization of a profitable operating life from the economizer may conceivably be lower than 0.2 cc. per liter, but this can be determined only after years of experience.

The most virulent steel-feed-pipe corrosion occurs between the temperature limits 180–200 deg. fahr; and no such range is exhibited by the steel-tube economizer. Water in its passage through and temperature elevation in the economizer gradually rejects a portion of its dissolved gases in the form of bubbles which cling to the tube wall and by coalescence establish for themselves a slower rate of travel than the water, whose velocity is materially below the region of turbulent flow. Besides materially reducing conductivity, these bubbles through their oxygen content both occasion the corrosion and distribute it over the entire surface.

The characteristic corrosion phenomena in the case of steel-tube economizers are pit holes. The primary cause for these may be exceedingly small pieces of imbedded mill scale or segregated impurities in the metal which form electric cells and occasion roughness, or an initial roughness on the surface to which the bubbles of gas adhere and produce minute air pockets. The appearance of a pit hole is accompanied by a stalagmite or barnacle-like growth of corrosion products completely covering the pit hole and projecting above the surface. These barnacle-like protuberances consist of three successive layers of iron hydroxides in the order of their proximity to the iron surface, $Fe(OH)_2$, $Fe_3(OH)_8$, and $Fe(OH)_3$, which in their dehydrated forms correspond respectively to the ferrous, black, and red oxides of iron. The hydroxide $Fe_3(OH)_8$ only is adherent, and constitutes the binder and the bulk of the volume. The growth of these projecting surfaces further arrests the bubbles and the electrolytic potentials accelerate the action, but all causes combine to keep it very localized. The result is a punctured surface.

LABORATORY PROCEDURE IN WATER ANALYSIS

1 If the water originates with the Condenser Division as a water for circulation, perform (7), calculate according to (8), and report on this basis.

2 If the sample originates with the Air Separation or Research Divisions, perform the analysis according to the detailed procedure which follows. A memorandum from the chief of the division concerned will be issued covering as far as data permit the following facts:

- *a* Purpose of the analysis
- *b* History and origin of the sample
- *c* Any physical observations which would direct a preponderance of suspicion toward peculiarities to be expected in the analysis.

3 Record all numerical results in parts per million (p.p.m.)

4 Record from observation in clean glassware qualitatively—

- *a* Turbidity
- *b* Presence of visible suspended matter
- *c* Color
- *d* Odor hot
- *e* Odor cold.

(*Continued on page 342*)

[1] A Method for Practical Elimination of Corrosion in Hot Water Supply Pipe, F. N. Speller, *Jour. Am. Soc. of Heating and Ventilating Engrs.*, vol. 23, no. 9, January 1917.

[2] Simple Methods for Determining Dissolved Gas Content of Boiler Feed Water, J. R. McDermet and D. Wertheimer, *Power*, Nov. 2, 1920, p. 686.

Boiler Tests with Pulverized Illinois Coal

By HENRY KREISINGER, MILWAUKEE, WIS.,[1] and JOHN BLIZARD, PITTSBURGH, PA.[2]

In this paper the author presents a summary of the results obtained in an extended series of tests of a 468-hp. water-tube boiler fired with pulverized Illinois coal.

The results show that, contrary to the customary specification, it is not necessary to pulverize the coal to the extreme fineness of 85 per cent through a 200-mesh screen in order to get good combustion and good efficiency. This ability to burn coarser coal means increased capacity of the pulverizing mills and decreased cost of coal preparation.

The results also show that it is not necessary to dry coal to about 1 per cent moisture in order to burn it successfully in pulverized form, and it is stated that with most eastern coals drying is not at all necessary.

Good results can be obtained when the coal is burned at rates varying from 0.5 lb. to 2 lb. per cu. ft. of combustion space per hour, and the best results at a rate of 1 to 1.5 lb.

THIS paper gives the summary of the results of a series of 11 tests made on a 468-hp. Edgemoor boiler equipped with a Foster superheater and fired with pulverized coal at the Oneida Street Station of The Milwaukee Electric Railway and Light Company, Milwaukee, Wis. The tests were made by the Fuel Section of the U. S. Bureau of Mines in coöperation with the Research Department of the Combustion Engineering Corporation. The powdered-coal equipment was designed and installed by the Locomotive Pulverized Fuel Company. The coal burned in these tests came from the Illinois coal field. The object of the tests was to determine what overall efficiency can be obtained with pulverized Illinois coal under various conditions of furnace operation and different preparation of coal as to degree of fineness and percentage of moisture.

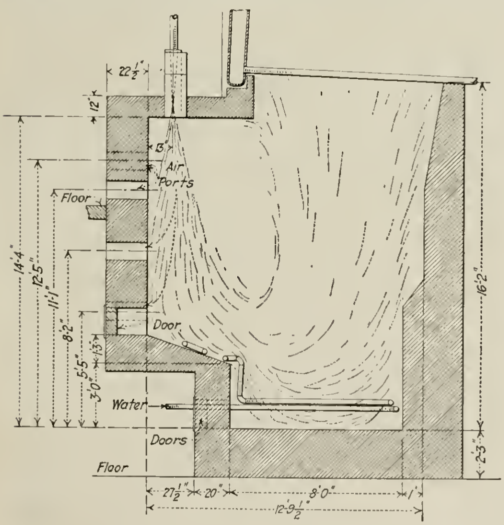

Fig. 1 Section through Furnace, Showing Arrangement of Burner and Cooling Coil over Hearth and Near Bottom of Furnace

The tests were made in a thorough manner, everything being done to make the results accurate and reliable. The pulverized coal was weighed in specially designed tanks placed on platform scales as it was supplied to the furnace. The tests were from 17 to 25 hours in duration.

Tests Nos. 28 to 30, inclusive, were made with the usual preparation of coal as it is burned in the plant under ordinary operating conditions. Test No. 31 was made with the same condition of coal as the three previous tests, but with the furnace provided with a cooling coil over the hearth and along the walls near the bottom of the furnace to facilitate the removal of ash. Tests Nos. 32 to 35, inclusive, were made with the same furnace arrangement as test No. 31, but with the coal pulverized to a lesser degree of fineness. Tests Nos. 36 to 38, inclusive, were made with the same furnace arrangement as in the previous four tests, but with undried coal.

Fig. 1 shows the arrangement of the burner and the cooling coil over the hearth and near the bottom of the furnace. The cooling coil consisted of three lengths of 2-in. pipe over the hearth and two lengths along the side walls and the rear wall. The total surface of the coil was 48 sq. ft.

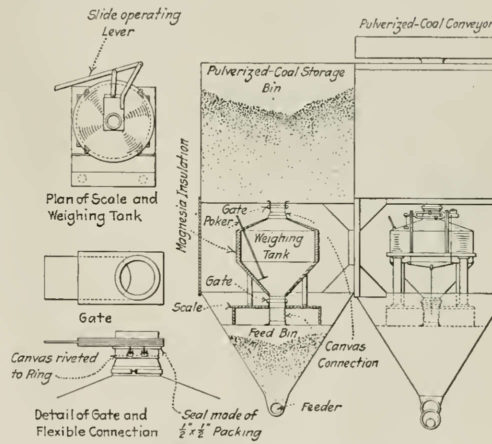

Fig. 2 Coal-Weighing Apparatus Used in Tests

Fig. 2 shows the coal-weighing apparatus, which was placed between the storage bin and the feed bin. There were two burners and two feeders, and the coal to each feeder was weighed separately. The weighing tanks were connected to the storage bins and the feeder bin by flexible canvas connections to permit weighing and to prevent the coal dust from escaping into the room when the weighing tanks were filled and emptied. The tests were started and closed with the feeder bins empty.

The feedwater was weighed in two water tanks placed on platform scales. The water supplied to the cooling coil was measured by a 2-in. water meter which was calibrated at the rate of feeding the water through the cooling coil, and its measurements were found reliable to within less than one-half of one per cent.

Flue-gas samples were taken at six points in the uptake and collected over one-hour periods. Flue-gas temperatures were measured with thermocouples at the same six points where samples were drawn for analysis, and readings were taken every 15 min. The flue-gas temperature given in Table 1 is the average of the measurements with the six couples.

Results of the Tests

The results of the tests are given in Table 1. The quantities of heat absorbed by the boiler, superheater and cooling coil, when the latter was used, are itemized separately. In the heat balance the losses by radiation are given by a separate item. In a series of tests on the same boiler and setting the radiation loss per square foot of exposed surface should be nearly constant and should vary only slightly by the capacity developed by the boiler. For the calculation of the radiation loss it was estimated that 250

[1] Research Engineer, Combustion Engineering Corporation.
[2] Fuel Engineer, U. S. Bureau of Mines.
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TABLE 1 SUMMARY OF RESULTS OF 11 STEAMING TESTS ON AN EDGEMOOR BOILER BURNING POWDERED COAL, AT ONEIDA STREET POWER STATION, MILWAUKEE, WIS.

Heating Surface:			
Boiler	4680	Draft—Natural	Rating of boiler: 468 hp.
Superheater	594	Burner—Lopulco vertical	Volume of furnace: 1660 cu. ft.
Furnace coil	48	Coal feed—Screw and air blast.	Greatest height of furnace: 16.7 ft.
Total	5322 sq. ft.		Greatest width of furnace: 9.3 ft.
			Greatest length of furnace: 13.3 ft.

1 Test Number	28	29	30	31	32	33	34	35	36	37	38
2 Duration, hours	22.90	23.72	18.17	23.62	23.60	22.47	25.22	23.53	23.43	23.33	16.73
Coal as Fired											
3 Per cent through 100 mesh	96.10	95.80	.....	95.40	93.20	93.10	90.80	88.60	.....	94.40	95.40
4 Moisture content, per cent	1.42	2.92	2.75	2.55	3.79	3.07	3.60	3.47	7.69	8.23	8.23
5 Volatile matter, per cent	36.62	36.66	37.45	36.58	36.57	36.29	37.17	36.27	35.82	34.42	34.70
6 Fixed carbon, per cent	48.16	46.63	46.08	48.07	48.43	49 01	46.39	48.87	45.74	46.39	44.67
7 Ash, per cent	13.80	13.79	13.72	12.80	11 21	11.63	12.84	11.39	10.75	10.96	12.40
8 Sulphur, per cent	2.66	3.64	3.49	2.92	2 40	2 66	3.43	2.99	2.10	2.21	2.90
9 Calorific value, B.t.u.	11956	11860	11875	12085	12172	12178	11889	12188	11565	11508	11245
10 Total fuel fired, lb.	40214	39862	52746	46613	43947	45469	47459	41250	43729	41640	36315
11 Coal fired per hour, lb.	1756	1681	2903	1973	1862	2024	1882	1753	1866	1785	2171
12 Coal fired per hour per cu. ft. of combustion space	1.10	1.05	1.81	1.23	1.16	1.26	1.18	1.09	1.16	1.12	1.36
Ash and Refuse											
13 Carbonaceous content in furnace slag, per cent	0	0	0	0	0	0	0	0	0	0	0
14 Carbonaceous content in 2d and 3d pass refuse, per cent	4.15	3.49	5.00	5.25	9.52	7.19	7.52	7.37	4.97	4.32	4.49
15 Carbonaceous content in uptake dust, per cent	4.95	5.24	7.35	5.13	7.70	6.45	7.81	5.57	3.91	3.50	3.28
16 Calculated total carbon in refuse, per cent of coal fired	0.50	0 54	0.62	0.36	0.87	0 61	0.67	0.30	0.24	0.22	0.26
17 Softening temperature of coal ash, deg. fahr.	.....	2050	2210	2120	2120	2110	2060	.....	.....	.....	.....
Ash Account (per cent of ash fired)											
18 From bottom of furnace	29.20	25.50	41.50	48.10	10.10	24.10	37.80	59.40	48.10	47.10	41.60
19 From 2d and 3d pass	12.10	11.60	5.80	10.40	10.30	7.00	9.10	10.50	8.30	7.70	8.70
20 From dust collector	31.50	25.00	33.20	29.20	27.50	29.00	25.50	30.10	32.80	26.00	26.30
21 Unaccounted for	28.20	37.90	19.50	12.30	52.10	39.90	27.60	0.00	10.80	19.20	23.40
Air											
22 Temperature, air at furnace, deg. fahr.	83	90	80	76	85	71	64	74	79	72	75
23 Pressure air at feeder, inches of water	5.00	5.30	7.50	5.10	5.60	5.50	6.40	5.90	5.70	5.50	6.20
24 Excess air in flue gas, per cent	30	22	18	18	19	15	20	25	19	16	20
Flue Gas											
25 Carbon dioxide, per cent by volume	14.10	14.90	15.40	15.50	15.30	15.80	15.10	14.60	15.50	15.80	15.40
26 Oxygen, per cent by volume	4.80	3.80	2.90	3.30	3.20	2.40	3.60	4.10	3.20	2.90	3.60
27 Carbon monoxide, per cent by volume	0	0	0.26	0	0	0.10	0.10	0	0	0	0
28 Pounds of dry flue gas per pound of coal	12.40	11.20	10.60	11.00	11.30	10 80	11.00	11.70	10.70	10.40	10.60
29 Temperature of gases in uptake, deg. fahr.	517	492	610	483	457	472	470	486	484	466	514
Draft											
30 At uptake, inches of water	0.12	0.10	0.27	0.09	0.06	0.08	0.05	0.09	0.10	0.05	0.15
31 Top of furnace, inches of water	0.00	0.02	0.00	0.00	0.01	0 00	0.01	0.02	0.02	0.03	0.03
Steam and Water											
32 Steam pressure, lb. absolute	184	186	196	189	188	187	185	186	183	182	185
33 Degrees superheat	60	59	80	58	53	61	67	79	74	70	102
34 Temperature of feedwater, deg. fahr.	108	99	99	101	101	100	100	103	98	100	99
35 Temperature of water to coil deg. fahr.		No coil		54	53	52	50	48	46	46	46
36 Temperature of water from coil, deg. fahr.		No coil		129	146	145	118	151	139	130	144
Rates of Heat Absorption											
37 Per cent of builder's rating (boiler only)	106.6	103.9	167.4	111.7	102.7	112.4	103.4	104.8	101.9	94.4	113.5
38 Horsepower developed (boiler only)	498.8	486.5	779.0	523.2	480.8	526.0	484.0	490.5	477.0	442.0	531.5
39 Horsepower developed (superheater only)	15.8	15.3	32.9	16.3	13.7	15.0	15.4	20.5	18.4	16.3	27.9
40 Horsepower developed (furnace coil)		No coil		49.7	55.0	59.7	45.9	17.5[1]	32.0	29.1	26.8
41 Total horsepower developed	514	502	812	589	549	601	545	528	527	487	586
B.t.u. Absorbed per Sq. Ft. of H. S. per Hour											
42 By water in boiler	3567	3482	5575	3743	3437	3758	3466	3508	3413	3207	3798
43 By steam in superheater	892	861	1856	920	772	845	869	1155	1039	934	1573
44 By water in furnace coil		No coil		33900	37600	40770	31270	33190	21920	20160	18440
Heat Absorbed per Pound of Coal as Fired, B.t.u.											
45 By water in boiler	9500	9690	8990	8870	8630	8710	8625	9360	8560	8405	8190
46 By steam in superheater	301	304	380	277	246	249	274	391	330	311	430
47 By water in coil		No coil		843	995	988	815	335	575	554	414
48 Total absorbed	9801	9994	9370	9990	9871	9947	9714	10086	9465	9270	9034
Heat Balance (Per cent of heat in coal fired)											
Heat absorbed											
49 By water in boiler	79.4	81.6	75.6	73.4	70.8	71.5	72.4	76.8	74.0	73.0	72.7
50 By steam in superheater	2.5	2.5	3.2	2.3	2.0	2.0	2.3	3.2	2.8	2.7	3.8
51 By water in coil		No coil		7.0	8.2	8.1	6.9	2.7	5.0	4.8	3.7
52 Total and thermal efficiency	81.9	84.1	78.8	82.7	81.0	81.6	81.6	82.7	81.8	80.5	80.2
Heat Carried Away											
53 By dry gases	10.8	9.1	11.4	8.9	8.2	8.6	9.0	9.5	9.0	8.5	9.9
54 By steam from burning hydrogen	4.1	4.3	4 2	4.1	4.1	4.2	4.2	4.0	4.2	4.1	4.2
55 By steam from moisture in coal	0.1	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.8	0.9	0.9
56 By steam entering with air	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
57 By carbon monoxide	0.0	0.0	1.0	0.1	0.1	0.2	0.4	0.0	0.0	0.0	0.0
58 By carbon in ash and flue dust	0.6	0.6	0.7	0.4	1.0	0.7	0.8	0.4	0.3	0.3	0.3
59 By radiation	2.5	2.6	1.9	2.2	2.3	2.1	2.3	2.4	2.4	2.5	2.2
60 Heat unaccounted for	—0.3	—1.3	1.6	1.3	2.9	2.2	1.3	0.6	1.4	3.1	2.2
61 Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Cooling coil in operation during first $8^1/_2$ hours of test only.

B.t.u. were lost per sq. ft. of the exposed surface per hour when the boiler was operated at 100 per cent of rating, and 350 B.t.u. when operated at 200 per cent of rating. The radiation loss was calculated according to the percentage of rating developed. These calculations of the radiation loss leave the true "unaccounted for," which consists of errors. In a series of well-conducted boiler tests this true "unaccounted for" should be close to zero and should vary on both sides of the zero line according to whether the plus or minus errors predominate.

Effect of Fineness on Results of Tests

It has been customary to state that in order to get good results the coal must be pulverized to a fineness of 95 per cent through a 100-mesh screen and 85 per cent through a 200-mesh screen. Table 2 gives the results of complete sizing tests of the coal burned in Tests Nos. 32 to 35, inclusive. The coal was much coarser than specified by the foregoing statement. The results of these tests seem to indicate that it is not necessary to pulverize the coal to the extreme fineness of 85 per cent through a 200-mesh screen in order to get good combustion and good efficiency. The completeness of combustion seems to be more a matter of a proper furnace and burner design and the right way of supplying air than of the fineness of the coal. The losses due to coarseness of coal would be shown by the greater percentage of carbon in the refuse. The average loss due to this cause for the four tests with the coarser coal is 0.7 per cent. The average of this loss for the previous four tests is 0.6 per cent. The averages of the efficiencies are very nearly the same.

TABLE 2 RESULTS OF SIZING TESTS OF COAL BURNED IN TESTS NOS. 32-35

Test No.	—Percentage of Coal Passing Through Screens— 20-mesh	40-mesh	100-mesh	200-mesh
32	99.9	99.2	93.2	67.0
33	99.9	99.2	93.1	70.1
34	100.0	98.9	90.8	65.5
35	99.8	98.0	88.6	64.0

The ability to burn coarser coal means increased capacity of the pulverizing mills, and decreased cost of coal preparation.

Effect of Moisture in Coal on Results of Tests

Another statement that has been generally accepted is that coal must be dried to about 1 per cent moisture in order to be success-

(Continued on page 326)

On the Organization of an Engineering Society

By Morris Llewellyn Cooke,[1] Philadelphia, Pa.

The place which the engineer has come to occupy in our social economy suggests a reconsideration of a type of association and organization adopted at a time when the conception of the field of engineering was much more restricted than it is today. A gradual amplification of the definition of engineering and some regrouping of the divisions of engineering practice may be expected. While looking forward to a large and more or less immediate increase in the ranks of organized engineers, we need more than anything else an increase in the activity of the individual member. The structure of our present organization makes almost no provision for deciding in democratic fashion what is to be done and who is to do it. Bold and far-sighted administrative leadership in the execution of plans is difficult under the type of board or committee control which obtains in most societies of engineers.

To take advantage of present opportunities for public service, professional solidarity is the first requisite. But to wield wisely our rapidly accelerating power we need such democratic control of policies and such constant publicity as will permit larger individual initiative and even aggressive leadership in the execution of plans.

Before one can discuss intelligently the characteristics of the organization best adapted to an engineering society, the attempt must be made to reach some conclusion as to the essential nature of an engineering body and as to the scope of its functioning in the whole scheme of human society. Here again as in industry—and in life itself—before we can plan effectively we must know something as to the desired product, both as to its quantity and kind. We must know what is to be the relationship between organized engineering and other agencies through which the human spirit functions.

H. G. Wells tells us that even before "the coming of speech" there was the "fear of the old man of the tribe."[2] Here apparently is to be found the very beginning of our concepts of government, of sovereignty and of society. That we did not progress very rapidly in this matter of community organization is shown by the fact that some millions of years later we find Louis XIV proclaiming himself—and himself alone—to be the State. *"L'etat, c'est moi."*

A good many people still look upon the Government—and the State—as something entirely apart from themselves, as residing largely in a single individual or at least within a very small coterie of those holding high office. Indeed, today's popular concept of sovereignty has not in many respects progressed much beyond that entertained by cave men.

But this doctrine is rapidly becoming too simple to command the confidence and loyalties of a race kept spellbound by the continuous revelations of science as to the interrelations of natural phenomena. Everywhere the nations are seeking an organization for society which shall be much more highly differentiated than that which obtained during the immemorial reign of force. We seek to distribute the function of leadership. In our own land every man is protected by statute in being a bit of a sovereign. The recognition of essential law, the spread of education, the elevation of mind over matter, and the philosophy of Christ make possible "preeminence by consent"[3] rather than by force. It is because of this new type of environment quite as much as on account of the ever-widening development of science and its application in the field of engineering that the engineer is being accorded a rapidly advancing status in modern civilization. Any one who has lived near to the brain and heart of our own Government—as some of our profession did during the war—knows that even in the face of grave danger the substance of unity is frequently missing in such ideas as sovereignty, government and the State. Of course one of the tenets on which our own nation was founded was the complete separation of Church and State. This action grew out of a clear recognition of one master division in sovereignty as it affects the lives of men. More recently we have seen the development of the organization of the labor movement in more than one nation to the point where tacitly or otherwise it exerts in some measure the prerogatives of sovereignty. Again, only the blind can fail to see the business groups in every nation exerting powers of sovereignty, sometimes through governmental channels and at other times entirely independent thereof. I have of course reference only to activities on the part of organized labor and organized capital which may be said, generally speaking, to have or to warrant the approval of organized society. Both groups of course at times seek to trespass, and as a matter of fact do err in trespassing beyond these bounds.

We should constantly have in mind that under present-day concepts the bases of national sovereignty lie ultimately in the wills of men. It is on this foundation that we Americans have reared the house of our national life with its various phases—industrial, social, professional, religious, etc. Threading its way through them all like the framework of a building in process of constant construction and reconstruction we find the Government coördinating—sometimes unifying—the life of the people. But never, let it be remembered, is government an end in itself.

In view of the foregoing, may we not altogether properly look forward to the day when the profession of engineering will be given that "preeminence by consent" which is more than an equivalent for sovereignty? It is altogether in the interest of society that we should prepare ourselves for such an "exercise of supreme authority" as will be consistent with the momentous content of engineering as it will be but a few years hence.

Competent observers outside the profession begin to sense the implications of our rapidly growing control of the bases of our common life. Thorsten Veblen refers to the profession as "the sufficient and indispensable general staff of the mechanical industries on whose unhindered teamwork depends the due working of the industrial system and therefore the material welfare of the civilized peoples."[1] Again, he says the industrial system "appears to be approaching a critical pass beyond which it will no longer be practicable...to entrust its continued adminstration to others than suitably trained technological experts." Equally suggestive of our rise to power are the titles of such recent books as Creative Chemistry[2] and The Conquering Engineer.[3]

The type of organization for an engineering society such as we seek is the one best adapted to make our group an effective cog in the whole scheme of social organization. No one engineering organization can seek its best development and largest future except as one link in the totality of the profession. It follows, then, as has been said on another occasion, that—

> Only through the solidarity—the essential oneness—of all the branches and divisions of the engineering profession will it be possible first to formulate and express an adequate sense of our public responsibilities and then to develop and use our collective initiative in their execution.[4]

We need an emphasis on the common characteristics of all good engineering in order to reveal the unity of the engineering approach. This once established we shall have what some one has called "mass morale"—an absolute essential for our highest professional development.

In the light of this definition of the function in human society of engineering and the engineer, our codes and definitions and standards of one kind and another take on a new importance. The dedication of the recently organized Federated American Engineering Societies exclusively "to the service of the community, state and nation" was indicative of a widespread feeling that the engineer can know but one allegiance when public and private interests are in conflict. Theoretically, this has been our pro-

[1] Consulting Engineer, Mem. Am. Soc. M. E.

[2] An Outline of History, H. G. Wells, p. 125.

[3] Studies in the Problem of Sovereignty, Harold J. Laski (Yale University Press), p. 19.

For presentation at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[1] Bulletin of the Taylor Society, vol. iv, no. 4, August 1919.

[2] Creative Chemistry, E. E. Slosson (Dodd, Mead & Co.).

[3] The Conquering Engineer, Charles W. Baker (Dodd, Mead & Co.).

[4] The Inspiring Outlook before American Engineering, from the *Journal of the Engineers' Club of Philadelphia,* October 1920.

fessional attitude for some time past, as it has been of the doctor and the lawyer. But in the further step the Federation took with regard to publicity, service to the community as our objective becomes something more than a phrase. Under Article X of the Federation's Constitution it is provided that the "organization shall stand for the principle of publicity and open meetings," which through a by-law is interpreted to mean that "the privilege of attendance at all meetings of the American Engineering Council, of the Executive Board and of Committees, when not in executive session, shall be extended to any proper person;" also that "any proper person shall have the right to inspect and make true copies of the official records of all meetings of the Council, the Executive Board and Committees." By these stipulations the activities of the Federation are quite as open to view and review as those of the Government itself. This attitude is entirely in keeping with the profession's obvious destiny. Every engineering organization should adopt these practices, to the end that this attitude in favor of publicity and against secrecy become the hallmark of engineering. As a profession we cannot be too grateful to the sponsors of this fundamental change. Engineers now and in the future should jealously guard against any backward step in this matter. How better than through these provisions for publicity "shall we let the people know that we are building knowledge for their use, that we are serving every interest that they have and yet are slaves to none of them, that we will listen to every thought they bring and yet will weigh and value them with thoughts of other men in mind."[1] In fact, in the absence of studied and widespread and uncomprising publicity, such power as is undoubtedly coming to the technological group may become a menace. Unless we seek and obtain far-reaching public sanctions as we go along, something akin to a Frankenstein may result.

Consideration of the conditions under which engineering has more and more come to be recognized as a profession suggests that it will be increasingly difficult for the individual engineer to do his job except as he has a part in a highly differentiated professional engineering organization. This interdependence is well expressed by an English economist, R. H. Tawney:

> A profession may be defined most simply as a trade which is organized, incompletely, no doubt, but genuinely, for the performance of function. It is not simply a collection of individuals who get a living for themselves by the same kind of work. Nor is it merely a group which is organized exclusively for the economic protection of its members, though that is normally among its purposes. It is a body of men who carry on their work in accordance with rules designed to enforce certain standards both for the better protection of its members and for the better service of the public. The standards which it maintains may be high or low; all professions have some rules which protect the interests of the community and others which are an imposition on it. Its essence is that it assumes certain responsibilities for the competence of its members or the quality of its wares, and that it deliberately prohibits certain kinds of conduct on the ground that, though they may be profitable to the individual, they are calculated to bring into disrepute the organization to which he belongs. While some of its rules are trade-union regulations designed primarily to prevent the economic standards of the profession from being lowered by unscrupulous competition, others have as their main object to secure that no member of the profession shall have any but a purely professional interest in his work, by excluding the incentive of speculative profit.
>
> ....The rules themselves may sometimes appear to the layman arbitrary and ill conceived, but their object is clear. It is to impose on the profession itself the obligation of maintaining the quality of the service, and to prevent its common purpose being frustrated through the undue influence of the motive of pecuniary gain upon the necessities or cupidity of the individual.
>
> The difference between industry as it exists today and a profession is, then, simple and unmistakable. The essence of the former is that its only criterion is the financial return which it offers to its shareholders. The essence of the latter is that, though men enter it for the sake of livelihood, the measure of their success is the service which they perform, not the gains which they amass. They may, as in the case of a successful doctor, grow rich; but the meaning of their profession, both for themselves and for the public, is not that they make money but that they make health, or safety, or knowledge, or good government or good law. They depend on it for their income, but they do not consider that any conduct which increases their income is on that account good. And while a boot manufacturer who retires with half a million is counted to have achieved success, whether the boots which he made were of leather or brown paper, a civil servant who did the same would be impeached.[2]

Again, as an integral part of any discussion of engineering organizations should come a discussion of the organization of engineering itself. Its development had been so largely haphazard that the resulting fabric is not one that yields readily to logical organization. Indeed, our engineering front is very ragged. Here and there we find salients pushed so far out into the regions of the unknown as to constitute almost a menace to balanced progress—simply a useless diversion of energy and funds. Every one of us can think of phases of engineering upon which time and thought are devoted entirely out of proportion to the importance of the matter when considered as a part of the whole scheme of engineering progress. On the other hand, every one can suggest matters calling for investigation, coördination, and pure research, and for the lack of which whole sections of our engineering front are held back. I have specially in mind at the moment our own specialty of management. We know almost nothing about it except in an empirical sort of a way. And yet for the lack of such laws and data as would doubtless result from broad-visioned experimentation in administration and management, almost every undertaking of man is conducted under a heavy preventable loss. There are few studies in this field which insure an immediate or measurable financial reward, hence this master subdivision of engineering receives in a twelve-month probably not as much financial support as goes into researches on the incandescent lamp every day in the year.

One of the world's greatest authorities on organization, Wilhelm Ostwald, has discussed this unbalanced state of knowledge in connection with the sciences. It is almost word for word applicable to engineering:

> For what is organization? What is the meaning of this process that has proved to be of fundamental importance in all departments of our present social life? The word relates to the existence of the characteristic desired in living beings, in organisms, and it is among them, in fact, that we find the principles in question put into practice and their existence long recognized. We know that a living creature is all the more perfect in proportion to its having been able to develop proper organs for the varied functions peculiar to its existence, and in proportion to its assuring more completely the common and organized coöperation of these organs by means of a central nervous system. In connection with all organization there come into question two related yet distinct operations: on the one hand a division of functions and their apportionment to special organs for the purpose of having each single function all the more perfectly carried out by the particular organ formed for it; and secondly, a coördination of these single distributed functions in the interest of their common service in such a way that each single organ carries out its activities, in point of space as well as of time, so that it thereby produces the greatest gain for the whole organism. Therefore the distribution of functions and the combination of functions are the very essence of organization, and so we shall not be able to organize science otherwise than by separating its functions and then by reuniting them in collective efficiency.
>
> A suitable division of functions implies, moreover, a knowledge of the separate functions—i.e., it presupposes a general survey of the total range of the sciences, and demands therefore a system of them, and this is shown to be the great practical problem that must be solved if we are to organize scientific progress logically.
>
> One occasionally hears the objection raised that an organization of the sciences is not to be thought of, for the reason that science is the highest manifestation of spontaneous mental activity, and therefore is to be gratefully received, but should not be consciously and systematically directed toward definite problems and fields of work. Such an objection is not justified, for the reason that all human progress in all departments rests upon the fact that those things which have occurred heretofore unexpectedly and by chance are transformed into a systematized harvest in the field of human activity through our recognition of relationships established by law. Such an objection in the face of science has still less justification for the reason that science in its very essence rests, as we well know, upon the systematic, logical, and rational ordering of single facts.
>
> ....We are therefore confronted by the task of subjecting the whole range of science to the same organizing and systematizing process which has been carried out so successfully in single sciences, to the advantage of society as a whole.[1]

Before we organize new engineering societies or carry further the subdivision of existing ones into professional sections, we should put engineering through a systematizing process somewhat similar to that suggested for the sciences.

Perhaps of more immediate interest to us is the fact that organization is an attribute of life. We can group inert things as we do when we gather so many potatoes into a basket to make a bushel. But this is "aggregation, not organization." We management engineers should be the first to recognize that it is impossible to organize any but living entities. An engineering

[1] The Liberal College, Alexander Meiklejohn.

[2] The Acquisitive Society, R. H. Tawney (Harcourt, Brace & Howe), p. 92.

[1] The System of the Sciences, Wilhelm Ostwald, p. 110. (Rice Institute Pamphlet, Nov. 3, 1915.)

society in reality gets but little benefit from those who are "simply members." Their dues of course help. But one of the major tasks of all engineering organizations and societies is to get every member genuinely into some part of the play.

While it is an important task, it does not appear to be a difficult one. We are probably within the actual facts in assuming that not 50 per cent of the members of A.S.M.E. attend even one engineering meeting a year, and that less than 10 per cent of the 13,000 members indulge in any other form of organized engineering activity not directly associated with earning a livelihood. This condition exists largely because to remedy it never seems to have been set up as one of our problems. Possibly it has been assumed that to stagger along under the load of the inertia of the inactive 90 per cent is inherent in our proposition. In fact, I am not sure that we have not done many things which directly encourage this attitude of non-participation. The withholding of the vote from junior members apparently has had this effect. In fact, our whole attitude toward young men is one which holds them at arm's length and further seems quite out of harmony with modern thought. The world at large is coming to hold that progress is to some extent at least woven out of the thoughts of the less able members of the community—certainly that even the least conspicuous have an altogether vital contribution to make.[1]

Can we not look forward to the day when to be "simply a member" of any professional organization will be as exceptional as it is today to be "something more than a member?" One way to bring this about might be to have one section—possibly the Management Section—either make activity of some kind a test for membership or set up an active list on which would be carried only the names of real participants in section work. There are now so many different ways of coöperating to further the aims of an engineering society that every one can do something.

We have sought to see in the organization of an engineering society something far deeper and broader than the structure of its government—particularly because of the obvious application in this field of the adage, "The least governed are the best governed." Nevertheless administrative and managerial policies are of the essence of our task.

For some years past—particularly since the war—there has been a marked increase in the activities of all engineering organizations. For the most part this added activity has expressed itself in increase of membership campaigns, the multiplication of technical literature, and to a lesser extent in interest in public affairs. Practically no thought has been devoted to a study of the structure of the organizations through which we make ourselves felt. Engineering organizations are for the most part identical in type. This common scheme of association was designed at a time when there was no recognition of the field and function of the engineer as we understand it today. No material change has been made in the government of these societies except in the case of certain national associations which have slightly democratized their election machinery and more recently granted some measure of autonomy to local branches. This current type seems to err (1) in that there is little opportunity for a continuing and effective administrative direction and control, and (2) that there is almost no provision for the development of what might be termed the non-technical mind of the profession.

The constitution of every engineering society with which I am familiar not only places the administrative direction in the hands of a board, but makes no provision for a genuinely responsible administrative and managerial official. As I have elsewhere pointed out, the secretary of every engineers' association is by its constitution and by-laws subordinate to the board, not only in the sense that he is supposed to operate his office generally to the satisfaction of the board, but in the further sense that he is not supposed to inaugurate policies or to act in matters of any importance except in an effort to execute what has become the will of the board. In other words, the secretary of our typical society—nominally its manager—is not in reality a manager. Hence we have no one in the organization who in any way corresponds to the president of a company. I do not know that we should have. But I am sure that we have a very primitive and halting type of group direction and control through the board of directors. The weakness, in my opinion, does not grow so much out of the group control as out of the fact that the group gives very little time to the job. In the A.S.M.E. this is not more than thirty hours a year on the average.

The presidency as a rule goes to some distinguished member of the profession, and not always with regard to his capacity for administrative work. Even the best administrator would have little opportunity to accomplish results in the usual one-year term. Almost before the president knows what the problem is, his term of office expires. Usually our presidents are chosen in the midst of their professional success. They are busy men and cannot give all their time to the job. It would help if the president could be given duties somewhat comparable to those of the chairman of the board in private organizations. Such an arrangement would certainly meet the requirements for some years to come. If, however, the operations of engineering organizations grow as rapidly as now seems possible even for this post, effective service will mean more than a one-year term.

But the organization of the board and the functions assigned to a one-year president are relatively unimportant compared to the status given the secretary, executive secretary, or managing director who is charged with the administrative conduct of the society's affairs. If we are to attract to such posts and hold men capable of expressing the power and sweep and vision of present-day engineering, we need some *constitutional* delegation of responsibility to an official selected by the board, holding office at the pleasure of the board, and of course reporting to the board—but only in the sense that any president of a corporation reports to his board or that a city manager reports to the commission for the time being in office. The present arrangement, even when the secretary acts as if he had the authority, gives too much opportunity for avoiding responsibility in debatable matters. The present system too frequently results in the doing of the obvious, and in a more or less insipid and even halting administration. The board acts in a way as a buffer between the membership and the secretary. It has the power, but practically always refuses the responsibility which should go with it. The administrative official, even if fairly successful, is so in spite of the obvious handicaps.

The effort to reduce all engineering organizations to a single type is futile. Local initiative and even variation are to be encouraged, but as engineers, our obvious duty is to eliminate unnecessary overlap in field or function. Wherever economies can be effected by setting up joint agencies, this should be done.

In the matter of developing the non-technical mind of the profession and affording it adequate opportunities for more or less regularly recording its judgments, almost nothing has been done. In the absence of such a "mind" it is worse than futile to assume that any one can "speak" authoritatively for the profession. Now and again the effort is made to voice the engineering opinion of the nation, but it comes from such shallow waters that action is but little affected. But if we can organize to really sound out the depths of our professional thought, the judgments so rendered are certain to be woven into the very fabric of the future.

It has been said that "in respect of any undertaking, centralization, i.e., the administrative and management control recommended above, is the way to do it, but it is neither the correct method of deciding what to do nor the question of who is to do it."[1] Except as to the purely technical phases of engineering, there is practically no organized effort being made to decide what our engineering societies should be and do. In fact, it is only recently that a program for the profession has been recognized as a problem. It is quite unusual for an engineering society to afford an opportunity for the discussion of those society and professional affairs not directly related to specific engineering details. Every engineering organization should devote its best energies to developing a method whereby the task of the engineers as an organized group can be considered and outlined, and then kept constantly abreast the best thought of the profession and of the times. Either under the auspices of The Federated American

[1] The New State, M. P. Follette (Longmans, Green & Co.), pp. 1–150.

[1] Economic Democracy, C. H. Douglas.

(*Continued on page 356*)

THE DESIGN OF LARGE LOCOMOTIVES

(Continued from page 314)

Blow-off cock handles should be so located that they can be operated by a man in position where he can see the water glass, and preferably without leaving his seat. The water glass, steam gage, air gages, etc., should be so located that they can be seen by the engineer when in usual position on his seat.

The throttle lever, power reverse lever, cylinder-cock lever, sander valves, brake valves, etc., should be located where the engineer can reach them handily when sitting in usual position on his seat or sitting with his head out of the window. It appears like a small detail, but it is a worth-while one to locate the straight air valve where it can be reached easily by an engineer when in such a position that he can see a man at the back of the tank giving signals for coupling to a train.

The lubricator must be at such a height that a man can see the feeds, and it must be high enough to avoid pockets in the oil pipes. It must be far enough below the cab roof to be filled easily.

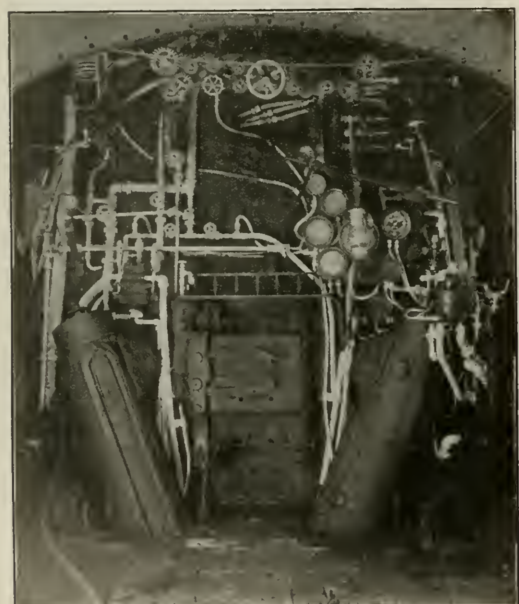

Fig. 6 Location of Boiler Back-Head Fixtures in Large Locomotive

Cab equipment requires careful study and it is difficult to locate the various appliances by drawing, but it has been done. A cab with a large amount of equipment on the boiler back head, yet which is regarded as being reasonably convenient, is shown in Fig. 6.

The use of clear-vision windows has made it somewhat difficult to arrange the seats so that either seat or window will be a height to suit different men. This problem, however, has been solved for one road by its motive-power department chief, who has developed an adjustable seat made of steel and having a spring cushion and an upholstered back. The back being secured to the seat and independent of the back of the cab prevents any vibrations resulting from shaking of the cab wall.

Tender Capacity

Tender capacity should be arranged so as to reduce to a minimum the time a locomotive is detained from the productive work of hauling trains for the purpose of taking water and fuel. This implies large fuel and water capacities, but in arranging for suitable tender capacity care must be taken to avoid unnecessary weight, as any increase in the weight of the tender produces an equal decrease in the weight of train that can be hauled behind the tender.

Tender fuel space should be arranged so as to enable the locomotive to handle a full train with as few stops for fuel as may be feasible.

On territories equipped for water to be taken on the run or when stops for purposes other than taking fuel or water are made regularly at stations where water may be taken, the water capacity should be only sufficient to supply the locomotive when handling a full train, between water stations, with a moderate surplus for unusual delays.

On territories handling a large percentage of through trains with few stops, tenders of large capacity are desirable as they permit keeping locomotives more continuously at work. Where water is scarce and the supply has to be hauled to water tanks, tenders of large capacity are desirable as they reduce the number of water stations that must be maintained as well as the number of locomotives, cars, and men employed in hauling and handling water at these stations.

In addition to reducing time consumed by trains on the road, together with overtime pay to train and engine crews, large-capacity tenders effect a substantial saving by reducing the fuel consumed in starting and accelerating trains as well as the damage to locomotive machinery, draft rigging, tires and rail which frequently results from stopping and starting long freight trains. Train dispatching is simplified and the movements of superior and opposing trains are expedited, as a train which keeps moving interferes less with the movements of other trains than one which must stop frequently, thereby introducing uncertainty as to how long it will be detained.

BOILER TESTS WITH PULVERIZED COAL

(Continued from page 322)

fully burned in pulverized form. In order to determine to what extent this statement is true, tests Nos. 36, 37 and 38 were run with undried coal. The results of the tests show that the completeness of combustion was as good as with the dried coal. There was no loss due to CO in the flue gases and the losses due to combustible in the refuse averaged only 0.3 per cent for the three tests, which is in fact less than the average with the dried coal.

The losses due to moisture in coal of course increased 0.5 to 0.6 per cent, which increase is at the rate of about 0.1 per cent for every 1 per cent of increase of moisture in the coal. The average decrease in the boiler efficiency for the three tests is about 0.7 per cent, which checks closely the increase in the losses due to increased moisture in the coal. It seems, therefore, that it is not necessary to dry the coal down to 1 per cent of moisture in order to get good boiler efficiency. In fact, it seems that most of the eastern coals can be pulverized and burned with good results without drying.

Capacity of Boiler That Can Be Developed with Pulverized Coal

The capacity of boiler that can be developed with pulverized coal depends entirely upon the size and shape of the furnace. With the present knowledge of the art of burning powdered coal the best results are obtained when the coal is burned at the rate of 1 to $1^1/_2$ lb. per cu. ft. of combustion space per hour. Good results can be obtained when the coal is burned at rates varying from $^1/_2$ to 2 lb. per cu. ft. of combustion space per hour, which gives a considerable working range. In Table 1 the rate of combustion is given by item 12. The range covered by this series of tests is from 1.05 to 1.81 lb. of coal per cu. ft. of combustion space. If it is desired to operate the boiler at high rates of working, a large furnace must be installed, and the combustion space must be so arranged that the flames are given the longest possible path through the furnace. The design of burners and the admission of air are very important at high rates of combustion. It appears probable that future developments in the design of furnaces, burners and the air supply may make possible higher rates of combustion than the limit given above.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Losses in Convergent Nozzles

THE paper here abstracted, by Prof. A. L. Mellanby and Wm. Kerr, deals in particular with the anomaly of the velocity coefficients and especially with the falling off in the standard of performance of convergent-type nozzles with restriction of the range of expansion.

This fact has been thoroughly demonstrated by experiment and may be shown in the form of a curve representing the variation of the coefficient of velocity or of discharge with change of pressure ratio. This curve always shows continuous reduction of the coefficient of discharge with limitation of the range, thus apparently indicating higher proportionate energy losses for the lower fluid speeds, as, for example, in Fig. 1.

Curve 4, which is derived by Professor Gibson from experiments on an air venturi meter, demonstrates that this effect is common to the expansion of different fluids. Although the venturi form is apparently convergent-divergent, it is operating only as a convergent type within the expansion ranges to which the discussion applies, and from which the coefficients were obtained.

Fig. 1 shows coefficients of discharge. The velocity coefficients are directly comparable with these, but in general are slightly higher. The nozzle efficiency may be taken as given by the square of the coefficient of velocity; and, since the higher ratios show the lower coefficients and correspond to the lower speeds of flow, the efficiency is apparently poorer with the less rapid motion.

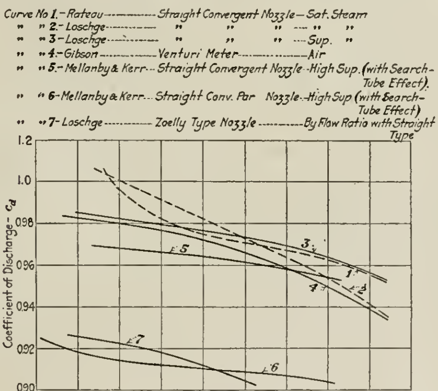

Fig. 1 Various Discharge Coefficients

Such a result is contrary to any preconceived ideas of the matter, as it would seem only natural to expect the best efficiencies at the lowest speeds. The anomaly so presented has been frequently remarked upon, and has created a feeling of perplexity that shows itself in the widely varied explanations that have at times been advanced.

The various hypotheses that would account for the vagaries of nozzle flow are presented and discussed by the author.

One hypothesis which they offer is that the non-uniform distribution of velocity across a section of nozzle might be conceived as independent of pressure variation, which might be considered due to boundary and viscosity effects and is actually known to exist in slower pipe flow. This is examined mathematically and at first glance appears to give an adequate solution, but does not, as the authors explain further.

To give a real explanation of the behavior indicated by the curves in Fig. 1, the authors endeavor to examine the causes underlying the growth of loss along the expansion.

The ordinary idea of nozzle loss is that it is mainly due to friction effects that increase rapidly with the speed. The authors, however, proceed to prove that e, which is the total energy loss per second in the nozzle, is not a purely frictional loss, and while such a loss may be involved in it, it is accompanied by another effect either of constant magnitude or increasing only with the low power of the speed, but sufficiently important to counteract definitely the natural influence of the normal frictional loss.

If two such loss effects exist and can—even imperfectly—be separated, it would be of interest to secure data as to the order of frictional resistance at high velocity speeds, and also whether these are at those speeds proportional to the square of the speed as they are at moderate speeds.

As regards the convergent nozzle, which is, by the way, the

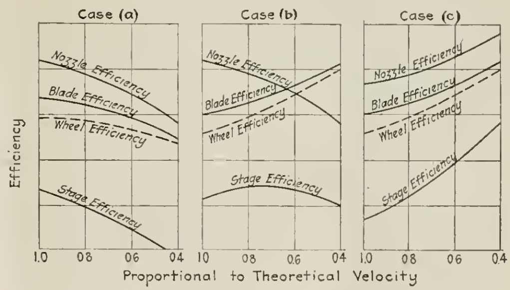

Fig. 2 Efficiency-Curve Forms

type most generally used in modern practice, there is direct experimental evidence that a velocity of efflux closely agreeing with that of sound presents the best condition, and the authors ask whether this is due to some particular virtue in this high speed, and whether this characteristic fact applies to the action on the blading or is peculiar to the nozzle alone.

Is it in brief the effect of the speed or something peculiar to the expansion? Fig. 2 shows three possible combinations of rational curve forms that could be used as a result of more or less accurate deductions from test figures, where nozzle and blade effects cannot be definitely separated. The wheel-efficiency curves represent a change of form due to the necessary consideration of mechanical losses. As regards the stage-efficiency curves, case (*a*) requires the highest speed, case (*b*) a figure somewhat lower, and case (*c*) very moderate values indeed.

All turbine designs may be classified under one of these cases. Case (*a*) depends for its development on the availability of better materials that would make possible the use of higher blade speeds; case (*b*) comprises designs based on the assumption that practically the best conditions have already been reached, while the designs of case (*c*) rely for the attainment of the ends on the multiplication of stages. Marine impulse turbines belong to this class, which may be partly due to the influence of some such conditions as are embodied in case (*c*), but also to the somewhat lower blade speed supposed allowable in marine applications.

The experimental method used by the authors consists simply in passing a search tube along the axis of the expanding jet, in conjunction with which accurate measurement of the mass flow is made. These observations are carried out on any given nozzle under fixed initial conditions of supply, which are so arranged that the expansion is confined to the superheat field.

The reheating effect on the fluid due to the losses in the expansion is determined from the equation—

$$0.718\left(\frac{V_1}{P_1}\right)^{1/2}\frac{G}{A} = \frac{r\left(1 - k - r^{\frac{n-1}{n}}\right)^{1/2}}{k + r^{\frac{n-1}{n}}} \qquad \ldots\ldots\ldots [1]$$

in which P_1 = pressure of supply, lb. per sq. in.
V_1 = specific volume, cu. ft. per lb.
G = mass flow, lb. per sec.
A = flow area, sq. in.
$r = P/P_1$ = pressure ratio at any point where pressure is P
k = reheating or loss factor
n = index of the law (PV^n = constant) for the reversible adiabatic in the field of expansion
= 1.3 for superheated steam.

Here k depends on A, which in certain cases may be measured and in other cases determined otherwise.

Either side of Equation [1] expresses the value of what has been termed the jet function, since certain important quantities that outline the jet conditions are embodied therein. Which side is used in any particular instance depends upon which variable is being considered. Thus to write the jet function F as—

$$F = 0.718\left(\frac{V_1}{P_1}\right)^{1/2}\frac{G}{A} \qquad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

provides a form in which the flow area of the jet is the essential variable, and it is seen that this is simply inversely proportional to F. If the function is written—

$$F = r\,\frac{\left(1 - k - r^{\frac{n-1}{n}}\right)^{1/2}}{k + r^{\frac{n-1}{n}}} \qquad \ldots\ldots\ldots\ldots\ldots [3]$$

a form is obtained in which the loss factor is the important quantity considered. The relationship between k and F is not very direct, but, with F and r known, k can always be computed.

Again, it is easy to show that—

$$\left(1 - k - r^{\frac{n-1}{n}}\right)$$

is proportional to the kinetic energy of the jet; while—

$$\left(1 - k - r^{\frac{n-1}{n}}\right)^{1/2}$$

is similarly proportional to the velocity. Also the factor—

$$\left(\frac{k + r^{\frac{n-1}{n}}}{r}\right)$$

is in direct proportion with the specific volume of the fluid. These meanings for the detail factors are rather useful, and besides the fundamental importance of Equation [1], it is probably advisable to emphasize the following:

$$\text{If volume factor} = \frac{k + r^{\frac{n-1}{n}}}{r} = m$$

then

Jet flow area varies as $\dfrac{1}{F}$

Actual jet energy varies as $(Fm)^2$

Actual flow velocity varies as (Fm).

The absolute results of the various quantities so represented by mere ratios can be readily obtained at any time, since all are referable to the initial conditions, thus:

$$\text{Energy (ft-lb. per lb.)} = \left(\frac{144n}{n-1}\right)P_1V_1\left(1 - k - r^{\frac{n-1}{n}}\right)$$

$$\text{Velocity (ft. per sec.)} = \left\{\left(\frac{288gn}{n-1}\right)P_1V_1\right\}^{1/2}\left(1 - k - r^{\frac{n-1}{n}}\right)^{1/2}$$

$$\text{Specific volume} = V_1\left(\frac{k + r^{\frac{n-1}{n}}}{r}\right)$$

From the forms of these it follows that the loss of energy per lb. is—

$$\frac{144n}{n-1}P_1V_1k$$

and this energy being dissipated in heat causes the specific volume to be

$$\frac{V_1}{r}k$$

in excess of what it would be theoretically.

These considerations show that if by experiment or otherwise the jet function is established for any point on the jet by means of relation (2) then, by means of experimental values of r and Equation [3], it becomes possible to determine the velocity and volume conditions at the point considered, and the total expansion loss that has accrued up to that point.

Strictly speaking, k is a reheating effect rather than a loss effect, but under the conditions of single-nozzle testing the difference between these is entirely negligible and need not be considered. Consequently the terms reheat and loss are used indiscriminately in specifying the quantity that k represents.

In addition to this, the authors show how various coefficients employed in nozzle work may be obtained from the general expression. This applies in particular to the coefficient of discharge and coefficient of velocity.

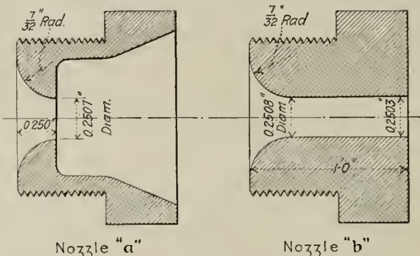

FIG. 3 CONVERGENT-NOZZLE FORMS

In the actual tests two convergent nozzles were used and the main tests were carried on with initial pressure of 75 lb. per sq. in. abs. and initial temperature of 560 deg. fahr. (An initial temperature of 400 deg. fahr. was also used in some tests, but the difference in the results for the two conditions proved to be very small.)

The two nozzles are shown in Fig. 3. Table 1 gives the various data; the function values included are for definite flow areas only, that is, for plane cross-sections in the parallel regions. The definite sets of figures in each case are obtained by variation of the back pressure, and the flow and function values are therefore obtained in terms of the pressure ratio of operation of the nozzle.

TABLE 1 DATA ON TESTS OF TWO FORMS OF CONVERGENT NOZZLES

Nozzle	Initial pressure, lb. per sq. in. (abs.)	Initial temperature, deg. fahr.	Steam flow, lb.	Duration of test, sec.	Nozzle pressure ratio[1]	Values of F at throat	Values of F at outlet
Simple Convergent Nozzle (a)	76.0	559	46	1301	0.580	....	0.2193
	76.0	565	46	1304	0.574	....	0.2195
	76.0	568	46	1314	0.593	....	0.2181
	76.0	569	43	1311	0.710	....	0.2044
	76.0	567	35	1321	0.834	...	0.1650
Convergent Parallel Nozzle (b)	76.4	558	59	1742	0.498	0.2088	0.2100
	76.4	566	49	1460	0.495	0.2077	0.2088
	76.4	565	45	1355	0.582	0.2055	0.2066
	76.4	565	40	1301	0.717	0.1903	0.1914
	76.4	567	33	1349	0.852	0.1515	0.1524

[1] Outlet pressure divided by initial pressure.

In conjunction with these, fall-of-pressure curves have been obtained for each condition. The expansion curves are very smooth lines and no material pressure fluctuations within the

place without loss.

The authors point out that the experimental points in Fig. 4 lie on quite a smooth curve. They also find it is allowable to omit from further consideration the two and three sets in each case, and that in order to cover the full range of action dealt with experimentally, it is sufficient to consider only the case represented by the points marked (*i*), (*ii*) and (*iii*) on each flow curve.

The three different outlet conditions for each nozzle may now be assumed as being completely established, and the probable internal conditions for any and all of these cases may be considered. This, however, is not quite as simple as it looks.

Thus, if we consider nozzle *a*, the problem takes the form of a determination of the F curves which represent the internal conditions along the jet. Again, Equation [2] gives F as a function of A, and if A could be calculated at various points from the nozzle sectional areas the problem would be simple. The authors show, however, that this cannot be done, because where the temperature is changing rapidly the pressure is not uniform over a plane cross-section and the area for any given pressure is not the same. The best way to obtain the correct forms of the F curves is by trial and error, using a rather complicated equation which the author gives as a check. It was in this way that the three curves shown in Fig. 4 for nozzle *a* were obtained. These curves are not continued beyond a ratio of 0.9. They seem, however, to be converging together and are very close to the theoretical. The above method of derivation is not employed to carry the curves further, because the method ceases to be at all sensitive when transition is made from the steep portions of the pressure-ratio curves to the flat top parts.

As regards the convergent parallel nozzle *b*, it is found that when throat values are plotted each practically lies on the corresponding F curve of nozzle *a*, which would tend to confirm the correctness of these curves.

On the whole, the F curve in Fig. 4 may be used for the purpose of determining the forms of the loss curves throughout the various expansion ranges, but in passing from the F values to the loss which these values denote, it becomes necessary to bear in mind that the resultant figures are affected by experimental errors. While these errors are small in so far as their effect on the F values is concerned, this is not so in reference to the difference between theoretical and actual F figures, and it is on these differences that the losses depend.

The losses for different r values can be determined from the F curves of Fig. 4 by means of Equation [3], and the work may be facilitated by employing calculating charts based on that equation.

The authors discuss in detail the subject of the boundary loss and the convergent loss and come to the following general conclusions:

The losses in a nozzle are referred to by a factor k which, in continued product with the initial pressure and volume conditions, gives the energy loss per pound. If this factor is strictly constant for any given ratio of expansion, independent of supply conditions, then the flow per square inch of area is accurately proportional to:

$$\left(\frac{P_1}{V_1}\right)^{1/2}$$

Any dependence of k on P_1 and V_1 upsets this proportionality, but the discrepancy will be the smaller if only a portion of the total k is thus affected. General experimental work shows that mass flow is closely proportional to the above factor, but not exactly so, the disagreement being of much the same order as experimental error.

It has been shown that in the expansion of a fluid through a nozzle there are at least two distinct types of loss. One, an effect of friction, seems demonstrated with fair conclusiveness; the other is apparently an inherent feature of the convergent portion of the expansion.

hydraulic mean depth and of a speed factor that varies only with the ratio of expansion. The constant involved will, of course, cover the influence of the surface finish.

This boundary loss may conveniently be considered as due to a scattering of flowing molecules resulting from impingement on the irregularities of the surface, with consequent retransformation of their flow motion into heat motion.

The second type, called the convergence loss, is caused by the rapid convergence in the entrance. It is shown that this effect is too great to arise from the work done against the deformative stresses created by viscous action; and it is indicated that the cause probably lies in effectual mass motions within the streaming body of fluid. The loss factor is shown to be largely dependent

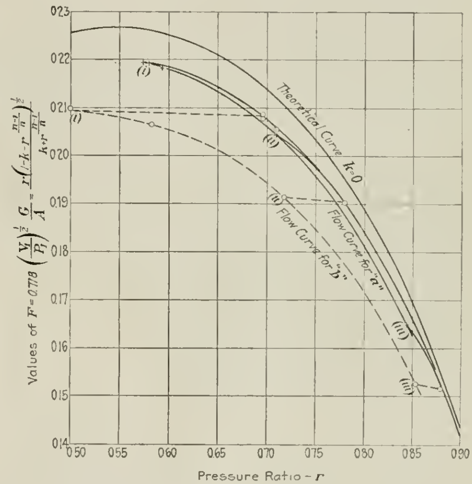

Fig. 4 F Curves

on the velocity developed in the convergent portion of the jet, but it must also be influenced by the actual nozzle form; and therefore any expression given the loss must contain some function of the convergence. Since with a fixed convergence the velocity is primarily important, the loss is affected by initial conditions of supply, and therefore departure from the practial rule that flow is proportional to the square root of P_1/V_1 must be expected. This departure will be the greater in those cases where this particular loss is a large proportion of the whole, e.g., in the purely convergent types, and this is in rough agreement with the experimental evidence available.

This convergence loss is then attributable to the establishment of molar currents in the main stream by and in the convergence. The damping out of these as the jet narrows to a straight path would cause a reheating effect by retransformation of kinetic energy.

It will be seen that the separation of frictional and convergence effects gives at once, through their different natures, a definite reason why the nozzle coefficients should fall as the expansion range is narrowed. The latter effect, measured per pound, is not reduced so rapidly as the available energy, and therefore has an increasingly important influence as the pressure ratio of action rises.

The rate of fall of the coefficient, whether of discharge or velocity, will depend on the relative magnitudes of the two losses. With any convergent type having a fixed inlet form the fall should be

less rapid as the straight tail length is increased, owing to the ready manner in which the frictional effects acquire a dominant influence. With nozzles of equal tail length, however, the more objectionable convergence will cause the more rapid fall. Thus, considering the convergent types used in actual turbine work, the forms at inlet are such as would compel belief that their convergence loss is more severe than that of the simple circular straight types, since there is rectangular formation, curvature of axis, and distinct differences in curvature between the two pairs of opposite sides. In this connection it is significant that the very scanty data obtainable on practical nozzles confirm this finding, the curves derived by Christlein, for instance, having an extremely rapid fall.

Again, the size of the nozzle would presumably have an influence on this loss, as the disturbing currents might then be supposed to be more extensive. If so, the slope downward of the coefficient curves would be more noticeable for the larger nozzles. There are practically no large-scale steam experiments, but reference to Fig. 1 will show that Professor Gibson's curve for air displays this feature. Now these experiments were made with diameters of the order of $1^1/_2$ in., that is, several times the size of experimental steam nozzles, and it would therefore seem that there is a definite dimensional influence.

The effect of dimensions on the convergence loss will be opposite to that on the boundary loss. It must be clearly in view that the frictional occurrences are apparently inversely dependent on the hydraulic mean depth, and therefore small-scale experiments are most suitable for the examination of these. Thus, in the authors' experiments the introduction of an $^1/_8$-in. diameter search tube into a $^1/_4$-in. bore nozzle increases the surface by 50 per cent and reduces the flow by 25 per cent, i. e., the search tube doubles the effect and therefore makes it the more readily determinate. For the same reason efficiencies obtained from such small nozzles are not directly applicable to larger sizes, and therefore to say that the experiments are faulty because in practice better values are apparently shown, is no sound charge. Application to the practical forms can only rationally be made when the constant factors in the different loss effects are known.

It may be taken, then, that the total loss to any point x along the jet within the boundary form is given by—

$$k_t = a_1 \int_o^x (Fm)^2 \frac{l}{A}\, dx + a_2(P_1V_1)^{\frac{1}{2}} \int_o^x \left\{ f(c, x) \frac{d}{dx} (Fm) \right\} dx \quad \text{. . [26]}$$

This expression is too involved to be of much practical value, but considerable simplification is possible with only moderate loss of accuracy. It may be permitted to charge the frictional loss against the tail piece only, and relate this to the average velocity factor therein; while the entrance loss may be made directly dependent on the speed established in the convergence, thus:

$$k = a \times \frac{L}{\eta} (Fm)_0^2 + b(P_1V_1)^{\frac{1}{2}} (Fm)_c \quad \text{. . . . . [27]}$$

where a = constant for surface
L = length of parallel portion
h = hydraulic mean depth of parallel portion
$(Fm)_c$ = velocity factor at end of convergence.

Although (Fm) contains k as a term, the influence of this is not great and (Fm) might be taken as equal to the theoretical—

$$\left(1 - r^{\frac{n-1}{n}}\right)^{\frac{1}{2}}$$

Actually, however, it will be found that by using a suitable chart for calculation rather closer approximations to the real values can be obtained.

Taking the actual nozzles used, the constants are of the following order: $a = 0.0055$; $b = 0.0005$. The constant a is for a moderately well-finished bored-out brass nozzle, while b covers the convergence effect for a small nozzle having a straight axis and a radius of entry nearly equal to the diameter.

For practical application further experimental investigations seem necessary, and a few final remarks on the best forms for these might be given.

The boundary loss will be most readily obtained from examination of the action in straight parallel lengths. The value of the jet function F is constant along such a path, and the growth of loss is closely represented by a straight line. For these reasons pressure readings are only necessary at entrance to and outlet from the parallel portion. Again, this frictional loss is most clearly shown by flow experiments on small-size nozzles.

Consequently for the determination of frictional constants a few long parallel nozzles—of small bore and having different surfaces—might be used; provision also being made for the observation of at least two pressure values.

Examination of the convergence loss requires determination of the conditions in a clearly defined area at the termination of the entry curve. Any chosen convergence must then be fitted with a very short parallel outlet; although with the more awkward form rather greater lengths might be necessary to insure fairly stabilized conditions. There are effects both of curvature and size, and it is probable that experiments with air flow might give a more ready means of examination.

For the convergence effects, then, a few standardized entrance forms might be used—each with short parallel outlet—each form, say, in triplicate, differing only in linear dimensions. Mass-flow determination accompanying pressure reading at outlet would then allow of establishment of the general variation of this loss, and any odd form that might be used at times in practice could be reasonably covered by interpolation from the known standard results. (Paper before the *Northeast Coast Institution of Engineers and Shipbuilders*, Feb. 18, 1921, 40 pp., 22 figs., *etA*. Abstracted from advance proof.)

Short Abstracts of the Month

AERONAUTICS (See Power Plants and Varia)

AIR MACHINERY

Pressure Regulation in Air Receiver or Line—Operating Air Compressors in Parallel

The Automatic Regulation of Air Compressors, Robert Nitzschmann. In compressor operation it is usually necessary to maintain a constant air pressure. In some cases, particularly with small and medium-size units, hand regulation is employed for governing the delivery air pressure either by varying the amount

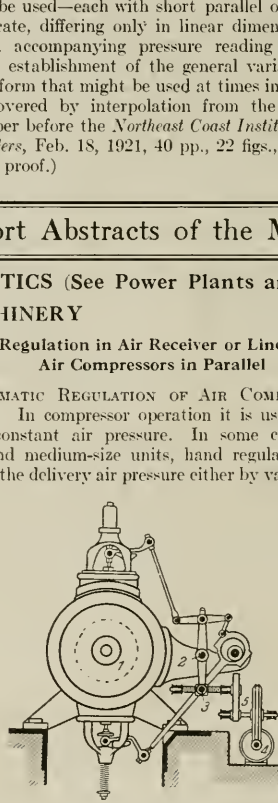

Fig. 1 Device for Automatically Regulating Air Pressure of an Air Compressor

of inlet air (throttling regulation) or by operating directly on the steam supply to the driving prime mover. For larger installations automatic regulation is necessary, which again may be of two kinds; namely, operating by the air pressure directly, or through some kind of a servo-motor.

In the present article a device is described which makes it possible to regulate the air-compressor output not only from the pressure at the compressor directly but also in accordance with the pressure with air lines fed by the compressor.

Fig. 1 shows the governing device as applied to a steam-driven air compressor. Here, 1 is the steam cylinder; 2, the valve-gear shaft; 3, the lever of the valve-gear shaft with the crosshead;

4, an electric motor; and 5, an intermediary element between the electric motor 4 and the lever 3.

The operation of the device is as follows: When the air pressure in the receiver varies, an appropriate relay (Fig. 2) sets the motor 4 in motion in such a way that, for example, the motor 4 rotates the shaft 2 of the valve gear governing the steam admission to cylinder so that the admission decreases, which results in a corresponding decrease in the speed of operation of the compressor. This variation of admission lasts until the desired pressure is reestablished in the receiver. In the case of falling off of pressure in the receiver, a similar operation takes place but in the reverse sense.

Fig. 2 shows the arrangement of the pressure relay employed with a polyphase servo-motor. According to the position occupied by piston 1 of the relay, the contact arms 2, 3 and 4 press against either the contacts 5, 6 and 7(pressure too high and the motor

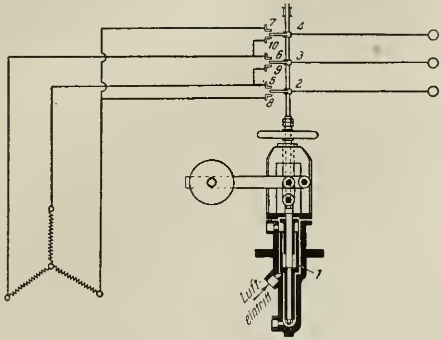

Fig. 2 Electrical Relay Employed with the Device Shown in Fig. 1
(*Lufteintritt* = Air Inlet)

decreases admission of steam to the steam cylinder) or contacts 8, 9 and 10 (pressure too low in the receiver and more steam is caused to flow into the steam cylinder).

Where an extensive system of piping and machinery has to be supplied with compressed air, especially from several air compressors located at different points, it is often important that a certain predetermined amount of air be supplied at a constant

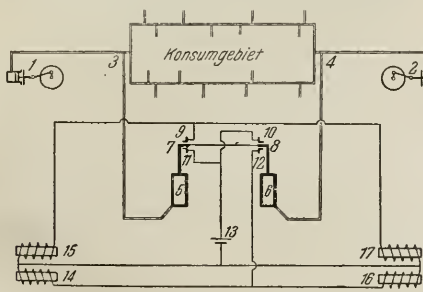

Fig. 3 Device Shown in Figs. 1 and 2 Applied to a System Employing two or More Compressors
(*Konsumgebiet* = Piping and Machinery Fed from the Compressors)

pressure. Fig. 3 shows the connections to the regulating motors to cover such a case.

In this figure 1 and 2 are two air compressors located at different points; 3 and 4 are the points at both ends of the system supplied by compressed air at which the given pressure is maintained; 5 and 6 are the pressure relays belonging respectively to 3 and 4 with pistons carrying the electric contact arms 7 and 8; 9, 10, 11 and 12 are respectively the stationary contacts of the pressure relays; 13 is a source of electric current; and finally 14, 15, 16 and 17 are the electric relays operating the servo-motors located respectively at each of the compressors 1 and 2 and governing the admission of steam to the steam cylinders in the manner described.

With this system of governing, the operation is as follows: If, for example, at the point 3 of the piping system fed by the compressors, the air pressure becomes excessive, the movable contact 7 is forced against the stationary contact 9. The two motors 1 and 2 at the compressors remain idle and the equalization of pressure takes place right in the piping system without calling on the automatic regulation. It is only when the pressure at 4 also exceeds the desired limit that the circuit is closed, the electric relays 15 and 17 are energized, and the steam supplied to the engines driving the compressors 1 and 2 is simultaneously reduced. The regulation is similar when the air pressure in the line falls below the desired limit.

With appropriate variations the same method of regulation may be applied to rotary compressors and may be used to govern the compressor output instead of the receiver pressure. (*Feuerungstechnik*, vol. 9, no. 9, Feb. 1, 1921, pp. 74–75, 3 figs., *d*)

FUELS AND FIRING

What Determines the Clinkering Ability of Ash ?

Constituents in Ash that Cause It to Fuse, G. A. DeGraaf. The discussion applies in particular to bituminous coal. Among other things, the author shows that sulphur in bituminous coal occurs mainly in the form of iron pyrites, which, when burned

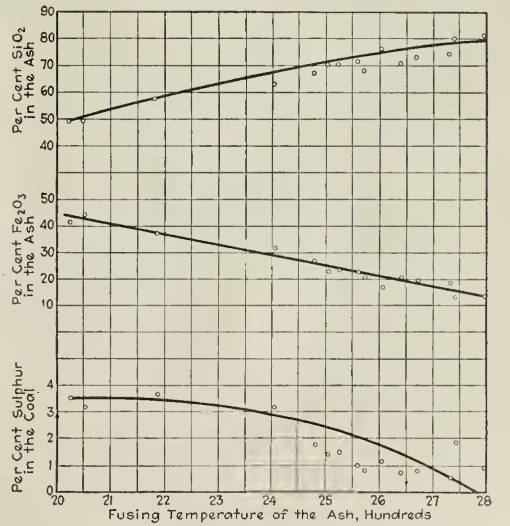

Fig. 4 Curves Showing Relation of Fusing Temperature of Ash to Percentage Content of Silica, Iron Oxide and Sulphur

with the coal in the fuel bed, forms iron oxide; a material which by itself would not produce clinkers. If, however, this iron oxide is exposed to high temperatures in the presence of silica and silicates usually also available in the ash, clinker in the form of fusible silicates may be produced.

It is temperature of the grate and of the fuel bed near the grate that determines whether a certain coal will form troublesome clinker or no clinker at all. Because of this, it is important to keep the grate and the part of the ash bed near it at as low a temperature as possible during operation.

On the other hand, however, if coal contains pyrites in large lumps they may fuse before they are completely burned and start the formation of clinkers. The conclusion to which the author comes is, therefore, that although high sulphur content may increase the possibility of clinker formation, it is not a definite indication that clinkers will be produced, as the action depends upon the form in which the sulphur is present.

The author calls attention to the fact that the complexity of the content of the ash makes it difficult to draw a conclusion as to its tendency to form clinker. Fusibility of ash depends apparently upon the ratio of the silica to the iron, aluminum, calcium, etc., present. As a rule, ash high in silica contains little iron and will not fuse easily, but if the silica decreases and the iron increases, fusing will take place at a lower temperature. The author does not believe that a definite relation between the clinkering properties of coal and the chemical composition of well-mixed ash can be found, especially as in addition to the chemical analysis there are many other factors which influence clinkering, such as the construction of the furnace, combustion space, draft, cooling of the grates, etc., as well as the methods of firing.

Fig. 4 is of interest as giving an idea of the relation of fusing temperature of ash to the percentages of silica, iron oxide and sulphur.

The author explains the methods of carrying out fusibility tests of ash and in particular the use of Seger cones. (*Coal Age*, vol. 19, no. 12, pp. 534–539, 5 figs., *pe*)

LUBRICATION (See also Power Plants)

Tests on Lubrication with Emulsified Oils

LUBRICATION OF STEAM CYLINDERS WITH OIL EMULSIONS, Dr. Eng. Hilliger. Data of tests bearing on performance and consumption of lubricant by steam engines lubricated with plain oil and oil emulsions, carried out at the Salbke Works of the R. Wolf Company, Magdeburg, Germany, on a 25-hp. non-condensing locomobile engine.

In the course of these tests either plain oil or an emulsion of oil with saturated lime water was used, the lime water having a content of 1.2 grams (18.4 grains) of lime per liter (0.26 gal.) of distilled water.

The plain oils, which were all of mineral origin, had viscosities (Engler, at 50 deg. cent.) varying from 33.6 to 39.4. The content of lime water was in excess of 40 per cent but below 50 per cent.

The steam cylinder of the locomobile engine was provided with pressure lubrication of the usual type feeding 16 grams (246 grains) of oil per hour. The engine gear was abundantly lubricated in order to reduce friction losses as far as possible. Previous tests have shown that the usual indicator method of measuring cylinder performance was not sensitive enough for the present purpose and the governor was so set that at each revolution the amount of steam flowing into the cylinder was dependent exclusively on the boiler pressure. The relation between the boiler pressure and the average indicated pressure was derived through very careful indicating of the various steam pressures and was repeatedly tested during the course of the experiment.

It was found that for an operating pressure of 12 atmos. the mean indicated pressure was 5.06 atmos. with saturated and 4.93 atmos. with superheated steam. In the course of the tests the boiler pressure was maintained constant and the load varied by means of a resistance formed by a bank of incandescent lamps.

Method of Testing. In order to compare the lubricating ability of various oils, it is necessary to produce in the cylinder a very thin oil film, such that its wear may be observed through an increase in the energy consumed by friction. The better the lubricant the better it will adhere to the rubbing surface and the longer it will withstand the wear produced by the friction of the rubbing parts. In order to produce a sufficiently thin film of oil, the lubrication was begun in each test by supplying the usual amount of lubricant to the cylinder and then cutting it off entirely. During the period when the lubricant is supplied at the usual rate, a film of oil is built up on the inner walls of the steam cylinder. At the same time small quantities of oil collect in the piston rings and in several other dead spaces in the cylinder. When the supply of lubricant is discontinued, the film on the cylinder walls is at first maintained by supplies from these small oil reserves and its distribution from them depends on the quality of the oil. Gradually, however, the oil film is worn away by the rubbing of the parts, which causes a falling off of mechanical efficiency, which may be represented in the form of an efficiency curve. The length of the period that this decline of mechanical efficiency continues is an indication of the ability of the oil to adhere to the walls, and also of the ability of the oil to act as a lubricant even when present on the walls of an engine cylinder only in films of exceeding thinness.

In this way the lubricating qualities of the oil and its economy of consumption may be expressed in comparable figures. The economy of consumption of oils may also be determined from their minimum consumption, which means the amount of oil at which the mechanical efficiency of an engine attains its maximum value and is not improved by further additions of oil. Tests along these lines have been carried out in addition to the tests referred to above. When the supplies of oil in the cylinder were

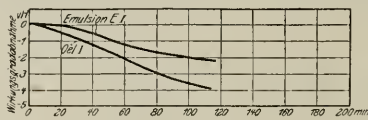

Fig. 5 Tests with Saturated Steam

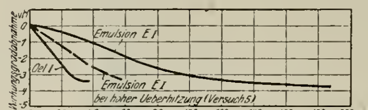

Fig. 6 Tests with Moderately Superheated Steam

FIGS. 5 AND 6 COMPARISON OF EFFICIENCY CURVES OF AN ENGINE LUBRICATED WITH OIL AND WITH AN EMULSION

(*Wirkungsgradabnahme, vH.*, efficiency, per cent· *Bei hoher Ueberhitzung*, at high superheat.)

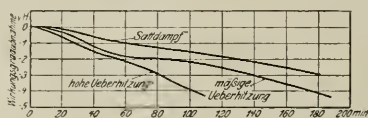

Fig. Tests with Oil Lubrication

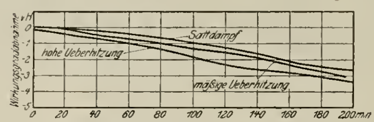

Fig. 8 Tests with Emulsion Lubrication

FIGS. 7 AND 8 INFLUENCE OF SUPERHEAT ON EFFICIENCY CURVES WITH OIL AND EMULSION LUBRICATION

(*Sattdampf*, saturated steam; *hohe Ueberhitzung*, high superheat; *mässige Ueberhitzung*, moderate superheat; *Wirkungsgradabnahme, vH.*, efficiency, percent.)

exhausted, a predetermined amount was forced into the cylinder and the resulting increase of efficiency determined. These tests also served to prove that the decrease in efficiency found from the previous tests was due exclusively to the gradually decreasing amount of lubricant supplied to the cylinders. If a given amount of oil forced into the cylinder was found insufficient to bring the mechanical efficiency of the engine to its original value, the amount was gradually increased until this took place. The amount of oil finally delivered which resulted in the efficiency of the engine being brought back to its original value, was the minimum amount necessary for a regular operation of the engine. In all experiments the engine cylinder at the beginning of the test was carefully washed out with a mixture of some other lubricant with gasoline.

Data of Tests. Figs. 5 and 6 show efficiency curves of an oil and an emulsion with saturated and moderately superheated steam. From this it would appear that the emulsion is a much better lubricant than the plain oil, especially at moderate superheat. [By moderate superheating is meant such that the steam temperature is 330 deg. cent. (626 deg. fahr.), while at high superheat it is 430 deg. cent. (806 deg. fahr.).]

made therefrom, not only at moderate but also at the higher superheats.

From the results obtained in these tests it would follow generally that emulsions are better lubricants than the oils from which they are made, and that they maintain their lubricating properties longer when working with higher superheats. In order to bring this out more clearly Figs. 7 and 8 have been plotted, where the curves represent data of tests with an oil and an emulsion (different from those with which the tests in the two previous figures were made) with saturated, moderately superheated, and highly superheated steam. From these figures it would appear that the tests with oils produce quite divergent results, while the efficiency curves from the tests with emulsions lie very close together. From this it may be concluded that the lubricating properties of the emulsion are much less affected by the increase in the degree of superheat than those of plain oil.

In order to facilitate the comprehension of the data collected in the course of these tests, the author employs a characteristic number for denoting the variation in efficiency instead of an efficiency curve, namely, the time in minutes during which a falling off of 1 per cent takes place in the mechanical efficiency. Such numbers which may be used for comparing various lubricants are derived directly from the curves and are presented in Table 1 for saturated, moderately superheated, and highly superheated steam. From this table, again, it is readily seen that the lubricating values of the emulsions are much higher than those of the original oils from which the lubricants were made. It also appears

TABLE 1 TIME IN MINUTES DURING WHICH EFFICIENCY DECREASES BY 1 PER CENT

Oil No.	Saturated Steam Oil	Saturated Steam Emulsion	Moderately Superheated Steam Oil	Moderately Superheated Steam Emulsion	Highly Superheated Steam Oil	Highly Superheated Steam Emulsion
1	31	55	9	37	...	15
2	70	112	38	85	31	65
3	..	...	...	...	84	150
4	..	...	193	250	178	225

clearly that high superheat affects oils more than emulsions containing them.

As regards the comparative consumption of oils and emulsions, it would naturally be expected that this would depend on the lubricating ability of the material. In all tests the oil feed was found to be sufficient for operating the engine in the usual manner. Data of the tests having for their purpose the determination of the minimum sufficient amount of oil are presented in Table 2. Where the plus sign is affixed to a value it shows that the amount given would have to be slightly increased in the regular operation of the engine. From this table it would appear that emulsions are much more economical than the oils from which they are made.

TABLE 2 MINIMUM SUFFICIENT CONSUMPTION OF LUBRICANT IN GRAMS PER HOUR

Oil No.	Saturated Steam Oil	Saturated Steam Emulsion	Moderately Superheated Steam Oil	Moderately Superheated Steam Emulsion	Highly Superheated Steam Oil	Highly Superheated Steam Emulsion
1	16	8	16+	8	....	16+
2	8+	8	8+	8	16+	16
3	....	..	....	..	16	16
4	....	..	16	8	16	16

The number of tests, however, was not large enough to furnish data sufficient to express numerically the degree of economy presented by the emulsions. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 10, Mar. 5, 1921, pp. 248–249, 5 figs., *eA*)

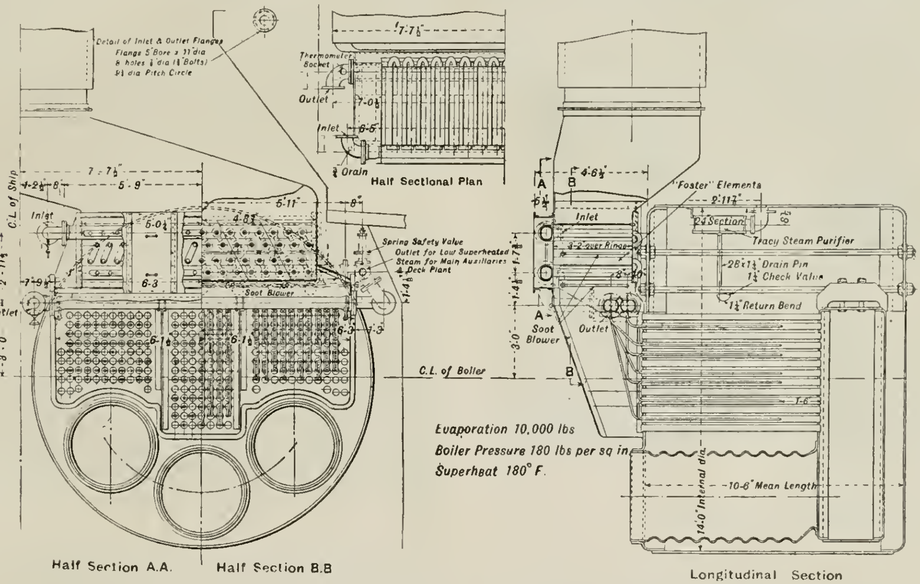

Fig. 9 Foster Double-Stage Superheater Applied to Cylindrical Marine Boiler

MACHINE SHOP (See Special Tools)

MARINE ENGINEERING

A Superheater Giving Steam of Two Different Degrees of Superheat

Foster Double-Stage Superheater. Description of a combined flue-type and smoke-tube superheater giving a superheated steam to marine engines and low-superheated steam to auxiliaries, manufactured by a British company.

In the ordinary flue-type superheater the ends of the tubes nearest the combustion chamber are very liable to corrode through, which is said to be due mainly to the impinging at high velocity of the small particles of moisture which pass from the stop valve into the superheater elements. The risk of failure from this cause is somewhat reduced by the usual thickening of the tube ends, but it rather increases danger on account of the high temperature reached by the superheater elements at the bend necessary to provide the desired steam temperature inside the tubes.

The Foster double-stage superheater, Fig. 9, has a number of waste-heat elements arranged in the uptake into which the steam

from the boiler in led, as a result of which it passes into the flue elements absolutely dry and at a temperature about 60 deg. fahr. above saturation point. In addition to this, the steam as it leaves the boiler is passed through a Tracy purifier where it is freed from the impurities which otherwise would be deposited on the interior surface of the superheater.

From the waste-heat elements the steam is led to the main headers in front of the boiler leading to the flue-tube superheater elements, but before reaching the headers the steam passes through a pipe fitted with a spring-loaded safety valve and a stop valve from which steam for the main auxiliaries and the deck machinery can be drawn. This enables these engines to work economically with low-temperature superheated steam and without the disadvantages which are found to accompany a high degree of superheat.

As the steam entering the headers already contains approximately 60 deg. fahr. of superheat, the number of superheater elements is smaller, and the elements instead of being brought practically to the combustion chamber are stopped at a distance of about 1 ft. 6 in. from the ends of the tubes, and hence the tubes are not subjected to the maximum temperature of the furnace gases.

In the Foster superheater the end of the superheater tube carries a standard $^3/_4$-in. type thread (Fig. 10). The steel nut carrying a

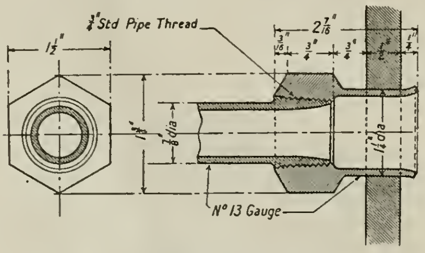

FIG. 10 CONNECTION OF SUPERHEATER ELEMENTS TO HEADERS IN A FOSTER SUPERHEATER

$1^1/_4$-in. diameter mouthpiece is expanded into the header. If the tube should fail, the mouthpiece can be readily removed in the usual way and only the nut will be damaged. (*Shipbuilding and Shipping Record*, vol. 17, no. 10, Mar. 10, 1921, pp. 285–286, 2 figs., *d*)

PAPER INDUSTRY (See Power)

PIPE

CENTRIFUGALLY CAST STEEL PIPE, George K. Burgess. Abstract of a report of tests carried out by the author in 1918 at the Bureau of Standards on samples from hollow steel cylinders made by the W. H. Millspaugh process.

No data as to the process itself are given, except that the cylinders were cast in a machine revolving about its horizontal axis. The cylinders are said to have walls from $^1/_2$ in. to $3^1/_2$ in. thick. The outer surfaces were fairly smooth but the interior surfaces were rough. Plain carbon- and nickel-steel cylinder castings were investigated in the condition as cast and after various heat treatments.

Results of the radial surveys for hardness and chemical analyses show there is a gradual increase in carbon from the outside to the inside surface for all castings. This increase ranges from 0.02 to 0.09 per cent and appears to be roughly proportional to the carbon content, so that the percentage in variation remains practically constant. The nickel and phosphorus appear to follow the carbon very closely in their behavior as to segregation; manganese and silicon, on the other hand, are nearly constant across the radial section, while sulphur, although somewhat erratic, in general is distributed similarly to carbon.

The hardness surveys follow closely the chemical segregation, the higher numbers occurring on the inside layers. Stresses across section of tubes were measured by cutting out rings, and it would appear that the internal stresses are of the order of the elastic limits of the material, the outer zone of the casting being in compression and the inside ring in tension.

Various attempts were made to improve these castings by heat treatment, the data of which are given in the form of tables. Most samples show good tensile strength for their composition and treatment, and there does not appear to be any marked difference in values for longitudinal and transverse specimens.

Certain of these treated steel castings would appear to compare favorably in their properties with those of forged material of the same composition. For example, the physical properties of some of the castings are equal to or better than ordnance requirements for gun forgings.

The only evidence of unsoundness of the metal was the presence of small blowholes in the inner zone, usually within $^1/_{16}$-in. of the surface.

The microstructure of some, at least, of these castings is better than that of ordinary castings; certain ones show pronounced ingotisms (dendritic structure). The nickel steels contain more slag inclusions than is usual in ordnance steel, showing that this centrifugal process may not clear up a basic steel. The ingotism and coarse-grained structures of these centrifugal castings can, in general, only be removed by prolonged and repeated heat treatments., i.e., normalizing followed by double quench and draw. (*The Iron Age*, vol. 107, no. 12, Mar. 24, 1921, pp. 764–766, 5 figs., *eA*. In this connection, attention is called to an editorial in the same issue, p. 789, discussing the centrifugal casting of steel as a metallurgical development which may become of importance.)

MANUFACTURE OF WROUGHT PIPE FOR HIGH PRESSURES. For hydraulic purposes very strong pipe is required because the high pressures of hydraulic lines exert enormous bursting forces and the potential energy of the water under such working pressures closely approaches that of the thrust of a steel rod working as a piston under similar pressure.

The pipe must therefore be made with unusual care, and furthermore, to be efficient in the face of the friction developed by fluid flowing under enormous pressures and high velocities, the pipe must be clean and smooth and must be capable of bending without excessive distortion of the internal diameter. These conditions require that the pipe be welded and rolled according to the best mill practice, and from metal possessing the usual combination of high tensile strength and great ductility. The practice described below is that followed by the National Tube Company, Pittsburgh, Pa.

To make pipe for hydraulic purposes the solid ingot is rolled down to plates of the required dimensions, which eliminates laminations occurring in plates rolled from built-up bars and insures homogeneity of the pipe wall. Defects such as blisters or blowholes are obviated in the skelp from which pipe is made by a mechanical process of working the metal in bloom form known as "Spellerizing." It is a kneading process which consists of subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surfaces.

High-pressure pipe of smaller sizes is manufactured by the butt-welding process. The hot plate is welded into pipe at a point close to the end of the furnace by drawing it through a die shaped like a bell with a hole in one end. The pipe is reheated several times and drawn through dies having gradually decreasing diameters until the proper size is obtained. This is done in order to weld thoroughly the very thick abutting edges of the seam and to provide the necessary strength at this point. When pipe is not intended for high-pressure service, it is drawn through only one or two dies.

The larger sizes of pipe for high-pressure purposes are made by a process in which the edges of the plate are overlapped by the seam. The plates are properly rolled, heated and bent into rough tubes (skelp), and are then charged into a furnace where they are heated to a welding temperature. From the furnace they go into the revolving rolls of the welding apparatus, so grooved that they form a circular opening between them of approximately the same

size as the outside diameter of the pipe. In this opening is a bullet-shaped mandrel, and as a skelp comes from the furnace it is caught by the rolls which force it forward over the mandrel and press the overlapping edges together into a sound weld.

To make one length of the strong pipe used for certain purposes, two lengths of pipe are welded in this manner and then telescoped, this being arranged in such a way that the welds of the telescoped pipes are at diametrically opposite points. In this position they are reheated to a welding temperature and are both passed at once through the welding rolls, thus forging them into a single length of heavy-walled pipe.

After the pipe has been welded it is passed through rolls which give it the required outside diameter, and through cross-rolls to straighten it and give it its true circular shape. The pipe is then slowly cooled on a continuously traveling table, after which the tags and the ends which have become damaged in manufacturing are trimmed off and the pipe is subjected to a hydraulic test to prove the soundness of wall and weld. The test pressures vary from 700 to 3000 lb. per sq. in. according to pipe size and type of weld.

Hydraulic pipe is made in nominal sizes of 9, 10, 11, and 12 in., and is tested with hydraulic pressures of from 1200 to 1800 lb. per sq. in., depending upon the size and upon the wall thickness. Each of these sizes is made in four different thicknesses and weights.

Making wrought pipe for high pressures is extremely exacting work, and such is the necessity of keeping the closest possible control on all the materials going into its manufacture that, e.g., at the plant of the National Tube Company—the largest manufacturers of this pipe in the country—everything from the ore to the finished product is made in the plant. (*Machinery*, vol. 27, no. 8, Apr. 1921, pp. 755–756, 5 figs., *d*)

POWER

Gear Drives in British Textile Mills

The Individual Gear Drive for Heavy Looms, G. F. Sills. Plenty of evidence is available in British practice to uphold the advantages claimed for the individual gear drive. As an instance, it is stated that the largest electrical individually driven weaving shed in the country up to the time of the armistice had 1162 plain, narrow-reed-space Lancashire-type looms individually belt-driven, each with its own motor. When a large extension was contemplated the owners went into the matter carefully and finally ordered a further 570 individually driven units equipped with a more expensive gear drive, in spite of the fact that the looms were of a

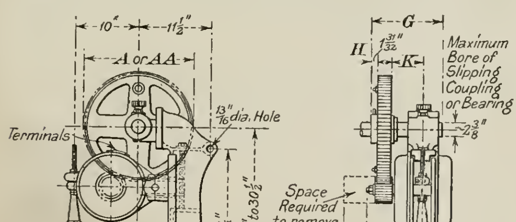

Fig. 11 Standard Loom Motor with Gear Drive ($^3/_4$ to $1^1/_4$ Hp.)

relatively cheap type and were weaving an article which did not command a high market price.

Fig. 11 shows a view of the latest electrical individual gear drive suitable for equipment up to $1^1/_4$ hp., made by the English Electric Company. (A number of similar equipments of only $^1/_2$ hp. have been supplied to the textile trade.)

This form of gear drive is claimed to be better built than was the case formerly. The pedestal section is stiffer and the pedestal casting is so arranged as to give heights of centers from the floor varying between $26^1/_2$ in. and $30^1/_2$ in. This means that the pedestal casting would be the same for the horsepower range from $^3/_4$ hp. to $1^1/_2$ hp.

Other improvements are the stiffer conical pin which holds the motor clamp in position, and an eyebolt which is supplied to fit on to this pin for carrying the stiffening rod back to the loom frame. A boss is also provided on the pedestal for carrying a second stiffening rod to the loom frame. The centers of the holding-down foundation bolts are the same as those on the old-type pedestal, thus allowing the new-type pedestal to replace the old-type without any considerable amount of alteration. This pedestal is also designed to allow of a loom crankshaft speed of 76 r.p.m. This particular gear drive is suitable for the ordinary loom.

Where the power required is over $1^1/_2$ hp. a much more substantial form of drive is used than that shown in Fig. 11. In this type the motor is not supported centrally, but has special end shields which are clamped to two side supports coming up from the pedestal. This has the advantage of transmitting shocks and power from the pinion to the ball bearings, thence to the end shields, and finally to the pedestal without in any way straining the stator of the motor.

In this extra heavy type of drive a slipping clutch is used for absorbing the shock of the motor pinion in the event of a "bang-

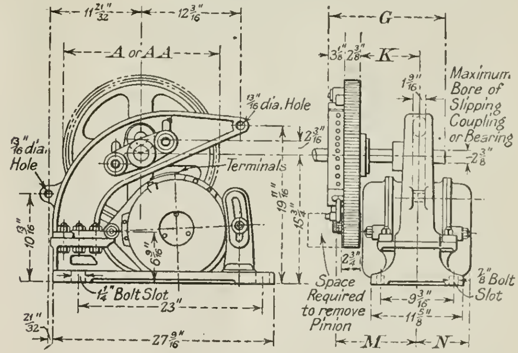

Fig. 12 Extra Heavy Individual Gear Drive for Looms with Low Centers

off," as there is considerable momentum stored in even a small motor rotor running at 965 r.p.m. The central cast-iron boss is a light force fit on the loom shaft to which it is keyed, and is also provided with three studs. The spur wheel is bored to be a loose revolving fit on a portion of the central boss, previously referred to, but is kept from turning on this by the spring bands which are adjustable for tension. At starting there should be no slip, and the correct setting is obtained by making a chalk line to cross the spur wheel and central boss with the loom stationary. The loom should be started up and stopped in the ordinary way, when the spur wheel and central boss should still be in the same relative position to one another. If there are any signs of slipping, which is clearly indicated by the chalk line just mentioned, the springs should be tightened until there is no movement. With this setting there should be a relative movement of from 1 in. to $1^1/_2$ in. on a "bang-off."

For looms with low centers (some as low as $15^3/_4$ in.) the drive shown in Fig. 12 is used. Loom motors are made specially for the purpose and are totally enclosed and equipped with ball bearings and grease lubrication requiring no attention for long periods. The starting torque of a loom motor is about $2^1/_2$ times that of the normal type. The temperature rise is only 35 deg. cent. as against 50 deg. cent. for the same type of commercial motor. (*The Electrician* (London), vol. 86, no. 2229, Feb. 4, 1921, pp. 150–153, 8 figs., *d*)

POWER GENERATION

Economic Features of Superpower Schemes

Industries and Superpower, Harold Goodwin, Jr. The cost of fuel and purchase of power for all the industries in the United States amounts to only about $2^1/_2$ per cent of the value of the products and is only about $4^1/_2$ per cent of the value of the materials going into these products. (These figures apply to the country at large and not to individual industries.) Nevertheless the subject of power generation and distribution is, of course, of the highest importance.

As regards the determination of the future load, Dr. George Otis Smith, Director of the U. S. Geological Survey, has pointed out that the steam engine has been the cause of centralization of industry, while electricity has already been the means of decentralization, and the greatest mission of the superpower system should be the aiding of industry in its economic decentralization.

Fig. 13 shows the method of determining the limit of saturation

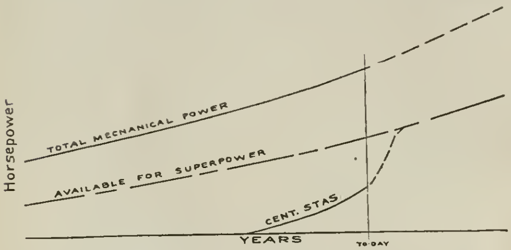

Fig. 13 Growth of Industrial Mechanical Power

of industries with power. The upper curve shows the growth of the total mechanical power and the growth which may be predicted for it in the future, while the next curve shows the proportion of the load which could be economically supplied by central-station service. The lower curve shows the growth of central-station power and the way its logarithmic extension would continue. It is evident that the limit of central-station supply of mechanical power should be reached if the present rate of growth is maintained for a few years, and that after the point of saturation has been reached the growth will be much more gradual.

This consideration would show that it is not safe to predict the load of the superpower system simply by the extension of the present growth curve of central stations.

The location of industries is determined by many factors, such as labor, transportation, raw-material supply, etc. In some cases there seems to be a tendency for industry to move to the nearest supply of labor; while in others plants have made arrangements for drawing labor to them instead of carrying the plant to the labor. Availability of power through the superpower scheme may be of assistance in facilitating the location of plants on sites otherwise desirable. If there is a tendency of industry to decentralize, availability of power will be one of the controlling factors in the building up of new industrial centers. (*The Journal of the Engineers' Club of Philadelphia*, vol. 38–2, no. 194, Feb. 1921, pp. 63–68, 5 figs., *g*)

Superpower Stations for Central Indiana, Frederick L. Ray. General outline of the needs, advantages and possibilities of a system of generating stations located in coal-mining districts and supplying the entire central part of the state. Credit for many of the ideas advanced is given to John A. Stevens, Mem. Am.Soc.M.E.

In this project primarily developed for central Indiana but which could be extended to cover practically all of Indiana and the eastern half of Illinois, it is intended to locate the power plant on the Wabash River because a project of this kind cannot be considered unless there is an abundance of water for condensing purposes, a condition which is fully satisfied by the Wabash River. The intention is to erect several plants of about 150,000 kw. capacity each in the coal field on the river between Terre Haute and Vincennes.

A table in the original article shows the approximate kilowatt-hours generated per month for some 25 cities of central Indiana, from which it appears that the total output is close to 45,000,000 kw-hr. per month produced at a cost of about 95,000 tons of coal, with a consumption of coal per kw-hr. varying from 3.20 to as high as 9.66 lb. and averaging about 4.5 lb. per kw-hr.

This current could be generated in a modern plant for 2.12 lb. of coal per kw-hr., including 30 per cent transmission losses up to the consumer, which would mean a saving estimated at more than 48,000 tons of coal per month, equivalent to a saving per year of approximately 600,000 tons.

The general outline of the design of the plant is given. It is intended to make provision on each boiler for the burning of powdered coal to the extent of 50 to 200 per cent of the normal demands. Then in an emergency it would be possible to increase the output to 400 per cent without crowding the stoker. The mixture of the flame from the powdered coal with that of the flame from coal and stoker would greatly improve combustion, and the trouble of ash removal with powdered-coal burning would be eliminated, for the ashes from the powdered coal would fall upon the ash and refuse from the stoker and could be readily dumped to ash pit and removed.

The railroads in this district should be electrified as quickly as possible, but not until all other industries have been taken care of. (Paper read before the Indiana Engineering Society, abstracted through *Power Plant Engineering*, vol. 25, no. 5, pp. 262–264, 1 map, *g*)

Superpower Zone in Canada, Robt. G. Skerrett. The author claims that Canada has set the pace for the United States in the creation of what may properly be termed a superpower zone, referring to the work of the Ontario Hydroelectric Power Commission.

Ontario, which is one of the most densely populated sections of the Dominion, is practically devoid of its own sources of fuel but has a large potential supply of water power. It was to develop this that the Commission was created in 1906. (Its powers and organization have been since modified by a number of subsequent acts of the Canadian Parliament.)

At the beginning, the main attention of the Commission was devoted to the development of the Niagara project. Later on, however, eleven other districts were covered and last year the transmitting wires distributed more than 315,000 hp., while it is expected that by the close of 1921 the total output for public use will amount to 750,000 hp. and will be approximately doubled in the next two years.

The charges for electric energy are such as to cover the expense of the service and create a sinking fund which in 30 or 40 years will leave each constituent community the owner of its plant.

Generally speaking, 1 hp. raised by steam entails an outlay in Canada today of from \$40 to \$60 annually, whereas the Commission is able to sell a hydroelectric horsepower for only \$18 for a twelvemonth.

An interesting feature of the rate-making system of the Commission is found in the fact that in each community the small user pays for energy the same price as the large consumer, and the rate in each locality is determined on its individual merits. The dominating purpose of the Commission is that there shall be an equality of right to power in all areas within range of the current generated in any of its plants.

In the early days the Commission bought all its supplies from dealers. Now, however, with its expanded organization, it buys lamps and other equipment in large quantities direct from manufacturers, giving the consumer the benefit of the cheaper price.

The installations owned by the Commission (not including franchise valuations) represent a cash value of close to \$57,000,000. The Niagara power development cost \$15,000,000 and the combined valuation of the Commission is well in excess of \$100,000,000. (*Scientific American*, vol. 124, no. 13, Mar. 26, 1921, pp. 246 and 258, 1 map, *d*)

POWER-PLANT ENGINEERING (See also Lubrication and Marine Engineering)

Canals as Sources of Condenser Water for Large Plants

The Cooling of Water in a Canal, L. C. Kemp. Description of a recent series of experiments carried out in England, and of interest because of a number of large power stations which are being erected on canal sites.

The Lero Road power station of the city of Leicester is situated on the banks of a canal, upon which it relies entirely for the cooling of circulating water for the condensers. It has approximately 9500 kw. of plant installed, comprising a turbine and reciprocating machinery supplied from different circulating systems. The inlet and outlet circulating-water ducts are separated by less than 200 yd. but sufficient cooling is available to operate the station satisfactorily.

The tests were carried out primarily to determine in a qualitative sense the conditions assisting the dispersal of heat in the canal, and also to establish, if possible, heat-gradient charts and an approximate dispersal factor which would be of value as a basis in determining the probable performance of proposed new power stations for similar sites. In the tests the following quantities were determined:

The heat quantity entering the canal from various sources.
Temperature of the canal surface in the area affected by the heat currents.
Atmospheric conditions.
Heat carried away through the lock.
Heat stored or released from the bulk of the water quantity affected, due to difference in average temperature before and after the test.
Cooling effect of cold river water entering the system to provide make-up for the water evaporated.

During the test the temperature of water showed a net increase at all points, and in order to gage the quantity of heat thus stored it was decided to measure approximately the total volume of the water in the area affected. To do this soundings were taken at selected sections of the basins, pool and stream.

As the temperature variations in certain portions of the area would be greater than in others, it was decided to divide the total area into zones over which the temperature variations were not large. Then:

$$\left.\begin{array}{l}\text{Total heat stored}\\\text{in the four zones}\end{array}\right\} = \Sigma \left\{\begin{array}{l}\text{Weight of water}\\\text{in each zone}\end{array}\right\} \times \left\{\begin{array}{l}\text{Net rise in}\\\text{temperature}\end{array}\right\}$$

The net rises in temperature between 10 a.m. and 4 p.m. have been obtained from an average of the rises recorded in Fig. 14.

The approximate dispersal factor was determined in the following manner:

Let ρ = dispersal factor of the day in B.t.u. per sq. ft. of water per hour per inch Hg difference in the vapor pressures corresponding to the water-surface temperature and the atmospheric wet-bulb temperature.

Average wet-bulb temperature reading = 49 deg. fahr.
Corresponding vapor pressure (V. P.) = 0.334 in. Hg.

$$\begin{array}{l}\text{Total heat quantity}\\ \quad X \text{ dispersed from}\\ \quad\text{the canal surface}\end{array} = \rho \times \Sigma \left\{\begin{array}{l}\text{(Area of each zone in sq. ft.)} \times\\ \text{(V. P. Hg corresponding to average}\\ \text{surface temperature—V. P. corre-}\\ \text{sponding to atmospheric wet bulb)}\\ \times \text{(Time in hours)}\end{array}\right.$$

$$\begin{aligned}461.8 \times 10^6 &= 31{,}200\,\rho \times (1.04 - 0.334) \times 6 \text{ (Basin A)}\\ &\quad + 23{,}900\,\rho \times (1.15 - 0.334) \times 6 \text{ (Pool)}\\ &\quad + 13{,}000\,\rho \times (0.93 - 0.334) \times 6 \text{ (Basin B)}\\ &\quad + 42{,}400\,\rho \times (0.82 - 0.334) \times 6 \text{ (Upstream zone)}\\ &= (132{,}000 + 117{,}000 + 46{,}500 + 123{,}500)\,\rho\\ &= 419{,}000\,\rho\end{aligned}$$

or

$$\text{Dispersal factor } \rho = \frac{461.8 \times 10^6}{419{,}000} = 1100 \text{ B.t.u. per sq. ft. per hr. per in.}$$

Hg difference in the vapor pressures corresponding to water-surface temperature and atmospheric wet-bulb temperature.

This factor represents the rate of cooling which actually took place during the test period and is therefore applicable only where the atmospheric and geologic conditions are similar. In conjunction, however, with heat-gradient charts its may be useful as a foundation on which to base an estimate of the degree of assistance which may be expected under particular conditions at other canal sites.

The investigation demonstrates strikingly that cooling is effected largely outside the circuit followed by the water between the circulating-water discharge and intake. The distance between these may be relatively small, but the heat will leave the circuit followed by the water and flow for a considerable distance along the canal,

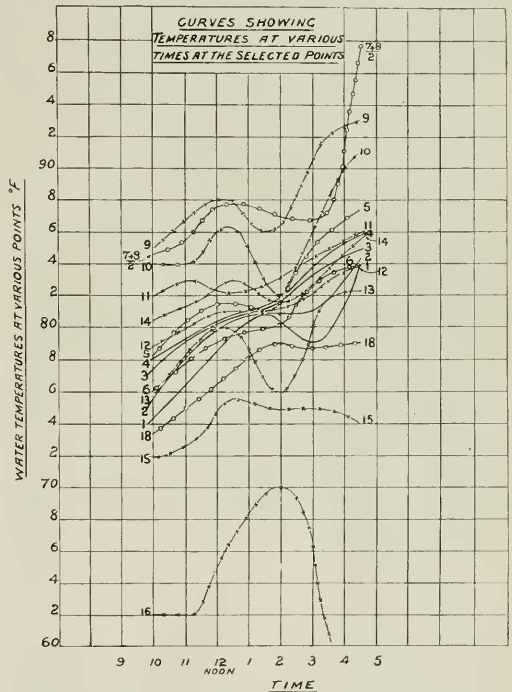

Fig. 14 Curves Showing Temperature at Various Times at Selected Points in the Canal Used as a Source of Condenser Water

thus increasing the cooling zone more or less adequately. In this case the heat actually flowed upstream for nearly a quarter of a mile against a slow current. (*The English Electric Journal*, vol. 1, no. 5, Jan. 1921, pp. 210–222, 8 figs., *ep*)

Proportioning Chimney Heights, Robt. Sibley and C. H. Delany, Members Am.Soc.M.E. The authors propose a method for ascertaining the diameter and height of chimneys in which a table and diagram given in the original article are used. It is claimed that by these means the fundamental dimensions of a chimney to produce a given amount of draft can be determined regardless of the kind of fuel used, provided the quantity of flue gas passing per hour can be approximately estimated.

In its turn the weight of flue gas passing per unit of time is said to depend for practical purposes on the weight of fuel burned and the percentage of excess air used in burning it.

This method is of interest as, in addition to giving the dimensions, it also apparently indicates the various combinations of heights and diameters of stacks to produce a given draft for the particular weight of flue gas considered.

The rule for altitude correction is given, and examples for calculating chimneys at sea level and at altitudes presented. (*Journal of Electricity and Western Industry*, vol. 46, no. 6, Mar. 15, 1921, pp. 299–300, 1 fig. and 1 table, *p*)

POWER PLANTS

Centrifugal Oil Cleaner. Description of a device developed at McCook Field, Dayton, Ohio. It consists of a spun copper bowl 5 in. in diameter and $1^1/_2$ in. high, mounted in a modified Liberty oil pump. It is driven by a steel shaft splined into the lower oil-pump gear of the Liberty-12 oil pump. The speed of this shaft is $1^1/_2$ times the crankshaft speed.

The oil is led from the oil tanks to the inside of the bowl which is rotating at 2550 r.p.m. when the engine is turning at 1700 r.p.m. The oil is set into centrifugal motion and all foreign matter of greater specific gravity than the oil is thrown and held to the inside edge of the bowl. A number of runs were made both with mineral lubricating oil and castor oil. In this latter test cold oil was mixed with fine emery powder, metallic filings and sand, which changed the color of the oil to a dark gray. After being run through the cleaner once the mixture emerged as clear as it was before it was mixed, and all of the emery, metallic particles and sand remained in the bowl.

The next test was made on a Liberty-12 engine run for 10 hr. at 1650 r.p.m. on a testing stand. The oil was not renewed during the run and after it was concluded the oil was emptied and the inside of the bowl carefully examined. It was found to be covered with a gummy deposit, in which a variety of substances were imbedded.

A study of the grit collected from the run reveals a large amount of iron and steel, which must have come from the piston rings and cylinder. There was also a large percentage of a very fine aluminum powder, which must have come from the pistons. A small quantity of bronze powder was observed, also babbitt bearing metal. Small chips resembling those from machining processes were present and also sand varying from very fine powder to small pebbles, and carbon in various forms and sizes. The sand may have come from the core sand that could not be cleaned out of the casting. There were also fine, brown particles that looked like sand but crushed easily and were presumably made up of dust taken in through the breather. The power required by the cleaner at 2250 r.p.m. varies from 1 hp. at 75 deg. fahr. to 0.35 hp. at 190 deg. fahr. (*Oil News*, vol. 9, no. 4, Feb. 20, 1921, pp. 21–22, 2 figs., *d*)

SPECIAL TOOLS

Boreas Cast-Iron Refuse Briquetting Machine. Description of a pneumatic press for briquetting cast-iron refuse.

It is claimed that by converting cast-iron filings and turnings into briquets not only can this material be usefully employed but the quality of the melt can be improved by making possible the introduction of silicon or manganese into castings in definite and concentrated form.

In the manufacture of the briquets cast-iron turnings and slaked lime are used, and the following mixture is quoted: 2 cwt. cast-iron turnings, 5 per cent slaked lime and 5 per cent water. The briquets made from this mass are placed on drying trays, allowed to remain there for some days, after which they are sufficiently hard to be piled for tempering. This latter, which generally takes from two to four weeks, depending on the water, can be done in the open air.

In dry weather it is advisable to water the briquets occasionally. Moisture in combination with the iron and lime gives a chemical reaction which forms a hard shell around the briquet. This is desirable as a final result, because it renders the briquet more suitable for handling, but must be avoided in the beginning as it might prevent the proper hardening of the inside.

If used in the cupola, they can be placed by means of a shovel, first of all filling in raw iron and old iron, thereafter the briquets, and lastly the cinders which act as a buffer to the following layer of raw iron and prevent the briquets from being crushed.

The "Boreas" press is adapted for pneumatic power and also for belt drive. In the first type the machine is a knee-joint press with the cylinder for compressed air suitable for pressure of 6 to 7 atmos. The belt-driven press is also of the knee-joint type but has a spindle instead of the air cylinder. The press makes three strokes per minute at a pulley speed of about 275 r.p.m., the power consumption being about $4^1/_2$ hp. The weight of the apparatus is approximately a ton and a half. (*Foundry Trade Journal*, vol. 23, no. 229, Jan. 6, 1921, p. 20, 1 fig., *d*)

STEAM ENGINEERING (See also Marine Engineering)

Rotary Steam Engines with Michell Thrust Bearings

Michell Crankless Steam Engine. Description of a high-speed engine designed by A. G. M. Michell, inventor of the Michell thrust block, for the purpose of testing whether by the use of these blocks it was practicable to construct crankless internal-combustion or steam engines which would presumably be lighter than engines of conventional type.

In the Michell engine the crank is replaced by a swash plate,

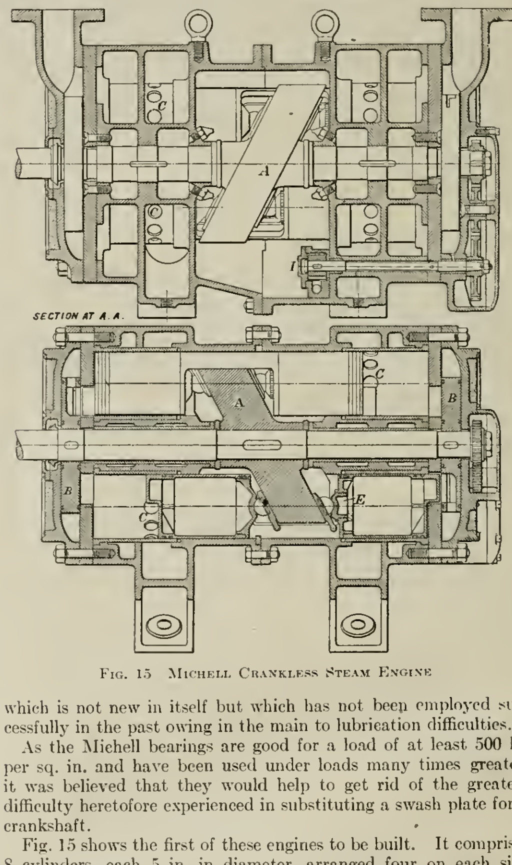

Fig. 15 Michell Crankless Steam Engine

which is not new in itself but which has not been employed successfully in the past owing in the main to lubrication difficulties.

As the Michell bearings are good for a load of at least 500 lb. per sq. in. and have been used under loads many times greater, it was believed that they would help to get rid of the greatest difficulty heretofore experienced in substituting a swash plate for a crankshaft.

Fig. 15 shows the first of these engines to be built. It comprises 8 cylinders, each 5 in. in diameter, arranged four on each side of the swash plate *A*, which is keyed to the driving shaft of the engine, which in its turn carries at each end a rotary valve *B* controlling the admission of steam to the cylinders. The engine works on the uniflow principle, the exhaust being discharged through ports *C*, of which there are eight for each cylinder, each $1^1/_8$ in. in diameter.

The pistons on opposite sides of the swash plate are rigidly connected in pairs to form a single unit, the weight of the unit being adjusted to that of the swash plate so as to secure perfect running balance. (Formula given in the original article.)

The thrust of the pistons is transferred to the swash plate through Michell blocks which are mounted on spherical seats,

and an ample supply of oil is maintained by means of a gear-driven pump.

Provision is made for adjusting the distance between the Michell blocks on opposite sides of the swash plate as at E. To permit this, one of the ball sockets is mounted on a screwed sleeve which can be adjusted by turning it by the notched head.

The engine was designed to run at 1200 r.p.m., but the tests have shown that this limit can be greatly exceeded. In the tests the steam was supplied at a gage pressure of 150 lb. per sq. in. and exhausted to a condenser in which a vacuum of 26 in. was maintained.

The swash plate was held at an angle of $27^1/_2$ deg., but Mr. Michell intends to reduce this in future engines to $22^1/_2$ deg., since the tests showed that the larger angle was unnecessary. The horsepower developed was 0.92 i.hp. per cylinder per 100 r.p.m., and it is believed the engine can be run at speeds up to 1500 revolutions. (*Engineering*, vol. 111, no. 2880, Mar. 11, 1921, pp. 290–291, 5 figs., *dA*)

TEXTILE INDUSTRY (See also Power)

Attention is called to the issue of *The Electrician* (London), vol. 136, no. 2229, February 4, 1921, containing several articles of interest to the textile industries, one of which, on Individual Gear Drive for Heavy Looms, is abstracted on a previous page under the heading Power. The other articles are: Some Considerations in the Application of Electricity to Textile Mills, by J. T. Randles, discussing estimates of power requirements, switch gear, electrification of new mills, balancing of group drives and the advantage of constant speed and steady turning which electric driving gives; Modern Methods of Driving Machines in Jute Manufacture, by T. Wodehouse and P. Kilgour, which discusses among other things the speed problem, methods of driving, carding processes, preparation of the warp and weft, cop winding and the various drives such as dressing-machine, loom and calender drives; and Continental Practice in the Electrical Driving of Textile Factories, by W. Dundas Fox, which is illustrated by numerous curves taken on various machines.

TUBING (See Pipe)

VARIA

Flotation Method of Separating Coal from Slate and Rock

Froth Flotation Applied to the Separation of Coal. Various methods of separating coal from slate and rock have been tried, such as separation by heavy liquids, air separation, etc. At present the most usual system is washing the coal in jigs, but the Mineral Separations Company, which made a big success of the flotation process as applied to the separation of metallic ores, is now trying to employ the same principle for coal.

The new system comprises several separate operations. In the first place the coal has to be ground so that the particles will pass through a screen of $^1/_{10}$ linear inch aperture. It is then mixed with from four to six times its weight of water and the mixture agitated, either by means of a rotary agitator or by an injection of air, while a small quantity of a special reagent is added. The reagent may be an oil or a coal-tar product, and it is stated that some industrial waste products may be so used. Approximately a pound or so of the reagent is required for each ton of material treated.

The agitation in presence of the reagent produces a multitude of minute air bubbles which attach themselves to the coal particles and bring the latter to the surface, while the ash-forming slate sinks to the bottom. The process is of a continuous character, the material circulating through the plant until all the economically recoverable coal has been extracted.

It is claimed that the process is applicable to the removal of dirt and of non-combustible matter from crushed coal destined for coking purposes, the preparation of clean coal for the manufacture of briquets, and the recovery of coal from screenings or old pit heaps.

As regards the plant itself, it appears that the dimensions of one having a capacity of 600 to 1000 tons per 24 hr. are: length, 37.5 ft.; width, 16 ft.; and height, 15.5 ft.

A feature of the flotation system is the facility with which one grade of coal, by means of reagent control, is separated from another grade without screening or classification. Thus a coal comprising pure coal (i. e., no free ash, only fixed ash), bone coal and shale is separable into its component parts, so that the pure coal can be separated and the bone coal left with the shale; the bone coal can be separated from the shale and included with the pure coal, or else separated from the shale for boiler, locomotive, or producer use. Apart from the separation and recovery of the good coal contained in waste and low-grade coal, there are certain special advantages as regards the application of the system to the cleaning of coking coals. Ash reduction reduces cost of handling and permits of a larger efficient charge to the coke oven; richer gas and larger quantities of by-products are yielded, and a harder, denser and sufficiently porous metallurgical coke is obtained.

The following typical separation was effected in the cleaning of a coking coal carrying 10.14 per cent of ash in the raw state:

	Pure Coal	Bone Coal	Shale
Per cent by weight	87.20	2.4	9.5
Ash content, per cent	3.25	19.2	72.1

Obviously the bone coal can be mixed with the high-grade coal if required, but in this particular case it was proposed to make from the pure coal a high-grade coke carrying from 5 to 5.5 per cent of ash and to employ the bone coal for boiler or producer use, rejecting the shale as waste. (*The Iron and Coal Trades Review*, vol. 102, no. 2763, Feb. 11, 1921, p. 197, *g*)

Trial Flights and Acceptance Tests for New Types of Aeroplanes. A. G. H. Fokker. The ideal test pilot is, or should be, the designer of the machine. Unfortunately, this combination is very rare, and the designer has usually to rely on reports of others as to the properties of his machine. Until reliable recording instruments are in our possession, the "personal element" will predominate in the tests and "scientific" pilots are not always available.

The following are the main characteristics which an aeroplane should possess, and on which the test pilot should concentrate his attention:

Getting Off. The machine should possess sufficient directional stability while running along the ground. As soon as the flying speed is reached it should be able to get off without the use of the elevator.

In Flight. There should be no hunting, either in the horizontal or the vertical direction. The changing over from "power-flight altitude" to "gliding-flight altitude" should be automatic and quick. Even at the lowest flying speeds wing-flap controls should be possible. When executing curves there must be no tendency to go into a nose dive or spin. When side-slipping the machine should still be controllable. All rudder organs should be properly balanced.

Landing. Smooth landing depends very much on the type of landing wheels and their position. By proper construction, any tendency to leave the ground again can be checked. (*Het Vliegveld*, Jan. 1, 1921, abstracted through *The Technical Review*, vol. 8, no 11, Mar. 15, 1921, p. 256, *g*)

WASTE UTILIZATION (See Special Tools)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Sir Robert Hadfield Prize

Sir Robert Hadfield has offered through the Institution of Mechanical Engineers of Great Britain a prize for the best design of an apparatus to determine the hardness of materials accurately and suitable for application in metallurgical work for cases in which present methods partially fail. The award or awards will be made by the Council of the Institution. The present funds amount to £154 sterling. A portion of the fund may be awarded for communications which advance the knowledge of the methods of testing hardness. Communications should be accompanied by scale drawings or by models or examples of the apparatus. If the communication is likely to be of commercial value, provisional protection should be obtained before submitting it. Address the Secretary, Institution of Mechanical Engineers, Storey's Gate, St. James Park, Westminster, London, S. W. 1, marked "Method of Determining Hardness." Communications should reach him by December 1, 1921.

Research Associations in Great Britain

The number of British Research Associations under the license of the Board of Trade acting through the Department of Scientific and Industrial Research now totals twenty-three. Sixteen of these associations have already been listed in the issues of Mechanical Engineering for March, August and November, 1920 (pp. 181, 470 and 638). The seven additional associations are:

The British Leather Trades Research Association, 26 Thomas Street, London, S. E.; Secretary, Miss M. A. Stevens.

The British Launderers' Research Association, 62–5 Bank Chambers, 329, High Holborn, London, W. C. 2; Secretary, J. J. Stark.

The British Electrical and Allied Industries Research Association, 19 Torhill St., Westminster, London, S. W. 1; Director of Research, E. B. Wedmore.

The British Silk Research Association, The Silk Association of Great Britain and Ireland, Inc., Kingsway House, London, W. C.; Secretary, A. B. Ball.

The British Motor and Cycle Car Research Association, "The Towers," Warwick Road, Coventry; General Manager, H. R. Watling.

The British Cutlery Research Association, P. O. Box 49, Sheffield; Secretary J. M. Denton.

The British Music Industries Research Association, Northern Polytechnic Institute, Holloway, London, N. 7; Director of Research, Dr. R. S. Clay.

The British Jute Industry Research Association and the British Cast Iron Research Association have been approved by the Department of Scientific and Industrial Research, but as yet have not been licensed by the Board of Trade.

The British Aircraft Association and the British Association for Liquid Fuels for Oil Engines have proposed their memoranda and articles of association. Certain other associations are engaged in preliminary considerations.

The International Research Council at Brussels has started an inquiry regarding the possibility of an international auxiliary language for the purpose of reporting scientific matters.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

Apparatus and Instruments A3-21. Resistance Thermometers. The experience of the Bureau of Standards in the construction of resistance thermometers and a description of the resistance thermometers in use have recently been published as a scientific paper. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Apparatus and Instruments A4-21. Sampling Tubes for Steam. Tests to indicate the best position of sampling tubes have been made at West Virginia University by Carl H. Cather and H. S. Dilcher. To determine the true value of the quality of the steam for which different calorimeters had been used in connection with various forms of sampling tubes, the entire steam remaining in the pipe from which the samples were taken was allowed to discharge through a 1/4-in. orifice into a 5-in. drum 15 in. long. The temperature of this steam after the throttling action had taken place was determined by a resistance thermometer placed in the drum. The average pressure of the steam at the top and bottom of the drum was also determined. By assuming that the quality of the steam determined by this device, which was called a standard calorimeter, was correct, the errors of the various calorimeters could be found. The results show that in many cases an error of almost 2 per cent can be obtained. From certain sampling tubes errors of both positive and negative value were determined. The results indicate that the best form of sampling tube is one in which the holes are drilled in straight lines and the holes are 1/8 in. in diameter. The results are more uniform and have a smaller value when used in a descending current of steam. Small holes 1/16 in. in diameter are not as good as holes of larger size. Address Prof. John B. Grumbein, West Virginia University, Morgantown, W. Va.

Cellulose and Paper A1-21. Testing of Paper. Circular No. 107 of the Bureau of Standards is devoted to paper testing. It may be obtained from the Superintendent of Documents at 10 cents per copy. It describes the method of testing paper and the apparatus used for routine work. Instructions are given for making tests of various kinds for the quantitative determination of ash, sizing and rosin, as well as qualitative tests for the kinds of loading and the various sizing materials. A bibliography is also included giving useful books, periodicals and Government publications on the subject. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A5-21. Concrete Mixer. A research performed at the Experiment Station of Purdue University on the best conditions for operating concrete mixers in regard to water control and speed. The report includes the strength and consistency of concrete, the time records for various operations, and the measurement of electrical power input. The report is published in the February 1921 issue of the American Concrete Institute. Address A. A. Potter, Director, Engineering Experiment Station, Purdue University, Lafayette, Ind.

Fuels, Gas, Tar and Coke A5-21. Fuel Research. Technical Paper No. 1 on the Assay of Coal for Carbonization Purposes: A New Laboratory Method, by Thomas Gray and James D. King, has been prepared by the Fuel Research Board. This describes the development of a method of coal assay from which the yield can be quickly and accurately determined. Experimental results of the paper explain how the method supplies this information. Price by post, 7d. Address Imperial House, Kingsway, London, W.C. 2.

Heat A7-21. Heat Transmission. The following papers by Dr. T. S. Taylor deal with work done by the Research Department of the Westinghouse Electric and Manufacturing Company in connection with the study of heat transfer:

A Hot-Wire Anemometer with Thermocouple, Am. Inst. Min. & Met. Engrs., Chicago Meeting, September, 1919.

Thermal Conductivities of Various Insulating and Other Materials. Am. Soc. M. E., New York Meeting, Dec. 2–5, 1919.

The Thermal Conductivity of Coil Wrappers. *Electrical World*, vol. 75, no. 7, Feb. 15, 1920, p. 369.

The Dissipation of Heat by Various Surfaces in Still and Moving Air. Am. Soc. M. E., St. Louis Meeting, May 24–27, 1920.

The Relative Conductor Temperature of Square and Round Insulated Cables, *Electrical World*, March 1920.

The Flow of Air through Small Brass Tubes. Am. Soc. M. E., St. Louis Meeting, May 24–27, 1920.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Air B1-21. Ventilation. Tests to determine the amount of air moved under various conditions. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

Air B2-21. Windmills. A new type of cam mechanism for use on windmills. University of Texas, Austin, Texas. Address Prof. Hal C. Weaver.

Apparatus and Instruments B2-21. DYNAMOMETERS. An investigation to develop a method of measuring power by electric means to eliminate the use and construction of expensive dynamometers. Brown University, Mechanical Engineering Department, Providence, R. I. Address Prof. W. H. Kenerson.

Apparatus and Instruments B3-21. FLUID METER. An investigation to develop an automatic liquid volumetric meter. Address Prof. Charles S. Brown, Vanderbilt University, Nashville, Tenn.

Electric Power B3-21. TRANSMISSION LINES. Trunk transmission lines is the subject of a bulletin in preparation by C. E. Magnusson, of the Engineering Experiment Station, University of Washington, Seattle, Wash.

Heat B1-21. HEAT TRANSFER. The Engineering Experiment Station at Pennsylvania State College has been working on the total transmission and conductivity of building materials. In their small "cubical" test box they have recently made special tests on the effect of flowing water on the transmission through concrete and brick. They have recently installed a new testing plate with blanks 2 ft. square over the measured surface. Special attention has been given to the measurement of temperature by thermocouples at various points on the plate and guard ring. Address Engineering Experiment Station, State College, Pa. R. L. Sackett, Dean.

Heat B2-21. HEAT TRANSMISSION. Bulletin 30 of the Engineering Experiment Station of Penna. State College on Heat Transmission through Cork Board and Air Space, by Arthur J. Wood and E. F. Brundhoefer, has been recently issued. The bulletin contains 38 pages of text and a large number of tables, curves and results, with a bibliography of 268 titles on heat transmission. The complete bulletin covers 139 pages. The tests show that conduction and transmission increase in a straight line with increase in temperature difference. The most reliable conductivity for Nonpareil cork board was 8.4 B.t.u. per sq. ft. per 24 hr. for 1 in. of thickness at 90 deg. fahr. difference in temperature. It was also found that the thickness of air spaces affected their insulating value. The experiments showed that the resistance due to multiple air spaces is not proportional to the number of air spaces. Address Prof. A. J. Wood, Pennsylvania State College, State College, Pa.

Heat B3-21. HEAT TRANSMISSION. Investigation relating to the heat transmission through a fiber insulating material known in the trade as "lith" and used in buildings as a heat insulator. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

Heat B4-21. HEAT TRANSFER. An investigation to determine the heat-transfer coefficient through various refractory materials. This necessitated the development of a method of measuring temperature for various phases of the steel industry. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

Heat B5-21. STEAM RADIATORS. Experiments covering 400 tests on different kinds of radiators and under different conditions have been made at Mason Laboratory, Sheffield Scientific School, Yale University. In connection with these tests the laboratory is coöperating with the Research Bureau of the American Society of Heating and Ventilating Engineers to find a standard method for testing radiators. Address Prof. E. H. Lockwood, Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn.

Heat B6-21. HEAT. Radiation and Convection from Radiators. An investigation to separate the heat transmitted from steam radiators by radiation and by convection is contemplated at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Heat B7-21. DISSIPATION OF HEAT. Dissipation of heat from wires and surfaces of various kinds, including the separation of the parts due to radiation and convection. The dissipation of heat from coils placed in parallel and in series and the effect of spacing. Research Department, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. Address C. E. Skinner, Manager.

Heat B8-21. HEAT TRANSMISSION. The Westinghouse Electric and Manufacturing Company is studying the subject of heat transmission through insulating materials and heat dissipation, which are important in the general study of the ventilation of electrical machines. Although much work has been done and reported (see *Heat A7-21*), much yet remains and the Research Department of the company is studying this question very minutely, giving special attention to the deteriorating effect on insulation. A number of papers have been published by Dr. T. S. Taylor, and a recent paper by Mr. Fetchheimer in the March *Journal A.I.E.E.* is based on the work carried out in the laboratory. Research Department, Westinghouse Electric and Manufacturing Company. Address C. E. Skinner, Manager.

Heat B9-21. PIPE COVERINGS. A bulletin giving the results of exhaustive tests on efficiencies of various kinds and combinations of commercial pipe covering is in preparation by the Engineering Experiment Station, State College of Washington. The tests are being made with equipment built especially for the purpose by which temperatures may be held constant 1/150 deg. by utilizing the expansive quality of hot oil with which the testing machine is filled. The oil-filled space constitutes the bulb of a large thermometer, the stem of which is a glass tube 1/8 in. in diameter.

Temperature measurement is made by a new White potentiometer built for thermocouple work. A study has been made of new methods of applying commercial pipe covering to secure greatest economic efficiency. This promises to be of considerable value.

Curve sheets are being prepared showing relations between temperature, thickness, yearly cost and savings for different kinds and combinations in commercial coverings. Address Dean H. V. Carpenter, Pullman, Wash.

Heat B10-21. HEAT TRANSFER TO OIL. A study is being made of the transfer of heat from steam to oil through steel pipes. The study is made to determine the heat transfer in warming pipes placed in oil tanks. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Heat B11-21. HEAT TRANSFER THROUGH GLASS. A determination of the constant of heat transmission for glass is being investigated at the Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Heat B12-21. THE JOULE-THOMSON EFFECT IN SUPERHEATED STEAM. The Joule-Thomson effect in superheated steam is being investigated by a candidate for a doctor's degree at Harvard University. The method used is that developed by Trueblood at Harvard some years ago. It is hoped to cover a temperature range to about 600 deg. fahr. and a pressure range up to that corresponding to the saturation pressure of about 600 deg. fahr. Address Prof. Harvey N. Davis, Harvard University, Cambridge, Mass.

Heat B13-21. CRYOGENIC ENGINEERING. The research group in cryogenic engineering at the Harvard Engineering School are working on problems connected with the liquefaction of air for commercial application of fractionating this liquid to obtain pure nitrogen for fixation and pure oxygen for welding and cutting, with the commercial production of helium from natural gas, and the separation of hydrogen from water gas for commercial purposes. Theoretically the oxygen from 1000 cu. ft. of air should be separated by a power consumption of 3 hp-hr. It actually takes from 50 to 75 hp-hr. Work is being done to improve the output. An endeavor is being made to support a non-competitive research by the three larger companies building apparatus for producing liquefied gases. The Research Corporation of New York endowed by Dr. Cottrell has granted certain funds for the prosecution of research work in cryogenic engineering at Harvard. Those doing this work have devised, constructed and perfected apparatus for measuring latent heats at atmospheric pressure and are just finishing this investigation for pure oxygen at the end of the range. The same is true for apparatus for handling coexisting phases up to pressures of 300 to 400 lb. per sq. in., and this apparatus should by this time be in operation on nitrogen-methane mixtures used in the helium problem.

An air-flow meter which will give reliable results at pressures as high as 3000 lb. per sq. in. is now being used. Heat-transfer coefficients and friction heads for high temperatures, low temperatures and high velocities will be determined by this investigation. A tentative temperature-entropy and Mollier chart of air is being prepared. Address Prof. Harvey N. Davis, Harvard University, Cambridge, Mass.

Hydraulics B1-21. FLOW OF AIR. A study of the pulsating flow of air is being made for the Flow Meter Committee of the A.S.M.E. by Prof. Horace Judd and Mr. Bucher. Ohio State University, Columbus, Ohio. Address Prof. W. T. Magruder.

Hydraulics B2-21. DRAFT TUBES. A study of the distribution of velocity across draft tubes at different angles and the continuity of flow. Rensselaer Polytechnic Institute, Troy, N. Y. Address Professor Arthur M. Greene, Jr.

Internal-Combustion Motors B1-21. NEW CYCLE. The performance of an internal-combustion engine operating on new cycle. Yale University, New Haven, Conn. Address Prof. E. H. Lockwood.

Internal-Combustion Motors B2-21. SOLID-INJECTION OIL ENGINE. The development of a solid-injection fuel-oil engine to determine a correct valve gear and the methods of feeding fuel oil directly into cylinder. An investigation on materials suitable for high-pressure work. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

Lubrication B1-21. OIL GROOVES IN BEARINGS. A test to determine the effect of oil grooves in bearings under various conditions of load, size of shaft and other details. Carnegie Institute of Technology, Pittsburgh, Pa. Address David C. Saylor.

Machine Design B1-21. FILLETS. An investigation to discover the strength of fillets. Mechanical Engineering Department, Ohio State University, Columbus, Ohio. Address Prof. W. T. Magruder.

Metallurgy and Metallography B6-21. PHOSPHORUS AND SULPHUR IN STEEL. The Joint Committee on investigation of phosphorus and sulphur in steel has recently made a third statement regarding its work. The Committee on Statistics has supplemented its bibliography on this subject, which is available on application to H. L. Whittemore, Bureau of Standards, Washington, D. C. This committee is anxious to obtain samples of material which have been used under commercial conditions and have given good service or failed in service with ordinary and high sulphur and phosphorus contents. The Committee on Manufacture is making two series of tests: one series covering six grades of material of varying phosphorus and sulphur content, and one series in which the sulphur is added in the later stages of manufacture. Dr. G. K. Burgess is Chairman of this Committee.

The Committee on Tests under the chairmanship of Dr. F. C. Langenberger is making excellent progress on testing rivet bars.

Independent tests are being made at the Watertown Arsenal and the U. S. Experiment Station at Annapolis, as well as at the Bureau of Standards. A committee on Service Tests is being appointed. Address C. L. Warwick, Sec.-Treas., A.S.T.M., 1315 Spruce St., Philadelphia, Pa.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession

of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

The Barrett Company D1-21. The Barrett Company has a research laboratory at their Shadyside plant at Edgewater, N. J. This plant is equipped for the physical study of coal tar and for making synthetic chemical investigations. A description of the laboratories and the new laboratory building was given in *Chemical and Metallurgical Engineering* for Jan. 26, 1921. The company is at work on various organic problems and at present the research laboratory has a possible total floor space of 5400 sq. ft. accomodating more than 210 chemists, in addition to those at some of their other plants. Each laboratory in which inflammable organic material is used is provided with two exits and shower bath heads are placed in each laboratory room. Extinguishers are found in each room as well as sand pails and fire hose. The laboratory is also provided to care for large-scale work.

The laboratory is under the charge of a chief chemist and assistant chief chemist and the work is divided into ten divisions, among which are the tar and oil division, organic, research, experimental, plant, engineering and clerical. The Barrett Company, Edgewater, N. J. Address C. R. Downs, Chief Chemist.

Cutler-Hammer Manufacturing Company D1-21. The Research Department of the Cutler-Hammer Mfg. Co. is equipped with the usual apparatus for studying the discharge of electricity through gases and machinery of various descriptions and for testing the functioning of controlling apparatus. A supply of direct and alternating current of various voltages and frequencies, a supply of air and gas under pressure and a complete equipment of vacuum pumps, gages and electrical measuring instruments are found in the laboratory. The laboratory is equipped with primary standards for testing all measuring apparatus, and also with a glass-blowing shop and a machine shop for the construction of apparatus. The laboratory investigates physical phenomena relating to the development of electrical controlling apparatus and electrical phenomena in connection with their manufactured products. Cutler-Hammer Manufacturing Company, Milwaukee, Wis. Address Arthur Simon, Engineering Department.

E—Research Personal Notes

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

New York University E1-21. The Department of Mechanical Engineering of New York University is to coöperate in the investigations of the American Society of Heating and Ventilating Engineers. Its laboratory will investigate the question of pipe sizes for steam-carrying capacity and is also planning to do research work on economizers. Address Collins P. Bliss, Professor of Mechanical Engineering, New York University, University Heights, N. Y.

State College of Washington E1-21. The Engineering Experiment Station Staff of the State College of Washington at Pullman, Wash., includes Dean H. V. Carpenter as director and fifteen members of the faculty of the College of Engineering, of which one is giving his full time to research.

University of Utah E1-21. The Legislature of Utah has appropriated $25,000 for use in metallurgical research in the School of Mines and Engineering, University of Utah. This appropriation covers the expense of research during the last two years. Address J. F. Merrill, Director.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file at the offices of the Society.

Chemistry, Analytical F1-21. Water Softening. A bibliography of 13 pages, Search 3305. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Fuels, Gas, Tar and Coke F1-21. Petroleum. History and Properties of Petroleum Fuels. A bibliography of 8 pages. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Heat F1-21. Heat Transmission. A bibliography of 268 titles on heat transmission, prepared by Arthur J. Wood and E. J. Brundhoefer of Pennsylvania State College. Address Prof. A. J. Wood, State College Pa.

Metallurgy and Metallography F1-21. Phosphorus and Sulphur in Steel. A bibliography on the action of phosphorus and sulphur in steel has been prepared by the Sub-Committee on Statistics of a Joint Committee investigating this subject. Address H. L. Whittemore, Bureau of Standards, Washington, D. C.

Steam Power F1-21. Superheated Steam on Fittings. Effect of Superheated Steam on Steam Pipe and Fittings. A bibliography of 2 pages. Search 3302. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

THE INTERPRETATION OF BOILER-WATER ANALYSES

(Continued from page 320)

5 Determine by titration—
- *a* Acidity or
- *b* Alkalinity to phenolphthalein
- *c* Alkalinity to methyl orange.

6 Calculate from (5)—
- *a* Acidity as minus CO_3
- *b* Alkalinity as plus CO_3
- *c* Causticity as (OH).

7 Analyze and calculate—
- *a* Suspended matter
- *b* Total dissolved solids
- *c* Loss by ignition (indicate qualitatively if there is any blackening of the residue during heating)
- *d* Inorganic dissolved solids
- *e* Calcium
- *f* Magnesium
- *g* Aluminum
- *h* Iron and manganese as iron
- *i* Silica
- *j* Sulphates
- *k* Chlorides
- *l* Nitrates (nitrometer)
- *m* Ammonium (free)
- *n* Bicarbonates (HCO_3)
- *o* Carbonates (CO_3)
- *p* Hydroxides (OH)
- *q* Calculated inorganic dissolved solids [sum of (7-*e*) to (7-*p*), inclusive].

8 When hypothetical combinations are required, calculate as follows and make out a careful balance sheet:
- *a* Iron, magnesium and aluminum as sulphates
- *b* Calcium as carbonate
- *c* Any remaining calcium as sulphate
- *d* Any remaining calcium as nitrate
- *e* Any remaining calcium as chloride
- *f* If any carbonate remains, calculate as much of the available magnesium to carbonate as possible
- *g* Any remaining magnesium to sulphate
- *h* Any remaining magnesium to nitrate
- *i* Any remaining magnesium to chloride
- *j* Any remaining anions to corresponding sodium compounds, the value for sodium being assumed
- *k* Express silica as such.

9 Apply to (7) and (8) the following criteria:

a If the silica exceeds 5 parts per million (p.p.m.) and the causticity 30 p.p.m., report as industrial pollution and discontinue. If silica exceeds 5 p.p.m. and the causticity is low, report as having passed through sanitary filtration for verification.

b If the calculated inorganic dissolved solids (7-*q*) are less than 60 p.p.m. or acidity is indicated under (5-*a*), determine acidity or alkalinity by an electrometric titration and report as (9-*b*).

c If the calculated inorganic dissolved solids (7-*q*) lies between the limits 60–300 and the sum of (8-*b*), (8-*c*), and (8-*k*) is less than 60 per cent of this total, or if (7-*k*) exceeds 25 p.p.m. or (7-*l*) exceeds 10 p.p.m., determine a real value of sodium-potassium and report as sodium under (9-*c*).

d If the calculated inorganic dissolved solids (7-*q*) exceed 300 p.p.m., discontinue.

e If the sum of the calculated inorganic dissolved solids (7-*q*) is less than 60 p.p.m., apply the sanitary analysis which follows.

10 Determine—
- *a* Oxygen consumed by permanganate on two samples within the temperature range 60–80 deg. fahr., one at the end of 15 minutes, one at the end of 3 hours.
- *b* Nitrites (qualitatively)
- *c* Nitrates [transfer (7-*l*)]
- *d* Free ammonia
- *e* Albuminoid ammonia
- *f* Kjeldahl nitrogen.

11 Interpret the limits as follows:
- *a* Oxygen consumed: High = 4 p.p.m.; low = 0.6 p.p.m.
- *b* Nitrites (qualitatively): High, distinct, faint, very faint trace, none
- *c* Free ammonia: High, 1 p.p.m.; low, 0.1 p.p.m.
- *d* Albuminoid ammonia: High, 0.2 p.p.m.; low, 0.02 p.p.m.
- *e* Nitrates: High, 10 p.p.m.
- *f* Chlorides: High, 25 p.p.m.

12 Apply the limits of (11):

	Free Ammonia	Albuminoid	Chlorine	Inference
a	High	Moderate	Low	Sewer gas
b	High	High	High	Sewage
c	High	Low	High	Human pollution
d	Moderate	Low	Very low	Vegetable matter

e High oxygen consumed, particularly in the presence of low acidity, is confirmatory of sewage.

f If the albuminoid nitrogen is approximately one-half the Kjeldahl nitrogen, it is confirmatory of high organic purity. If it is appreciably greater than one-half, it indicates pollution.

A.S.M.E. Locomotive Boiler Code Adopted by Council

An important step in engineering standardization was taken March 23 at the Boston meeting of the Council of The American Society of Mechanical Engineers, when it adopted in its final form that portion of the A.S.M.E. Boiler Code known as the Locomotive Boiler Code. This Code is a noteworthy contribution to the cause of the engineering profession by the eminent engineers who made up the committee. The work of preparation has been long, and the designers and users of locomotive boilers as well as the general public should be sincerely grateful for the Committee's whole-hearted devotion to this work with the consequent heavy sacrifice in time and money.

The necessity for such an addition to the Boiler Code arose from the fact that, while the boilers of locomotives operated on railways engaged in interstate service are covered by the construction and inspection rules of the Interstate Commerce Commission, there was found to be a vast mileage of industrial and short-line railroads in operation in the various states which, by virtue of their location, are not subject to the Interstate requirements. As a result of calls for a Code to cover the construction of boilers of this class, the Sub-Committee on Railway Locomotive Boilers was appointed in 1916. This Committee consisted of F. H. Clark, Chairman, F. J. Cole, A. L. Humphrey, S. F. Jeter, Wm. F. Kiesel, Jr., and H. H. Vaughan. The work of this Sub-Committee was interrupted somewhat by the war, but its preliminary report was submitted to the Boiler Code Committee in April 1919. A month later it was printed and distributed at the Spring Meeting in Detroit, and accepted at the business meeting of the Society. It was thereupon published in the August issue of Mechanical Engineering. The Sub-Committee has been coördinating the points of view of all who would be affected by such a code and the final result approved by the Main Committee and the Council is now ready for use. H. V. Wille and Kenneth Ruchton of the Baldwin Locomotive Works were brought into the Committee, and with F. J. Cole and James Partington, appointed in place of A. L. Humphrey resigned, represented the locomotive manufacturers. Constructive assistance was given by the mechanical division of the American Railway Association through its representatives A. W. Gibbs, mechanical engineer of the Pennsylvania Railroad, W. I. Cantley of the Lehigh Valley Railroad, and N. A. Ferrier of the New York Central Railroad. A. G. Pack, chief mechanical engineer of the Interstate Commerce Commission at Washington, has expressed great interest in the Code, and with his staff of engineers has been in frequent attendance at meetings of the Sub-Committee.

During the past two years Mr. Clark, the original chairman of the Committee, has been in China as technical adviser to the Ministry of Communications at Pekin, and Mr. Vaughan has carried on the work of the Committee as acting chairman.

The new Code deals with the chemical and physical properties of materials of locomotive practice and includes the necessary formulas and methods of construction in detailed specification form for manufacturing safe boilers. Attention is given to the desire of the locomotive builders to maintain the lowest possible weight consistent with strength. As compared with stationary boilers with a safety factor of five, the allowable factor for locomotive shells is four. Requirements in the use of safety valves and their method of test are rigid, as are the hydrostatic tests specified.

The new Code becomes Part I, Section III, of the A.S.M.E. Boiler Code.

Boilers constructed in compliance with the Code may be stamped with the official A.S.M.E. Boiler Code stamp, which is obtainable at the headquarters of the Society.

The stamp will be applied to the dome of the boiler and will be accompanied by name of state, manufacturer's state standard number, name of manufacturer, state's number, year put in service, working pressure when built.

Address all inquiries on this Code to C. W. Obert, Secretary of the Committee, 29 West 39th St., New York, N. Y.

Boiler Code Interpretations

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 324, 328, 329 (reopened), and 331 to 341 inclusive, as formulated at the meeting of February 3, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 324

Inquiry: In the formation of the header element of a water-tube boiler to operate at 500 lb. pressure, with a tubular header 2 in. O. D., is it necessary that the ligaments between tube openings, where $1^1/_8$-in. cross-tubes are inserted on $1^1/_2$-in. pitch, shall be designed under the requirements of Par. 192?

Reply: It is the opinion of the Committee that while the strength of the construction may be calculated by the ordinary formula for cylinders, there are elements in the particular design which may result in the ability to carry higher pressures than would be allowed by the ordinary formula. The Committee therefore recommends that a test be made as provided for in Par. 247 of the Code. It further recommends that in making the test the pressure that will cause the material to be stressed to the yield point, be determined.

Case No. 328

Inquiry: Is it necessary, in the manufacture of boiler and superheater headers of open-hearth steel pipe, that the tensile strength be calculated on the basis of 55,000 lb., or is steel of lower tensile strength allowable in material of this form as permitted under Par. 28*c* of the Boiler Plate Steel Specifications?

Reply: If the material in the header conforms to a steel specification other than the steel-plate specification and shows a lower tensile strength than 55,000 lb. per sq. in., it is the opinion of the Committee that it is permissible to calculate the header design on the basis of this lower value the same as is permitted for steel-plate material as indicated in Par. 28*c*. See also Case No. 218.

Case No. 329 (Reopened)

Inquiry: What tensile strength shall be used for the calculation of the maximum allowable working pressure of pressure parts formed of steel castings of Class B grade or of seamless steel tubing material?

Reply: It is the opinion of the Committee that the tensile strength used in the calculation of pressure parts formed of steel castings of Class B grade or of seamless steel tubing shall be the minimum tensile strength determined from tests made on the test specimens located and taken as given in Par. 88 of the Code. While the Code contains no specific statement as to the tensile strength of the material used in seamless tubing, it is the opinion of the Committee that 50,000 lb. could be used as a basis for calculating the safe working pressure.

Case No. 331

Inquiry: Is it permissible, under Par. 311*a* of the Boiler Code, to use in the blow-off connection a valve and a cock formed in a single body casting, instead of two separate valves or a valve and a cock as specified in that paragraph?

Reply: It is the opinion of the Committee that the use of two valves, or a valve and a cock, combined in one body, does not meet the requirements of Par. 311*a* of the Boiler Code.

Case No. 332

Inquiry: Is it permissible under the requirements of the Boiler Code to attach a nozzle outlet to a pipe header manifold by inserting the nozzle through a hole in the header and peening the edges over inside the header, as shown in Fig. 10, the nozzle being autogenously welded to the header on the outside for steam-tightness?

Reply: It is the opinion of the Committee that this construction will not meet the requirements of Par. 186, as peening over of the inserted edges of the nozzle will not afford greater strength to withstand the steam pressure on the cross-sectional area of the nozzle than flaring as specified in Case No. 235.

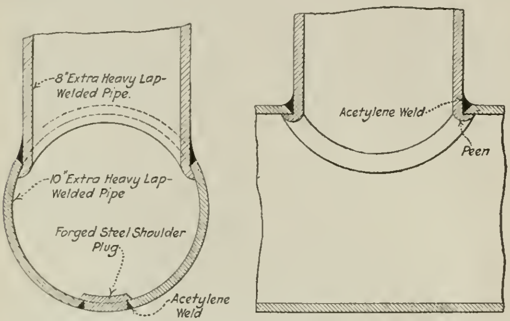

Fig. 10 Proposed Construction of Outlet Nozzle for Pipe Header with Inserted Edges of Nozzle Peened Over

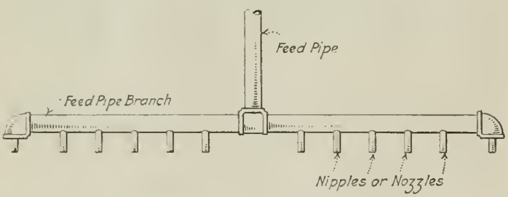

Fig. 13 Proposed Form of Internal Feed Pipe with Short Nipples for Outlets

Case No. 333

Inquiry: (*a*) Where a steam nozzle or safety-valve nozzle is placed upon a boiler drum in which the shell is made thicker than that required for giving a factor of safety of 5, do the requirements of Pars. 260 and 261 apply, which specify that the strength of the reinforcing ring shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and the rivet holes for the reinforcement, and that the strength of the rivets in shear on each side of the reinforcement shall equal the tensile strength of the maximum amount of the shell plate removed by the opening?

(*b*) Does Par. 325 respecting allowable shearing and crushing stress on rivets used for attaching lugs or brackets apply to other than h.r.t. boilers for constructions where the weight is more evenly divided between the lugs than in the case of h.r.t. boilers?

Reply: (*a*) The requirements in Pars. 260 and 261 are based on the use of a shell having a thickness corresponding to a factor of safety of 5 at the seams, or weakest part of the shell. Where the thickness of the shell is greater than necessary to give a factor of safety of 5, the openings through the shell, to meet the requirements of Pars. 260 and 261, need not be reinforced to any greater amount than that required for such a shell.

Aside from the requirements in Pars. 260 and 261, the flange of the nozzle should be made substantial enough to withstand cross-strains to which it may be subjected through expansive strains of the piping, etc.

(*b*) Par. 325 applies to all types of boilers irrespective of the number of lugs employed.

Case No. 334

Inquiry: Is it permissible, under the requirements of Par. 332, to apply the A.S.M.E. Code boiler stamp to a boiler whose construction cannot be completed in the shop so as to subject the drum or any of its parts to hydrostatic test? Such a test would only be practical after the boiler has been erected in the field.

Reply: It is the opinion of the Committee that those boilers which cannot be completed and hydrostatically tested in the shop may have the stamping applied before shipment, final certification to be made after hydrostatic test is made in the field.

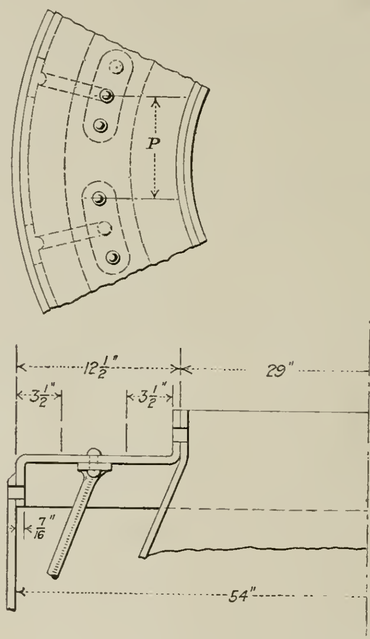

Fig. 14 Bracing of Top Head of Vertical Submerged-Tube Boiler

Case No. 335

(In the hands of the Committee)

Case No. 336

Inquiry: An interpretation is requested of the term: "or other opening," in Pars. 260 and 261 of the Boiler Code. Does it apply to openings cut for steel nozzles and boiler flanges?

Reply: It is the opinion of the Committee that the term, "or other opening," applies to openings cut for steel nozzles and boiler flanges, over 3-in. pipe sizes. (See last sentence of Par. 268)

Case No. 337

(In the hands of the Committee)

Case No. 338

Inquiry: Is it necessary in the construction of a 54-in. drum of a vertical water-tube boiler, which is formed of $1^3/_{16}$-in. plate with $3^1/_{32}$-in. tube holes, giving a ligament efficiency of 47.3 per cent, to use a butt strap $^7/_8$ in. thick as indicated in Table 1 of the Boiler Code? It is evident that the shell above the ligaments is much stronger than necessary for the desired working pressure

of 225 lb. per sq. in., and that $^{23}/_{32}$ in. thickness of shell is all that is necessary outside of the ligaments.

Reply: It is the opinion of the Committee that in the design of a joint for such a drum where the shell thickness is purposely made thicker than necessary for the working pressure in order to increase the ligament efficiency, the butt straps and riveting need not be proportioned for a greater strength than that necessary to carry the working pressure for which the drum is designed.

Case No. 339

Inquiry: Will an internal feed pipe formed of a main feed pipe with numerous small short nipples tapped into one side and with elbows at either end bushed down to similar small nipples, as shown in Fig. 13, meet the requirement of Par. 314 of the Boiler Code? This arrangement is made to force a certain amount of water to flow through the nipples instead of all through two nozzles.

Reply: It is the opinion of the Committee that the construction proposed does not meet the intent of this requirement, which specifies open ends of the pipe in order that incrustation may not under any circumstances cause stoppage.

Case No. 340

Inquiry: Is it permissible under the requirements of the Boiler Code to construct a 66-in. h.r.t. boiler for hot-water heating, to operate at pressures exceeding 50 lb., in which (*a*) handholes only are provided for cleaning and inspection, or (*b*) with manhole below the tubes only and tubes filling the entire upper space of the shell, there being no steam space required?

Reply: In the opinion of the Committee, this Case is fully covered by Par. 264, and the construction would be in accordance with the Code if sufficient provision was made for adequate inspection.

Case No. 341

Inquiry: What is necessary to determine the pitch of the braces to stay an annulus in the top head of a vertical submerged-tube boiler shown in Fig. 14 in which the annular space is $5^1/_2$ in. wide by 36 in. in inside diameter, and the boiler is to be operated at 100 lb. per sq. in.?

Reply: There is no specific rule in the Code applying to such construction. Par. 203*a* indicates the permissible coefficient *C* for the formula in Par. 199, from which the maximum distance between centers of rivets should be determined. Table 5 gives the permissible stress for braces which, in conjunction with the total pressure on the annulus (making proper allowance for angularity of the braces), designates the total brace area necessary. See also Case No. 308.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Largest Storage Reservoirs of the Western Hemisphere

To the Editor:

In the March issue of Mechanical Engineering, Robert Sibley, in a discussion of Recent Hydraulic Development on the Pacific Coast, stated that the storage reservoir of the Elephant Butte Dam in New Mexico is the largest in the western hemisphere, having a capacity of 2,600,000 acre-feet.

Perhaps Mr. Sibley by a slip of the pen wrote "western hemisphere" instead of "the United States of North America."

The Gatun Dam reservoir holds 4,201,000 acre-feet and the Gouin Dam reservoir at La Contre on the St. Maurice River, P. Q., Canada, 3,673,000 acre-feet. Thus their respective capacities are 62 and 41 per cent greater than that of Elephant Butte Dam reservoir. C. H. Ellacott.

Tampico, Mexico.

Calibration of Nozzles for the Measurement of Air Flowing into a Vacuum

To the Editor:

On further investigation of Mr. DeBaufre's paper, I have found that the apparent extreme accuracy of the discharge coefficient to which I called attention in my communication published in the April issue of Mechanical Engineering, was due to the fact that the experimental values were faired up before the table was compiled, and that the great variation from the average of the flow efficiencies given in column 6 of Table 2 actually represented the experimental results, even when the more usual coefficient of discharge was worked out.

I would therefore withdraw my previous remarks and at the same time call attention to the unsuitability of the shaped nozzle, such as was used in these experiments, for standard work. In this set of experiments, which were obviously carried out with great care, and for which the nozzles were obviously made as nearly geometrically similar as possible, the experimental discharge coefficient or flow efficiency varies by about $1^1/_2$ per cent. In my own work I always use geometrically similar square-edged orifices for standard measurements, as these are easy to reproduce with accuracy.

I find that such orifices can be reproduced so as to give coefficients of discharge that agree within $^1/_2$ per cent, and that calibration of a small orifice, say, one inch in diameter, can be applied with accuracy (i.e., to within plus or minus $^1/_2$ per cent) to orifices in the neighborhood of 30 in. in diameter.

My own tests on shaped nozzles fully bear out Mr. DeBaufre's results. It is impossible to predict the coefficient of discharge of such a nozzle within 2 or 3 per cent. John Hodgson.

Luton, England.

A New Hydraulic Turbine

To the Editor:

A new hydraulic turbine, the invention of Professor Banki of the Polytechnicum in Budapest, has recently attracted considerable attention in continental Europe. Simplicity, high efficiency, high rotating speed and low manufacturing costs are claimed for the new machine.

The principle of the Banki turbine is clearly shown in Fig. 1, where it is seen that the water passes through the blades of the runner *twice*, entering at the left and being discharged radially at the right, and imparting to the runner the greater part of its kinetic energy. The turbine runner is very simple in construction, consisting only of two end disks, a shaft and the blades, which latter are straight cylindrically curved plates with a center angle of about 72 deg.

It is claimed that the Banki turbine is equally efficient at low and high heads, and for low and high speeds, and that the speed and diameter can be selected to suit the requirements without sacrificing efficiency.

All types of Francis and Pelton turbines have a specific speed at which the efficiency is a maximum, and as the runner diameter and speed largely depend upon the quantity of water the turbine has to handle, the designer is restricted in their selection unless he is

willing to sacrifice the efficiency of the turbine. In the Banki turbine, however, the diameter of the runner is independent of the quantity of water passing through the turbine, so that the starting point of the designer can be the most advantageous speed, according to the nature of the drive, and the diameter may be determined to suit this speed.

Professor Banki states that the runner diameter may be obtained from formula: $D = 72.86\sqrt{H}/n$, where D is the diameter of the runner in feet, H the effective head in feet, and n the desired r.p.m.

The fact that the speed is independent of the quantity of water

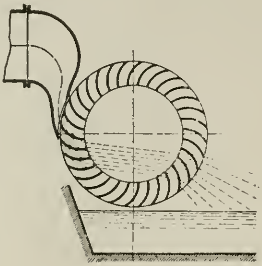

FIG. 1 THE BANKI HYDRAULIC TURBINE

is of very great advantage in hydroelectric power plants, where the cost of the electric generator decreases almost proportionally with the increase in speed.

The quantity of water determines the width b of the runner, which latter may be obtained from the formula: b = (0.024 to 0.03) nQ/H, where b is the width in feet and Q the quantity of water in cubic feet per second.

On account of its construction the setting of the Banki turbine may be very simple. It can be built in as easily as a water wheel and can replace existing water wheels without much change in the setting. It is claimed, moreover, that it is equally efficient at the low heads used until now in connection with water wheels, and at high heads of 500 ft. or more.

Several series of tests have been made in Budapest on Banki turbines of different diameters, under varying heads and different speeds, and efficiencies ranging between 80 and 90 per cent have been obtained, which compare favorably with those shown by other highly developed turbines. M. BURGER.

Elmhurst, L. I., N. Y.

Making Railroad Branch Lines Pay

TO THE EDITOR:

Commenting on the paper entitled Feeders for Railroads,[1] in which the author outlines the difficulties with which branch lines have to contend under present conditions and discusses the abandonment of unprofitable lines, practically the only solution of the problem that railroad officials have offered is to "raise the rates."

Presumably branch-line operation is unprofitable because of the limited volume of business—this bringing in insufficient returns for wages and maintenance.

Ordinarily the number of freight cars moved and the number of passengers carried may be computed in advance for each branch line. Unless new developments are forthcoming, the number of cars of freight in and out will be practically a constant from year to year; and the one train up one day and back the next that the author speaks of is sufficient to constitute good service. When milk is carried, or to take advantage of terminal facilities, or when more business develops, this becomes one mixed train a day each way. In a more thickly settled territory the demands for better passenger service are met by the addition of other trains, some of them mixed. These trains are a compromise between good service and bad, the public objecting to the slow, inadequate schedule and the railroad objecting to having to furnish service at so obvious a loss.

Mixed-train service is an abomination to passengers—its slow speed and the long waits, together with the infrequent trips, bring down their just wrath upon that intangible thing called "the company." Give these same people more frequent trains on a faster schedule and they will be willing to forego some comfort or pay more for the ride; also they will ride oftener.

To accomplish this, freight and passenger business should be separated as far as train service is concerned. By cutting freight service to not more than one train a day, the interests of all shippers would be served in a most satisfactory manner and at the minimum cost to the railroad As this would be strictly a freight train, its speed would be slow, making it possible to get along without the heavier rails and other trackwork necessary to heavy trains at high speed.

Now as to passenger service, why try to operate with steam trains? There seems to be no good reason why gasoline cars of three or four tons weight cannot be placed on all branch lines aside from the fact that officials do not want to do this. Railroad

GASOLINE CAR USED FOR PASSENGER SERVICE

men say that such cars are too light, will not stand up under continuous service, have to be repaired all the time, do not have carrying capacity. But these excuses seem ridiculous in view of the facts that locomotives have to be withdrawn at stated intervals for general overhauling (at, say, $4000 a shopping), have to be run monthly to shops for boiler work, are inspected and oiled and have minor repairs made at the end of each run.

A gasoline car can make as much speed as any branch passenger train. By the use of more than one car, or of trailers in conjunction with motor cars, a carrying capacity may be maintained to suit the traffic—and the operating expense is always in *direct proportion* to the load. The greatly reduced cost per passenger-mile makes it possible to provide more frequent trains for less money, and frequent service is the one thing that will induce more riding on branches.

Running out of Middletown, N. Y., there are two 15-mile roads—one an independent line and the other a branch of a trunk road. The branch line serves a more populous territory. Each road runs three trains a day each way, two of them mixed. The running time of the branch's mixed trains is an hour and a half, while a good bicycler can beat the passenger trains, pedaling over the automobile road that parallels the rails. The public has objected, as it always does, about slow, infrequent service and mixed trains—why shouldn't they when a gasoline car could shuttle the line continuously at 35 m.p.h. at less cost for the day's work than one steam-train trip? Traffic on this branch line remains about the same year in and year out, but with the public "served" using their autos as much as possible.

The short independent road is progressively managed—and therein may lie the reason for condemning branches generally, i.e., that the management has to do (get along) with the anti-

[1] Presented at the Annual Meeting, December, 1920, of the A.S.M.E. and abstracted in MECHANICAL ENGINEERING for January, 1921.

quated equipment given them and has to operate a road hundreds of miles away without the advantage of knowing actual needs, such as does one who is always on the ground. Upward of three years ago this independent road decided to try gasoline cars running out of Middletown.

Two cars like the one in the accompanying illustration were put on the road. The winter of 1920 severely taxed even the steam locomotives of all lines and this road maintained such service as it could, which was even more than the traffic warranted. There was no attempt to run the gasoline cars and they were sold to a southern road where they are running today. But as proof of the work of these cars, three more are being fitted up to start running this spring on the line out of Middletown.

The general manager has stated that it cost from 12 to 14 cents a mile to operate the cars, including gasoline and oil, repairs, two men at 40 cents an hour, and depreciation in four years. From this, one can reason that the cars could be junked at the end of four years and new ones bought without incurring any loss!

Moreover, the number of passengers carried while these cars were in service was double that of any previous similar period, which proves that people will ride more when they get service. While the number of steam trains was cut to two each way, there were added five gasoline trains and these latter (only) made stops at four wayside stations, maintaining the same schedule of 15 miles in 35 minutes.

This independent line is also paralleled by a good automobile road and the population, while less than along the branch line named, is distinctly of a better class financially and better able to ride in their own cars. There people knew that they were not being provided with Pullman service—they did not want it—but they knew that they were getting safe and speedy service and at intervals that served their convenience. They took pride in the "buses," as they persisted in calling them.

This was an interesting opportunity to compare two methods of doing the same thing. It is an engineer's comparison. Here are two roads as nearly alike as could be selected. One provides service as it has for forty years—the kind that is unsatisfactory to all concerned—and would abandon the line because receipts have not kept pace with increasing expenses. To abandon such a feeder would mean nothing to the trunk line, for it had a profitable through business.

But the independent road had no through business at all. Its little road constituted its entire stock in trade. To meet increasing costs, unconventional methods were adopted and a leaf borrowed out of the motor-truck book. Business was increased, net revenues increased, and the population turned into boosters. That is engineering. DONALD A. HAMPSON.

Middletown, N. Y.

Supplementary Reading for Students in Industrial Management

In the Correspondence Department of the January issue of MECHANICAL ENGINEERING, Prof. Bruce W. Benedict, director of shop laboratories of the University of Illinois, requested suggestions as to a list of books for supplementary reading by students in industrial management. In a second communication in the February issue, Professor Benedict appended a list used at the University of Illinois and urged again that the subject be discussed through this Department. Communications on this subject have been received from Robert B. Wolf and Walter N. Polokov, consulting engineers, of New York City, and from Hugo Diemer, director of LaSalle Extension University.

Mr. Wolf states that it is just as impossible to solve an industrial problem without a knowledge of the principles which have to do with the development of the individual centers of creation as it is to work in astronomy or mechanics without a knowledge of the laws of gravitation. For students who want to get at the problems of management evolution he suggests a study of evolution in the inorganic world, by taking up geology and by reading

- The Origin of the Species, by Darwin.
- Creative Evolution, by Bergson.
- The Art of Creation, by Carpenter.
- The Dore Lectures, by Troward.
- Science and Religion, by Keyser.

Mr. Polakov also believes that management deals primarily with men, therefore physiology and psychology should occupy the ranking place in a reading program. He states further that since management of industry aims at production of goods and wealth, a thorough grounding in economics is absolutely essential; and that, dealing with profound human problems, correctness of thinking and breadth of ideas are paramount, hence one must be well versed in mathematics and philosophy. With this end in view he submits the following list, divided into five groups:

Man:

- Mechanistic Conception of Life, by Loeb.
- Heredity and Environment in the Development of Man, by Conklin.
- Forced Movements, Tropisms and Animal Conduct, by Loeb.
- Psychology, by James.

Man and Society:

- Capital, by Marx.
- An Outline of the History of the Western European Mind, by Robinson.
- Vested Interests, by Veblen.
- America and the New Epoch, by Steinmetz.

Philosophy and Mathematics:

- Human Worth of Rigorous Thinking, by Kayser.
- Novum Organum, by Bacon.
- Human Engineering, by Korzybski (in preparation).

Managerial Principles and Practice:

- Organizing for Work, Industrial Leadership, and Work, Wages and Profits, by Gantt.
- Foremanship, standard course by Y. M. C. A.
- Industrial Manager To-day, by Webb.
- Principles of Scientific Management, by Taylor.
- Twelve Principles of Efficiency, by Emerson.
- Mastering Power Production, by Polakov (in preparation).

Miscellaneous:

- Scientific Management and Labor, by Hoxie.
- Industry and Humanity, by King.
- Fatigue Study, by Gilbreth.
- Fatigue and Efficiency, by Goldmark.
- Commercial Economy, etc., in Power Plants, by Smith.
- Time Studies and Rate Setting, by Merrick.
- Profits, Wages and Prices, by Friday.
- The Life and Work of H. L. Gantt, papers of 1920 Annual Meeting, A.S.M.E.

The list presented by Mr. Diemer was recommended by several members of the staff of La Salle and is as follows:

- Expense Burden, by Church.
- Business Statistics, by Copeland.
- Factory Organization and Administration, by Diemer.
- Twelve Principles of Efficiency, by Emerson.
- Office Management, by Galloway.
- Work, Wages and Profits; Industrial Leadership; and Organizing for Work, by Gantt.
- Motion Study, by Gilbreth.
- Principles of Industrial Engineering, by Going.
- Fatigue and Efficiency, by Goldmark.
- Human Factor in Works Management, by Hartness.
- Administration of Industrial Enterprises, by Jones.
- Hiring the Worker, by Kelly.
- Principles of Industrial Organization, by Kimball.
- Graphic Production Control, by Knoeppel.
- Getting the Most Out of Business, by Lewis.
- Time Studies as a Basis for Rate Study, by Merrick.
- Cost Accounting, by Nicholson and Rohrback.
- Applied Methods of Scientific Management, by Parkhurst.
- An Approach to Business Problems, by Shaw.
- Principles of Scientific Management, and Shop Management, by Taylor.
- Scientific Management, by Thompson.
- Purchasing, by Twyfort.

It is hoped that other discussion and other lists will be forthcoming, from which a "Three-Foot Shelf of Books" may be made up and kept on file at the headquarters of the Society.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

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Character and Knowledge in Engineering

Raymond Walters

QUALITIES of character as the prime factor in engineering success were stressed in the Carnegie Foundation report of 1915 in which were presented the opinions of 7000 engineers, all members of the four national engineering societies. In 94.5 per cent of the replies to a questionnaire sent these engineers the character group of qualities—character, judgment, efficiency, understanding of men—received a total percentage rating of 75, while knowledge of fundamentals and technique were rated at 25 per cent.

Good-scholarship in collegiate days as a mark of the eminent engineer is revealed in a recent study made under the auspices of the American Association of Collegiate Registrars, in which facts about the scholastic training of a group of distinguished engineers are given.

It is of interest to note at the outset that the criterion of eminence employed in this new study is the selection by the four national engineering societies of their officers and important committee members and representatives over a period of five years. This arbitrary criterion is of course not perfect. It leaves out success which is independent of professional activity and recognition, and tends somewhat to emphasize scientific and ethical aspects. However, reasonable limitation is a gain. Highly successful engineers outside of the societies are likely to be remiss in the obligation which Roosevelt once declared every man owes to the upbuilding of his profession. The scientific and ethical aspects are those which most profit the nation.

The most optimistic believer in the interrelation between good scholarship in college and good work in later life would hardly have ventured so high an estimate as the facts show the correspondence to be for the group of eminent engineers investigated. The facts are, that of the 392 collegiate graduates listed as eminent by the Registrars' Association and who represented the four national engineering societies,

182, or 46.4 per cent, stood in the highest fifth of their classes upon graduation;

109, or 27.8 per cent, stood in the second highest fifth of their classes upon graduation;

72, or 18.3 per cent, stood in the middle fifth;

14, or 3.6 per cent, stood in the next to lowest fifth;

15, or 3.8 per cent, stood in the lowest fifth;

The figures for the A.S.M.E. representatives in the "eminent" list are of particular interest to the readers of Mechanical Engineering. Of the 117 representatives of this Society, 54, or 46.1 per cent, were in the highest scholastic fifth; 30, or 25.6 per cent, were in the second highest fifth; 24 or 20.5 per cent, were in the middle fifth; 5, or 4.3 per cent, were in the second lowest fifth; and 4, or 3.4 per cent, were in the lowest fifth.

It was found that for five engineering schools which furnished more than half of the engineering graduates in the "eminent" list, the proportions were different as to the upper scholastic fifths. The second highest fifth led. The middle fifth more nearly approached the two higher fifths. The two low scholastic fifths had the same low percentage as in the total grouping.

The forty-seven other engineering schools which furnished 163 representatives and the twenty-three colleges having forty bachelor-of-arts representatives on the engineers' "eminent" list had exceptionally large percentages in the two highest scholastic fifths and small percentages in the low scholastic fifths.

Included in the Collegiate Registrars' study was an analysis of the scholastic training of all of the 730 eminent engineers embraced in the list. This disclosed that 580, or 79.5 per cent, were college graduates; 35, or 4.8 per cent, were college non-graduates; 115, or 15.8 per cent, had secondary-school training only. The student who starts and does not finish his collegiate course is shown in a particularly unpromising light.

Satisfactory returns could not be obtained covering the extra-scholastic activities of the eminent engineers in their college days—athletics, literary and engineering activities and social activities. No safe generalizations can be drawn. The one service the figures perform is, by contrast, to stress how definite and uniform for all groups considered is the correspondence between good scholastic work and good professional work.

Is there a contradiction between the Carnegie Foundation report of popular engineering opinion and the Registrars' Association findings as to scholastic standings? It does seem, from the Collegiate Registrars' facts, that popular opinion is overenthusiastic in its three-to-one proportion in favor of character qualities over knowledge of fundamentals and technique. This opinion might have been distinctly different had those who expressed it been aware of the very high scholarship records of the men they and their fellow-members have in the past elected to professional society leadership.

Aside from modification of overemphasis upon qualities of character, the Registrars' Association study does not contradict the Carnegie Foundation report. It combines with the latter in significant fashion. Taken together, the vote emphasizing personal qualities in engineering leaders and the study attesting the intellectual powers of engineering leaders (as shown by scholarship rank and later achievement) furnish an instance of the positive correlation between intellect and character which Prof. E. L. Thorndike, of Columbia, once expressed thus: "The brains and ability of the world have been, and still are, working for the profit of others."

For students in engineering colleges and for young engineers there are striking lessons in the results of these investigations.

Young men should beware of the notion that the student who does poor work or mediocre work has as good a chance for later eminence as the good student. Not *opinion*, but *facts*, explode this myth.

In the attainment of engineering success, as of all other success, time and chance, as a very old book tells us, cannot be entirely ignored. But luck is no persistent factor. The elements that tell in the long run are knowledge and character and the habit of action. The lesson for youth is a fresh emphasis upon these elements and upon the development of them in the one sure way—the efficient, whole-souled doing of each day's work.

Raymond Walters.[1]

[1] Registrar, Lehigh University, Bethlehem, Pa.; Secretary, American Association of Collegiate Registrars.

Lubrication and Hot Bearings

FROM time immemorial the bugbear of mechanics has been hot bearings. Most of us were brought up to fear heat in the bearings of machinery, and most of us have spent a good part of our lives in struggling to obtain a bearing and conditions that would allow that bearing to work without any heat at all.

Inspired by a paper on Practical Lubrication,[1] by Lieut. G. S. Bryan, U. S. N., I conducted some experiments with a pair of journals running in half-boxes with the upper side of the journal all exposed. A recess on the leading side of the journal was made in the box to receive oil and the corner was rounded to induce oil to run between the journal and the box. This recess was filled with a heavy oil. When the journal was revolved very slowly, nearly all the oil in the recess rolled under the journal and remained upon its surface. As the speed of the journal was increased oil was left in the recess, until at a speed of a thousand feet per minute of the journal nearly all of that oil was scraped off from the journal into the recess. Even at this speed there was sufficient oil left on the journal so that it did not abrade the metal. The temperature was so high that it would burn the flesh when the fingers were touched to the surrounding metal. Still that journal continued to run for a long time until the experiment was considered to be complete.

This heavy oil was then thoroughly cleaned from the journal and the boxes and kerosene oil put in its place. The spindle was revolved slowly and the kerosene oil left the recess and deposited itself on the journal. As the journal was gradually speeded up to a thousand feet per minute, the kerosene oil still appeared to remain on the journal; none was deposited in the recess and the journal revolved practically cold through quite a long period. While the heat from the first experiment with thick oil came very quickly, the kerosene-oil experiment was run for a considerable time, without excessive heating.

When an ordinary machine oil was placed in the recess and the journal revolved slowly, that oil all ran under the journal and seemed to remain on its surface. As this speed was gradually increased up to a thousand feet per minute, a portion of this machine oil was scraped off the journal and remained in the recess. Some heating was developed, but not enough to burn the flesh. This experiment was allowed to run through the same period of time as the others, but the heat did not increase above the original point, which was just where it was uncomfortable to the fingers held on the iron around it.

This oil was then removed and a so-called universal spindle oil was put in the same place. All of this oil left the recess at whatever speed the journal revolved and seemed to remain on the journal running continually between the journal and the box. So little heat was developed that it was just barely warm, regardless of the length of time it ran.

These experiments seem to show that Lieutenant Bryan is right when he says:

> The first effect of a high temperature in a bearing, then, is to thin the oil and thus decrease the friction. The effect of cooling the bearing is to increase the friction. There is no virtue in keeping a bearing at a very low temperature by the use of a considerable amount of cooling water, and there is no reason why a bearing should not be allowed to run at a high temperature as long as it is in good condition and is getting plenty of good, clean oil.

He further tells of one case of an average temperature of 205 deg. fahr. that was maintained for thirty days; and also of bearings which run regularly at temperatures of 190 deg. and 210 deg. that never cause any trouble.

Another thing that these experiments seemed to prove was that oil grooves in bearings are of no value. In most cases they are injurious, in that they reduce the bearing surfaces by just that amount. They also seemed to prove that instead of using graphite and various kinds of heavy oils when heat troubles arise, the best thing to do is to use a thin oil. This applies, of course, to high-speed bearings where the bearing is of sufficient area to sustain the load on the oil.

A further point brought out by these experiments—also brought out by Lieutenant Bryan—is that with oil constantly running on a bearing the oil can be exceedingly thin, because what is forced out by the load is constantly replaced by new oil and the bearing surfaces never come together.

But my thought in connection with this is that we have been deceived into a state of fear because there is heat in a journal. Any journal that will revolve long enough without abrasion to allow us to manifest this fear and worry, I consider to be perfectly safe.

Thousands of dollars are wasted every week in this country by the fact that mechanics stand and discuss and worry, and that engineers, superintendents and managers write letters, send telegrams and hold up the production in their works because the bearings of a machine are hot; and it is all useless fear.

C. H. NORTON.

[1] *Journal of American Society of Naval Engineers*, vol. xxvii, No. 4, November, 1915.

Lester G. French

As the May issue of MECHANICAL ENGINEERING is being released for printing, word has been received of the death of Lester Gray French, on April 18, at the French Hospital in the city of New York. For the past thirteen years Mr. French has been editor and assistant secretary of The American Society of Mechanical Engineers, which organization he has faithfully and ably served throughout that period, developing the publications of the Society to a very high standard.

Mr. French was born in Keene, N. H., in April 1869. He received his technical education at the Massachusetts Institute of Technology, from which he was graduated in 1891 with the degree of S.B. Since 1897 Mr. French has been associated with technical publications; in that year he became editor-in-chief of *Machinery*, continuing in this position until 1906, when he resigned to take up the publication of technical books, among them being one of the earliest American treatises on the steam turbine, of which he was the author.

A more detailed account of Mr. French's professional career will appear in the June issue of MECHANICAL ENGINEERING.

Americans to Greet British Engineers

There is a very deep sense of gratitude on the part of the engineering societies of the United States for the part played by the engineers of Great Britain in the war.

The inability of Sir Robert Hadfield to come to the United States to receive the John Fritz medal developed the idea in the minds of the trustees of the John Fritz Medal Board of Award that the occasion of presenting this medal in England might be made the opportunity for expressing greetings by the engineers of the United States to the engineers of Great Britain.

The idea has been worked out and a deputation will be sent to the summer meeting of the Institute of Civil Engineers. This deputation will consist of a delegate from each of the four societies represented on the John Fritz Medal Board of Award. Dr. Hollis will accompany the deputation and carry the message from the American engineers. The delegates that have been selected are Charles T. Main, representing the American Society of Civil Engineers, Col. Arthur S. Dwight, representing the American Institute of Mining and Metallurgical Engineers, Ambrose Swasey, representing the John Fritz Medal Board of Award and The American Society of Mechanical Engineers, and Dr. F. B. Jewett, representing the American Institute of Electrical Engineers.

Digging Panama Canals Underground by Hand

IN his various addresses upon the subject of industrial waste, Herbert Hoover has repeatedly referred to the bituminous-coal industry as one of our worst-functioning industries. "These mines," he said at the Syracuse meeting of the American Engineering Council, "operate seasonally and erratically. They proceed from gluts to famines, from profiteering to bankruptcy."

This seasonal operation means for the miner less than 200 days'

employment each year; and what is of even greater import, he does not know from week to week when he will have work to do, nor how much work there will be.

For this condition the mining industry is not wholly to blame. Coöperation by the railroads and large consumers of coal are necessary if a more regular output is to be secured; and to accomplish this some governmental or other central agency is urgently needed as a directing force.

Coupled with this bad economic functioning is the friction and strife between the coal operators and the miners, and more particularly the miners' union, The United Mine Workers of America, as told in the almost daily dispatches from the coal fields of West Virginia. Apparently, the situation is a deadlock, with intolerable conditions existing, for the relief of which no constructive policy has yet been proposed by the mine owners.

In this connection, and as a comment on the present status of the coal-mining industry, our attention has been directed to a paper presented before the American Economic Association by Arthur J. Mason, of Chicago, in which he contends that the present unsatisfactory conditions could be greatly alleviated by abolishing the arduous (and probably useless) labor of shoveling the coal by hand into the mine cars after the face has been shot in the mine. He would introduce machines for loading the coal, which, while primarily a mechanical problem with apparently little bearing on the general economic situation, he believes would have a most important psychological effect on the whole industry.

Mr. Mason is an ore engineer and approaches coal mining as an outsider, influenced more by the accomplishments in his own field than by the habits and precedents of the coal-mining industry. He has lived through the period of the remarkable development of the mechanisms for the handling of ore with which engineers are familiar and sees the possibility of an equally useful development in coal mining.

He gives the rather startling figures that 1,000,000 men in the United States pass their working lives down in the mine or near the pit mouth, and as part of their work shovel each year nearly 700,000,000 tons of coal into railroad cars from its resting place in the mine. "It is," he states, "as though we were to go back to spading our land in agriculture instead of plowing it."

How much coal is 700,000,000 tons? According to Dr. Mason's calculations, the coal mined in the months of January and February alone would fill the whole Panama Canal; and according to figures given out at the time the Canal was completed, the actual excavation for the Canal was about one-third the volume of coal now mined in this country each year!

The relation which mechanical loading might be expected to have to the general mining operation may be thus briefly summarized:

For each 1,000 tons brought up from the mine, 100 acres is provided below as a labyrinth of entries, rooms, tracks, switches, ventilation devices, so that in a big mine, raising 5,000 tons, almost a section a mile square is so organized—a bewildering city underground. This area largely arises from the pseudo-ownership which every miner acquires of his room or rooms, technically known as his "place."

In a coal mine, like any tunnel, the work will proceed with the frequency with which a face is shot. In Southern Illinois faces are shot about once in four days. If faces were shot every day, it would follow that the area to be kept alive, with all the agencies mentioned, would be correspondingly reduced. Two and one-half acres would become the equal of 10 acres, and the cost of mining over what is paid the so-called miner (about twice the miner's wages) would be reduced accordingly.

Machine loading would necessarily abolish the institution of "places" in coal mining. A group of six men with a loading machine and motor should average 100 tons of coal per hour loaded in mine cars, the crew passing from room to room.

In spite of the large economic waste in the coal industry in various directions, Mr. Mason believes that the greatest waste is in manhood. Hours needlessly spent in a mine is not what men most desire. "Can one conceive," he says, "a proposal more splendid than to bring to the surface and the light of day thousands of men to do some finer and better work, and to bring upward with them their families and dependents?"

Submarine Against Submarine

In his entertaining book, The Victory at Sea, Rear-Admiral Sims gives what to many will be a new conception of the efficacy of the submarine in hunting and destroying the submarine during the war. The belief is general that the most successful hunter of the submarine was the destroyer, and so far as absolute figures are concerned this is true. Destroyers, with their depth charges and gun fire, sank more U-boats than any other agency; but relatively the submarine itself proved a more destructive enemy of the submarine than did the destroyer.

The Allied destroyers, about 500 in number, sank 34 German submarines; auxiliary patrol craft, such as trawlers, yachts, etc., about 3000 in number, sank 31; while the Allied submarines, only 100 in number, sank 20. It is therefore evident that the latter surpassed in their effectiveness the most formidable of the surface anti-submarine vessels.

Admiral Sims regards this work of the Allied submarines as in a way the most astonishing development of the naval operations of the war. "It is particularly interesting," he says, "because from that day in history when the submarine made its first appearance the one quality which seemed to distinguish it from all other kinds of warship was that it could not be used to fight itself." It was supposed to be a vessel valuable almost exclusively to the weaker sea powers. It could destroy battleships and cruisers, but not vessels of its own kind, and for that reason has not been popular with nations having strong navies. Early in 1800 Robert Fulton endeavored unsuccessfully to sell to England the inventions incorporated in his submarine *Nautilus*. St. Vincent, then First Lord of the Admiralty, refused, saying, "Why encourage a kind of warfare useless to those who are masters of the sea and which, if successful, will deprive them of this supremacy?"

In connection with the recent war, Admiral Sims says it is important that we keep in mind the fact that the submarine is only occasionally a submarine; and that for the greater part of its career it is a surface boat. In the long journeys which the German U-boats made to the hunting grounds which lay in the Atlantic trade routes, they traveled practically all the time on the surface of the water. The ability to submerge was merely a quality which was utilized only in those crises when the submarine either had to escape a vessel which was stronger than itself, or planned to attack one which was weaker.

The simple fact that the submarine can accomplish its destructive work only when submerged, and that it can avoid its enemy only by diving, makes it plain that it must always hold itself in readiness to submerge at a moment's notice and remain under water the longest possible time. Its storage batteries, therefore, must not be wasted by needless under-water travel—in other words, it must spend all its time on the surface where it can be propelled by its Diesel engine, except during those brief periods when it is attempting to attack a ship or escape an enemy.

The situation with the Allied submarines, however, was quite different. The Allied submarine commander did not have to maintain such constant readiness to submerge and to remain submerged, for there were not German surface vessels operating on the high seas and he had no enemies to fear. The British and American fleets were attending to that. For this reason he was not compelled to economize his electric power so strictly and he could, in fact, spend a considerable part of his time under water. This gave him a great advantage in hunting U-boats, for he could cruise around all day at slow speed, with only the periscope of his submarine showing. "Just as the German U-boat could 'spot' an Allied destroyer at a great distance without being itself seen," says Admiral Sims, "so could the periscope of the Allied boat spot the German submarine on the surface long before this tiny object came within the view of the U-boat conning tower. Our submarine commander could remain submerged, sweep the ocean with his periscope until he picked up the German enemy; then, still under water, and almost invariably unseen, he could steal up to a position within range and discharge a torpedo into its fragile side The German submarine received that same treatment which it was itself administering to harmless merchantmen; it was torpedoed without warning; but, as it was itself a belligerent vessel. the proceeding violated no principle of international law."

Industrial Relations and the Engineer

Basic Principles Presented at Joint Meeting of New York Section of A.I.E.E. and Metropolitan Section of A.S.M.E.

"WHEN the mariner has been tossed for many days in thick weather and on an unknown sea, he naturally avails himself of the first pause in the storm, the earliest glance of the sun, to take his latitude and ascertain how far the elements have driven him from his true course. Let us imitate this prudence and before we float further, refer to the point from which we departed that we may at least be able to conjecture where we are now."

This quotation from Daniel Webster's speech against Hayne—made by Dr. Ira N. Hollis with particular reference to the present status of industrial relations—expressed the purpose of the joint meeting of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of the American Society of Mechanical Engineers on March 25. The program included dispassionate statements of the conditions on which correct industrial relations must depend and emphasized the necessity for analytical considerations of these conditions by engineers.

In his opening remarks, the chairman of the meeting, Walter Rautenstrauch, vice-president of the J. G. White Management Corporation and professor of mechanical engineering at Columbia University, emphasized the importance of the fundamental principles upon which permanent industrial relations should be based. He outlined these as: (1) The need for relationship between employer and employee, which is well founded economically; (2) the establishment of principles relative to the obligations of the parties involved as well as their rights; (3) a foundation of justice; (4) the organization of both parties for work, emphasizing production and service rather than organization for the acquisition of something.

The first speaker of the evening was Dr. F. H. Giddings, professor of sociology at Columbia University, who presented the social background of the problem of industrial relations. Professor Giddings made a distinction between the social background and the economic foreground. Economic questions enter into all disputes between organized labor and organized capital. A sound judgment of industrial relations rests equally, however, on an understanding of the social phases which relate to life itself, for the support and amelioration of which wealth is the means. He stressed as important the fact that the fundamental trouble with capitalism is that it is not capitalistic enough, in that wealth is not being used productively but is being wasted or even immorally squandered. The sensitive spot is not found in the distribution of wealth, therefore, but in the reactions of present-day industrial relations upon the wage earner himself. Men develop full lives not only through creative work but through relations with fellowmen as members of society. Through membership in numerous organizations and as citizens, opportunity for usefulness, happiness and self-expression are found. Therefore, quite normally, wage-earning groups desire a larger opportunity to share in the organization and control of things industrial. This desire is recognized in the present talk on industrial democracy. In closing, Professor Giddings emphasized the importance of a careful consideration of all the factors and the bringing forth of a solution by unprejudiced people. He outlined the place the engineer should have in bringing forth this solution on the basis of an intellectual rather than an emotional approach to the problems to be solved.

The address by Doctor Hollis, which will be printed more fully in a future issue of MECHANICAL ENGINEERING, developed the rise of the industrial worker coincident with the development of mechanical power. In it he analyzed the true measure of the rise of the industrial worker, in increase in numbers, increase in power of organized workers, gain in wealth, increase in opportunity and the development of a satisfaction through work for others, and dwelt on this last item almost entirely. He measured the rise of any human effort or agency by its tendency to minister to the satisfactions of life. No gain in numbers, power or wealth that does not accomplish this is a permanent gain.

Dr. S. M. Lindsay, professor of social legislation at Columbia University, related the recent enactments of state legislatures affecting industrial relations. He outlined the steps taken to protect women and child workers, compulsory safety enactments, and the laws passed to establish arbitration in industrial conflict.

Bringing up to date a paper delivered before the Spring Meeting of The American Society of Mechanical Engineers in 1919, L. P. Alford, editor of *Management Engineering*, presented the recent developments in organizing personal relationships in industry. Mr. Alford's previous paper reviewed the major lines of development of the 35 years preceding 1919.

Under the heading of Profit-Sharing Plans, Mr. Alford differentiated true profit sharing from allied schemes such as stock subscriptions, wage bonuses, saving methods, etc., and presented the conclusions of the National Industrial Conference Board Report of an analysis of 41 experiences of profit sharing, as follows: (1) From experience with profit sharing in the past with plans now in operation, profit sharing has been successful for limited periods; (2) judging by the long list of abandoned plans, and the comparatively small number that have endured more than a few years, the effectiveness of profit sharing in surviving the many vicissitudes of an industrial enterprise is decidedly uncertain; (3) in the light of the high percentage of abandonments due to dissatisfaction among the workers, it is reasonable to conclude that wise and efficient management plays a very important part in the success of profit-sharing plans.

Considering Methods of Wage Payment, two tendencies during the past two years were noted: (1) To pay an addition to earnings based upon an established wage-payment system; and (2) to return to piece-rate payments during the past few months.

Under Methods and Laws to Reduce Hazards in Industry, Mr. Alford reviewed the enactments in the various states. Progress was indicated by the reduction in accidental deaths from 35,000 in 1912 to 22,000 in 1919. In contrast the deaths on American highways have increased from 35,000 in 1912 to 100,000 in 1920.

Employment management made rapid strides in 1919 and 1920. At the present time with unemployment in industry estimated at 4,000,000 workers, employment departments are being disbanded or curtailed in proportion to reductions of working forces. Present conditions are leading to a study of the economic justification of employment work that will bring about a more substantial basis for the employment and personnel functions in the future.

Mr. Alford listed the declared rights of labor recognized by the proclamation creating the National War Labor Board which were written into the Versailles Peace Treaty. There have been no new developments in this regard in the past two years because of lack of Senate action concerning the Peace Treaty.

In his consideration of the Mutual and Joint Control Methods, he referred to the report of President Wilson's Second Industrial Conference in December 1919, and to the developments leading to the establishment of the Kansas Industrial Court.

In closing, Mr. Alford emphasized the engineering character of recent attempts in organizing human relationships in industry and pointed out the important responsibilities of the engineer in organizing and treating human activities on the same basis of knowledge as prevailing in the more technical aspects of the engineer's work.

The final paper of the evening was presented by Mr. A. L. De Leeuw, consulting engineer, who gave a critical analysis of the human tendencies that must be recognized in industrial relations. Working from the premise that the engineer must know the properties of the materials with which he builds, Mr. DeLeeuw outlined the situations brought about in industry by the two outstanding human tendencies, or sets of qualities, with which we have to reckon—the individualistic and the social. The necessity for leadership was expressed and the importance of well-informed, well-balanced labor leaders was emphasized. In closing, Mr. De Leeuw stated the need for some form of definite understanding between employee and employer by which the product and compensation are properly fixed and their relative relation maintained.

A.S.M.E. to Meet in Chicago May 23-26

Preceded by Trip to McCook Field and Followed by Excursion to Rock Island, Chicago Program Has Diversity, Interest and Value

THE 1921 Spring Meeting of The American Society of Mechanical Engineers bids fair to be the most popular of any of the recent Spring Meetings. The excursions to McCook Field and Rock Island Arsenal offer interesting opportunities which, coupled with the main sessions at Chicago, will attract the mechanical engineers of the entire country.

Excursion to McCook Field

The membership is afforded a fine opportunity to become acquainted with the nerve center of aeronautic development in this country. On Saturday, May 21, the Aeronautic Division, jointly with the S.A.E., is to visit McCook Field, Dayton. The morning is to be spent in an inspection of the shops and experimental laboratories, looking over the latest designs in aeroplanes and motors, parachutes, radio apparatus, cameras, etc. After lunch, to be served at the cafeteria, there will be a flying program. The evening will be spent at the Engineers' Club, when the gathering will be addressed by some of the leaders in aeronautic development.

Rock Island Excursion

Following the meeting at Chicago, two days—May 27-28—will be spent at Rock Island Arsenal with the Army Ordnance Association. The Ordnance Division will present an interesting program, and an inspection of the plant will be made. The visit to the Arsenal is limited to citizens of the United States who are not engaged in the manufacture of munitions for foreign governments. Saturday the 28th will be given over to a golf tournament to be held on the Rock Island links.

The Chicago Meeting

The four days, May 23-26, to be spent in Chicago are planned to include a remarkable collection of valuable professional sessions, attractive entertainment and interesting plant visits. The Professional Divisions have coöperated with the Committee on Meetings and Program to provide the strongest program possible. In so far as is practical, the plants to be visited have been selected with the idea of supplementing the technical program.

Chicago itself, the fourth largest city in the world, with its stock yards, its immense terminals, its remarkable schemes for municipal development, its wonderful educational institutions, and its fine parks, is well worth a visit, even without the attraction of the Spring Meeting. This virile metropolis—the center of a large number of A.S.M.E. members who are earnestly planning for the comfort of their guests—will undoubtedly attract the largest number thus far assembled at a spring gathering of mechanical engineers.

The tentative program given on the following page presents a great diversity of interest and is worthy of careful study.

Chicago Session

In accord with past practice, a session will be devoted to the consideration of the vital problems pertaining to the section of the country adjacent to the Spring Meeting city. The Chicago transportation problem has been selected as a subject of commanding interest, not only locally but nationally. In this session the Western Society of Engineers is coöperating, and its Terminal Committee has arranged a program touching on the problems of Chicago as a Mid-Interior Rail-Water Gateway. This program is valuable to all engineers in that it gives insight into the magnitude and complications of one of the earth's greatest railroad centers. Various phases of this subject will be presented by J. R. Bibbins, consulting engineer, Dept. of Transportation and Communication, Chamber of Commerce, Washington, D. C.; E. J. Noonan, engineer of the Chicago Terminal Commission; Hugh E. Young, engineer of the Chicago Planning Commission; and Bion J. Arnold, consulting engineer, of Chicago.

Industrial Education and Training

Realizing the growing need for development in education and training in the industries, an evening session has been assigned for a powerful presentation of this subject. The Committee on Training for Industries plans to have able speakers give their experience in developing successful schemes of training in the various industries, and with the important points brought out hopes to develop considerable activity in the future educational work of the Society. The fact that a recent Congressional Committee reported that the United States had fallen from first place to seventh in its educational standing among the nations, has emphasized the vital need of a careful consideration of this subject by the engineering profession.

Business Session

The important topic for discussion at the business session will be the extended changes planned in the Constitution and By-Laws.

Power Test Codes Hearing

Three codes will be presented for discussion and adoption during the Spring Meeting. These Codes are those dealing respectively with Reciprocating Steam Engines, Evaporating Apparatus, and General Instructions.

Sessions of Professional Divisions

Forest Products

At the Spring Meeting the Forest Products Division plans to complete its organization and will present three papers on phases of the development of engineering in the utilization of forest products.

Fuel

The general topic of the Fuel Session is the utilization of Mid-Western Fuel, and, as indicated on the program, the presentation will be made by men who have had broad experience in this field. An excursion to the successful pulverized-coal-burning plant of the Milwaukee Electric Railway and Light Company is planned in connection with this session.

Machine Shop

The Machine Shop Division is to discuss the development in machine tools and machine-shop practice brought about by the automobile industry, which has increased the sizes of machine-tool units, developed new requirements in accuracy, and revolutionized methods of manufacture.

Management

An interesting paper on the Organization of an Engineering Society, by Morris L. Cooke, will be presented at the Business Session. Its discussion, however, will be carried on during the Management Session, inasmuch as this paper was procured through the Management Division. It is also planned to receive the preliminary report of the Committee on Terminology which has been appointed jointly by the Taylor Society, the Society of Industrial Engineers, National Association of Cost Accountants, Industrial Relations Association of America, and the American Institute of Accountants. This committee has been working for several months on the preparation of a dictionary of terms used in management engineering, and the adoption and use of these terms will do much to clarify management literature and assist in the development of the art of management. L. W. Wallace will present an account of the work of the American Engineering Council Committee on the Elimination of Waste.

Materials Handling

The application of material-handling machinery to road building has been adopted by this Division for its Spring Meeting topic. The country needs better and cheaper highways, and the province of the mechanical engineer in providing machinery to satisfy these needs is well defined. This session should therefore be of great

interest not only to the designers of road-building machinery, but to the users as well. Motion pictures of modern road-building machinery will be shown.

Power

The Power Division is to coöperate with the Chicago Section of the A.I.E.E. and the mechanical and electrical sections of the Western Society of Engineers to provide the program for this session. The general subject will be Power Resources of the Middle West, and two strong papers will be presented.

Railroads

The Design of Large Freight Locomotives is the general subject selected for the Railroad Session. The three papers provided on this subject will furnish the basis for an interesting discussion of the needs and problems of the motive-power departments of the railroads.

General Papers

Five valuable papers will be presented at the two General Sessions. Mr. White's paper on the hydraucone regainer gives the history of the development of this device which has proved valuable in increasing the effectiveness of hydroelectric installations. Mr. Johnston's paper presents the results of a number of tests of oxy-acetylene welding and cutting blowpipes. These tests were made by the Bureau of Standards for the War Department shortly

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TENTATIVE SPRING MEETING PROGRAM

Chicago May 23-26, Headquarters at Congress Hotel

(Other subjects or changes to be announced later)

Monday Afternoon, May 23

Business Meeting: Discussion of Changes in Constitution and By-Laws
On the Organization of an Engineering Society, M. L. Cooke

Monday Evening, May 23

Reception and Dance at Congress Hotel

Tuesday Morning, May 24 (Simultaneous Sessions)

FUEL SESSION

Recording Ash-Pit Loss from Chain-Grate Stokers, E. G. Bailey
Boiler Tests with Pulverized Coal, Henry Kreisinger and John Blizard
Limitations of Mechanical Stokers Utilizing Mid-West Coals, E. H. Tenney
Capacity and Efficiency Limitations of Stokers Using Mid-West Coals, John E. Wilson
Discussion of Smoke Problem with Reference to the Health of the Community, Dr. John D. Robertson
Latest Requirements of the City of Chicago in Furnace Design, with Special Reference to Hand-Fired Boilers and Limits of Each Design, Frank Chambers

MACHINE-SHOP SESSION

Influence of the Automobile on Gear Cutting and Gear-Cutting Machinery, H. J. Eberhardt
Influence on Power Presses, Dies and Special Tools as a Result of the Demands of the Automobile Industry, Henry J. Hinde
Lathe Design, R. E. Flanders
Interchangeable Manufacture, C. B. Lord

MANAGEMENT SESSION

Industrial Waste, L. W. Wallace
Report of Committee on Management Terminology
On the Organization of an Engineering Society, (Discussion) M. L. Cooke

GENERAL SESSION

Capacity Tests of Dry-Vacuum Pumps, by the Low-Pressure Nozzle, S. B. Redfield
Report on Efficiency Tests of a 30,000-kw. Steam Turbine, H. B. Reynolds

Tuesday Afternoon, May 24

Excursions

Tuesday Evening, May 24

Session on Training for the Industries

Wednesday Morning, May 25 (Simultaneous Sessions)

CHICAGO SESSION

Some Aspects of the Problem of Chicago as the Mid-Interior Rail-Water Gateway, J. R. Bibbins
Development of Air Rights in Connection with City Freight Houses, E. J. Noonan
Freight Movement by Motor Trucks, Wiewpoint of Carrier and Public, Hugh E. Young
Freight-Tunnel System as a Terminal Distribution Agency, J. R. Bibbins and E. J. Noonan
The Function of the Terminal Survey, J. R. Bibbins
The Relation of Steam Roads to Rapid-Transit Development, Bion J. Arnold

GENERAL SESSION

Investigation of Oxy-Acetylene Welding and Cutting Blowpipes, R. S. Johnston
Interpretation of Boiler-Water Analyses, J. R. McDermet
The Hydraucone Regainer, Its Development and Applications in Hydroelectric Plants, W. M. White

PUBLIC HEARING ON POWER TEST CODES

This Session will be devoted to the discussion of the proposed Power Test Codes on General Instructions, Reciprocating Steam Engines, and Evaporating Apparatus.

Wednesday Afternoon, May 25

Excursions

Wednesday Evening, May 25

Dance at Congress Hotel

Thursday Morning, May 26 (Simultaneous Sessions)

RAILROAD SESSION

Design of Large Locomotives, M. H. Haig
The Needs for the 2-10-2 and Other Heavy Freight Locomotives for Road Service, A. F. Stuebing
Necessity for Improvement in Design and Operation of Present-Day Locomotives, H. W. Snyder

MATERIALS HANDLING SESSION

Planning and Organizing a Road Job for the Mechanical Handling of Material, C. D. Curtis
Road-Construction Plants, B. H. Piepmeier
The Mechanical Side of Highway Construction, R. C. Marshall, Jr.

FOREST PRODUCTS SESSION

Woodworking Education, Dean Moon

POWER SESSION

Power Resources of the Middle West.
(Authors to be announced later)

Thursday Afternoon, May 26

Excursions and Moving Pictures

Secretary Hoover Resigns from Presidency of F.A.E.S.

Executive Board of American Engineering Council Meets at Philadelphia—New Member Societies—L. W. Wallace Representative on U. S. Board of Surveys and Maps

An important meeting of the Executive Board of the American Engineering Council of the F.A.E.S. was held at the Engineers' Club of Philadelphia on April 16. The closing action of the session was the acceptance of Herbert Hoover's resignation as president of the Council. As a member of the Executive Branch of the Government Mr. Hoover felt that he could not consistently direct the activities of an organization which is engaged in furthering national activities involving legislation. In a resolution of regret at Mr. Hoover's retirement the Board voted its appreciation of his leadership during the organization period of the Council and his initiation of policies and effort.

In regard to the question of Government reorganization, it was voted to renew the activities of the National Public Works Department Association for the establishment of a National Department of Public Works. Committees of the Association in every state will coöperate with the Smoot-Reavis Committee of Congress in a movement to reorganize the Department of the Interior by placing the public-works functions of the Government under central control. The Council will also support the Smoot-Reavis Committee in its program for the revision of the governmental machinery to promote economy and efficiency in departmental administration.

A progress report of the Committee on the Elimination of Waste in Industry said that a series of intensive assays of more than 100 industrial plants has been completed, and that the field workers have made their reports. These reports are being collated and will be made public sometime in June.

Following the meeting of the Executive Board, a dinner, attended by 600 engineers, was given at the Bellevue-Stratford Hotel by the Engineers' Club of Philadelphia and its fourteen affiliated societies, comprising a membership of more than 4600 in Philadelphia and Eastern Pennsylvania. The presiding officer was Guilliaem Aertsen of the Midvale Steel & Ordnance Company and president of the Engineers' Club of Philadelphia. The toastmaster was Major Joseph A. Steinmetz, past-president of the Engineers' Club and chairman of the Aeronautic Division of the A.S.M.E. Mr. Aertsen, as president of the Club, presented Herbert Hoover, president of the F.A.E.S., with a certificate of honorary membership in the Engineers' Club of Philadelphia. Following the presentation Mr. Hoover delivered an address on the Reorganization of Government Departments.

Other speakers were Dean Dexter S. Kimball of Cornell University, vice-president of the F.A.E.S., whose subject was The Federated American Engineering Societies; J. C. Trautwine, Jr., editor of Trautwine's Hand Book, whose topic was The Engineers of Philadelphia, and George W. Pepper, lawyer and publicist. A summary of Mr. Hoover's address follows:

One problem of the new administration that has received the attention and thought of the organized engineers of America for many years is that of the reorganization of the Federal Government. To any student of Federal organization, one sweeping and fundamental necessity stands out above all others,—that the administrative units of the Government must be regrouped so as to give each of the great departments more nearly a single purpose. Such functions as public domain, public works, assistance to veterans, public-health functions, aids to navigation, to industry, to trade, purchasing of major supplies, are each and every one scattered over from four to eight departments, most of which are devoted to some other major purpose.

Economies can be accomplished from a public point of view by an elimination of the overlap in these different units of administration through unification into groups of similar purpose. The real economy to the nation, however, does not lie here, however great this may be, but it lies in their more effective functioning in their daily relation to the public.

As a result of the war the responsibilities for the major purposes of the Treasury, War and Navy Departments have been enormously increased. In the interests of efficiency they should not be called to responsibility for the administration of matters not pertinent to their major functions.

There is also some confusion between executive, advisory, and semi-judicial functions. One of the tendencies of government, both local and national, during the last twenty years, has been to add executive functions to commissions and boards created primarily for advisory or regulatory purposes. Executive functions cannot rise to high efficiency in the hands of Government boards in which each member has a separate responsibility to the public and is primarily engaged in a semi-judicial function.

Furthermore, during the last few years there has been a great growth of independent agencies in the Government reporting directly to the President, until his office is overburdened almost beyond the point of endurance, and coördination with executive departments is rendered extremely difficult. It is neither possible nor advisable to place all these outside organizations within the departments, but much could be done to mitigate the situation.

The economic changes in the world, growing out of the war, and their reflex upon our trade and industry make it vital, if we are to maintain our standards of living against increasing ferocity of competition, that we shall concentrate and enlarge our national effort in the aid, protection, stimulation and perfection of our industrial and commercial life.

We want no paternalism in government. We do need in government aids to business in a collective sense. In a department we do not want to either engage in business or to regulate business. We need a department that can give prompt and accurate diagnosis from both a foreign and domestic point of view of economic events, of economic tendencies and of economic ills; that can promptly and accurately survey economic opportunity, economic discrimination and opposition; that can give scientific advice and assistance and stability to industry in furnishing it with prompt and accurate data upon production, supplies and consumption; that can coöperate with it in finding standards and simplifications; that can by broad study promote national conservation in industry and the elimination of waste; that can study and ventilate the commercial side of our power possibilities; that can study and advise national policies in development of rail, water, and overseas transportation; that in fact covers, so far as government functions can cover, the broad commercial problems of trade, industry, and transportation. This can be accomplished more by coördination of existing governmental facilities than by increased expenditures.

Three More Societies Join F.A.E.S.

The membership of The Federated American Engineering Societies has been increased in recent weeks by The Boston Society of Civil Engineers, the Milwaukee Engineering Society and the Duluth Engineers' Club. There are a number of other societies which will probably become affiliated with the F.A.E.S. before July 1, at which time the opportunity of coming in as a Charter Member will expire. At present the membership of the Federation includes 24 engineering societies and clubs, including a total membership of nearly 50,000 engineers.

Council Appoints Representative on U. S. Board of Surveys and Maps

The American Engineering Council's Committee on Procedure has appointed L. W. Wallace, executive secretary of the Council, as its representative on the United States Board of Surveys and Maps. Mr. Wallace succeeds Alfred D. Flinn, secretary of Engineering Foundation, and has been assigned to the Committee on Coöperation.

The Federal Power Commission, Army Air Service, and Naval Aviation have been added to the membership of the Board and committees have been reorganized so as to better distribute the work. The Advisory Council of the Board has asked the American Engineering Council to assist in obtaining an adequate program involving a larger appropriation for topographic maps.

F.A.E.S. Establishes Permanent Headquarters in Washington

Permanent headquarters of the F.A.E.S. have been established at 719 Fifteenth Street, N. W., Washington, D. C., with L. W. Wallace, secretary of the Federation, in charge. In addition to office accommodations for the staff of the Federation, sufficient space has been obtained to provide a conference room for those who may desire to use headquarters for a meeting place. It will be the purpose of headquarters at all times to render as much personal service as possible for engineers who visit Washington, enabling them to transact business matters with the minimum amount of effort on their part. The new office will continue the services rendered by M. O. Leighton and A. C. Oliphant in the Washington office of Engineering Council.

History of Machine Industries of Windsor, Vt., Now in Preparation

There are certain localities, particularly in New England, where mechanics of early days did pioneer work of strikingly original character and which have had a marked influence upon the development of the machine industry of the entire country. One of these is Windsor, Vermont, and it is gratifying to learn that a complete history of the rather surprising mechanical accomplishments of that place is being prepared by Mr. Guy Hubbard of the Engineering Department of The National Acme Company of Windsor. Since in the ninety-two years of their existence companies which are either descended from or related to the Windsor concerns, men who learned their trades there, and things manufactured there, have become widely scattered, valuable information relating to this history has often been found available from very unsuspected sources. Further information would be greatly appreciated by Mr. Hubbard and full credit given for whatever is used.

Among the more important things which have been either originated or developed to a practical state in Windsor are the rotary gear pump, the Lincoln-type milling machine, the turret lathe, breech-loading and repeating small arms, and automatic screw machines. Among the famous mechanics who have a place in the history of these developments are James Hartness, Governor of Vermont, and the late Charles E. Billings, who are both Past-Presidents of The American Society of Mechanical Engineers.

Poster Issued in 1865 Showing Diversified Product of One of the Old Machine Firms of New England (Reproduced from a Distorted Photograph)

The line of machine industries at Windsor, which has continued unbroken down to the present time, was founded in 1829 as The National Hydraulic Company, builders of Hubbard's patent rotary pumps, which are still manufactured, practically unchanged, by The Fales & Jenks Machine Company of Pawtucket, R. I., who purchased the patent rights at Windsor in 1833. In 1830 The National Hydraulic Company built and installed the 20-hp. pump of the first water works of St. Louis, Mo. They later went into the manufacture of Kendall's patent underlock rifles, becoming in 1844 Robbins, Kendall & Lawrence, and in 1849 The Robbins & Lawrence Company (1849–1858). This was one of the most famous gun and machine-tool concerns of its time and did much to spread the interchangeable system both in this country and abroad. In 1854 and 1855 they built most of the machinery for the Royal Armory at Enfield, England.

The Robbins & Lawrence Company, through successive changes, under Mr. E. G. Lamson became The Windsor Manufacturing Company (1865–1869), which was succeeded by The Jones and Lamson Company. In 1888, following Mr. Hartness' identification with this company, it was moved to Springfield, Vt., and became The Jones and Lamson Machine Company, the manufacturers of the Hartness flat turret lathe. The Windsor Machine Company then took over the old shops at Windsor, where the Gridley automatic screw machine was developed, a machine original in its conception like its noteworthy predecessors. In 1915 this company became a part of The National Acme Company, being known as its New England Plant.

One of the many interesting documents which Mr. Hubbard has unearthed in the course of his researches is a poster, reproduced on this page, which was issued in 1865 by the Windsor Manufacturing Company and constituted a catalog of their products. This poster is a striking illustration of the diversity of output which machinery manufacturers attempted before the days of specialization, and is of particular interest because of the remark-

able character of the machines illustrated. There is shown a reasonably complete line of machine tools and metal-working machines, including a Lincoln miller and an indexing milling machine. In those day every town with water power had its sawmill, a requirement met by this company. Stone-channeling machines and air-driven diamond-pointed rock drills were produced primarily to meet the needs of the marble quarries of Vermont. And, finally, a magazine rifle was manufactured which is said to have done very effective service in some of the closing battles of the Civil War, and which was certainly in marked contrast to the muzzle-loading arms used to a large extent throughout that war.

American Railway Engineering Association

Annual convention in Chicago, March 15, 16 and 17. The rail committee, in their report, expressed surprise at the attitude of the mills toward the rail specifications adopted by the association in 1920. The mills refuse to roll rails of any weight under a contract requiring full compliance with the 1920 specifications and will roll according to modified specifications only if large extras are paid. The committee will determine during the coming year whether it is best to adopt two specifications, one without running into extra price and the other requiring an extra price, or to accept only one specification without extra cost over the manufacturer's base price, the association to be given a list of specific refinements in the order of their importance so that roads requiring a higher grade of rail will have the benefit of the association's judgment on the most valuable of such refinements. M. H. Wickhorst discussed the relation of shattered steel in fissured rails to the mill end of the rail. C. W. Gennet, Jr., explained how unsafe rails can generally be traced to unsound ingots. A new cut track spike specification was adopted by the association on the recommendation of the committe on track. A new bolt specification was also adopted. Bolts, other than heat-treated, must be of mild-carbon steel with a tensile strength of not less than 50,000 lb. per sq. in. and an elongation of not less than 15 per cent in 8 in. Heat-treated or high-tensile bolts must be of carbon or alloy steel and conform to the following minimum requirements: Tensile strength, 100,000 lb. per sq. in.; yield point, 70,000 lb. per sq. in.; elongation in 2 in., 15 per cent; reduction of area, 40 per cent.

Brief History of Engineering Council

At the final meeting of the Engineering Council held at Washington in December 1920, a committee consisting of J. Parke Channing, Philip N. Moore and Alfred D. Flinn was appointed to prepare a brief history of the activities of the Council from the time of its establishment in the spring of 1917 to its termination in December 1920. The Committee states that the report, which is now completed, is not a full record of the Council's activities but is rather a summary of examples indicating the variety of subjects handled and the methods of dealing with them. Through the instrumentality of Engineering Council, notable progress has been made in organizing the engineers of the country for service not only to the members of the profession, but also to national, state and local governments and the public, in matters of general interest in which the technical training and experience of engineers should be utilized. The work so well inaugurated will be carried on by the American Engineering Council of The Federated American Engineering Societies.

An Opportunity for Young Engineers

The attention of young engineers residing in Greater New York is called to the formation of a Tank Corps within the National Guard of the State of New York. The Eighth Coast Command Armory located in the Bronx has been designated as the home of the new organization. Recruiting is done at the office of L. K. Davis, ex-major, Tank Corps, A.E.F., 347 Lexington Ave., New York City, every Monday night between eight and ten, and at the Armory on Thursday nights.

The tank corps is a branch of the service essentially an engineering problem. It requires a diversified knowledge embraced in the activities of the engineering societies, and it is hoped that junior members of the various engineering societies may be interested in this Tank Corps.

A.S.M.E. TO MEET IN CHICAGO MAY 23–26

(Continued from page 353)

after the armistice. Mr. Redfield's paper presents a simple and effective method for making capacity tests with dry-vacuum pumps. Mr. McDermet's paper on boiler-water analysis throws new light on this old subject. The tests on the 30,000-kw. steam turbine reported by Mr. Reynolds in his paper present valuable data of tests of large units which are not generally available.

Hotels

It is anticipated that the hotels in Chicago will be crowded during the week of the Spring Meeting. To assist the membership in securing hotel reservations, a double card was sent out with the Spring Meeting circular. One half of the card is to be sent to the hotel and the other half to the Chicago Hotel Committee, who will keep in touch with the hotels and make sure that the member's request for reservation is given prompt and careful attention by the hotel. The Chicago Hotel Committee has no responsibility to engage rooms for the members, however, its sole duty being to secure the necessary action by the hotel.

Special Railroad Rates

Arrangements have been made with all railroad lines, except those in the Southeastern and Canadian Passenger Associations, by which members may obtain a considerable reduction in their railroad fares. When buying a ticket to Chicago ask your agent for a special rate certificate. Upon presentation at Chicago a half-fare rate home may be obtained, provided the return is over the same route used to go to Chicago. This special rate applies only if 350 certificates are presented, but as it applies to all rates over 67 cents, every member is requested to ask for a certificate so that those coming from long distances may be assured of the reduction.

ON THE ORGANIZATION OF AN ENGINEERING SOCIETY

(Continued from page 325)

Engineering Societies or otherwise, regular assemblies of engineers of all varieties should be held where subjects common to all can be discussed and plans for the public welfare developed in which the entire body of engineers can have a part.

It is not good engineering to drift to a result. We do not do it in our professional work. We decide what we want to do and then we do it, and usually pretty well within the time set. The time element is usually as easily determined as the design. It is something of the same spirit that we must get into our group activities. We must seek to formulate the community's problems and then cope with them as we do with the narrower problems of our everyday practice. No scheme of engineering organization will be satisfactory which does not include the broadest possible coöperation with other organized groups—professional, industrial, commercial, and social. Coöperation is of the very essence of the future. Our thought should be centered on the avoidance of any limits in our plans for coöperation.

In conclusion, it may be said that if in our organized activities we make efficient service our watchword and have uncompromising publicity as a day-to-day policy, we will provide a type of leadership which the people will follow. The old disciplines are largely gone. It is up to the technologists—"the profession of creation and construction, of stimulation of human effort and accomplishment,"[1] to erect those standards of effectiveness and aspiration to which a race may rally.

[1] Principles of Mining, Herbert Hoover.

Standard Power Test Codes

ALL who have occasion to test power-plant apparatus will be interested in knowing that the large A.S.M.E. committee which has for some time been revising the Power Test Codes of 1915 will hold its first public hearing on May 25 at the Congress Hotel, Chicago. This public hearing will constitute one of the sessions of the Spring Meeting of The American Society of Mechanical Engineers.

The three Codes which will be presented for discussion and adoption at this hearing are those on Reciprocating Steam Engines, Evaporating Apparatus, and General Instructions. Those who are not able to go to Chicago are urged to send in written criticism and discussion. A pamphlet containing reprints of these Codes in their present form will be supplied on application to the A.S.M.E. Committee on Power Test Codes.

Removable Lighting Fixtures

Recognizing the growing demand for removable electric lighting fixtures for domestic use, the New York Section of the Illuminating Engineering Society devoted its January meeting to a full discussion of the subject. The papers presented and the discussion which followed their presentation bore more or less directly on the proposal that standard ceiling and bracket fixtures be so equipped with plug connections that any layman can put up or take down any fixture at will.

So much interest was aroused at this meeting that the Council of the Illuminating Engineering Society has since considered the possibilities of this proposal and has adopted a resolution urging all concerned to coöperate to the fullest extent in bringing about complete interchangeability of removable lighting fixtures. The resolution lays particular stress on the standardization of the electric attachments and other devices in the early stages of this development.

Standard Tables for Refrigerants

Intimately connected with the work of the A.S.M.E. Committee on a Standard Tonnage Basis for Refrigeration, is the suggestion of its chairman, F. E. Matthews, that the tables which record the physical properties of the various refrigerants be standardized as to the data given and the form and the arrangement of the tables.

Engineers now have available a number of tables giving the physical properties of the saturated vapors of water, ammonia, carbon dioxide, sulphur dioxide, methyl chloride, ethyl chloride, and other media which have been employed or proposed as refrigerants. No two of these tables, it is thought, include exactly the same kind of data arranged in the same order under any uniform system of captions and symbols.

The United States Bureau of Standards is now formulating a table of the properties of ammonia in the saturated and superheated regions. The table covering the saturated region has already been submitted in a tentative form to the American Society of Refrigerating Engineers. Since it is through the direct efforts of that society that funds are being provided for the work of making the final observations and computations necessary to complete these ammonia tables, it may be assumed that the tables will be presented in the form that will be most convenient for the use of refrigerating engineers, provided such form can be determined in advance. The present time, therefore, seems most propitious to invite suggestions from engineers and others in an effort to arrive at the most practical form.

To precipitate discussion on this subject we print below a list of ten column headings which are suggested for the proposed standard tables of physical properties of vapors. The tentative report of the Bureau of Standards referred to, which was printed in the January 18 issue of *Power*, contains ten columns of data. Of the headings listed below, columns 1, 3, 7, 4, 5, 6, 9, and 10 are there employed in the order indicated. In addition to these the Bureau of Standards' table records the Specific Volume of Liquid and the Entropy of Vaporization. It omits, however, Gage Pressure (col. 2) and Weight of Liquid (col. 8).

1 Temperature, deg. fahr. (t)
2 Gage Pressure, lb. per sq. in. (?)
3 Absolute Pressure, lb. per sq. in. (P_1)
4 Total Heat of Liquid above (—) 40 deg. fahr. and deg. cent., B.t.u. (q')
5 Latent Heat of Vaporization, B.t.u. (r)
6 Total Heat of Vapor above (—) 40 deg. fahr. and deg. cent., B.t.u. (i)
7 Specific Volume of Vapor, cu. ft. per lb. (V'')
8 Weight of Liquid, lb. per cu. ft. (?)
9 Entropy—Liquid (s')
10 Entropy—Vapor (?)

The general confusion existing regarding symbols for these quantities is a matter which should also be cleared up if possible at this time. If the symbols adopted could be international standards the results would be well worth striving for. To that end the widest publicity and freest comment are hoped for.

It is probable that differences of opinion will be expressed concerning the inclusion of columns 2, 3, 9 and 10 in a table designed for the convenient use of the operating refrigerating engineer. The questions which naturally arise can be stated as follows:

1 Are all ten columns listed necessary for a handy working table?
2 What substitutions or additions should be made?
3 Should Gage Pressure (column 2) be included?
4 Should the two Entropy columns be retained?
5 What standard symbols should be employed for the quantities listed?

Answers to these questions and written discussion covering other points to be considered in the development of standard tables of physical properties of refrigerants will be given careful attention if addressed the A.S.M.E. Secretary of Standards and Technical Committees.

Automobile Headlighting Specifications Submitted for Approval

The Illuminating Engineering Society has submitted its Automobile Headlighting Specifications to the American Engineering Standards Committee for approval. These specifications are submitted in accordance with the special provision in the procedure of the Committee, under which important standards in existence prior to 1920 may be approved without going through the regular process followed in new work.

The specifications have been adopted in their essential details by the states of Wisconsin, Connecticut and Maryland, and by the Province of Ontario, and have been endorsed by the Standards Committee of the Society of Automotive Engineers; by the International Traffic Officers' Association, and by the conference committee on Uniform Vehicle Laws, representing some 30 different organizations, under the auspices of the National Safety Council.

The American Engineering Standards Committee would be very glad to learn from those interested of the extent to which they make use of these specifications, and to receive any other information regarding the specifications in meeting the needs of the industry.

The Headlighting Specifications of the Illuminating Engineering Society may be found in the Transactions of the Society, Vol. XV, No. 4, June 10, 1920. Copies may also be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York.

At a meeting in London on April 25, of the executive secretaries of the standards associations of the principle commercial countries of the world, Dr. Paul G. Agnew, Secretary of the American Engineering Standards Committee, represented this country. His plans include visits to Belgium, France, Sweden, Switzerland, and Czecho-Slovakia to exchange general information on standardization projects, and to establish more intimate relationship with the standardization bodies of these countries.

LIBRARY NOTES AND BOOK REVIEWS

Belts for Power Transmission. By W. G. Dunkley. Sir Isaac Pitman & Sons, Ltd. (Pitman's technical primer series). Boards, 4 x 7 in., 104 pp., diagram, 7 x 4 in., boards, $1.

This is a small volume, for students and designers, presenting and discussing the factors and considerations involved in belt driving. Tables of use to designers are included.

The Boiler Book. Compiled by H. E. Dart. Published by the Hartford Steam Boiler Inspection and Insurance Co., Hartford, 1920. Paper, 7 × 10 in., 65 pp., 20 illus., $1.50.

This book, which is a novel and useful addition to the published works on boiler practice, is a collection of formulas, data and general information of great value to all having to do with the design, installation, operation and maintenance of steam boilers of all kinds. In accordance with the established practice of the Hartford Steam Boiler Inspection and Insurance Co., all drawings, tables and other data included are in full accordance with the provisions of the A.S.M.E. Boiler Code. The book is published in loose-leaf form and contains a copious index. The illustrations are in the form of blueprints.

Compressed Air. By Theodore Simons. Second edition. McGraw Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 173 pp., illus., tables, $2.

This treatise is intended to give the student such an insight into the natural laws and physical principles underlying the production, transmission and use of compressed air, as will enable him to comprehend the operation of the various appliances used for this purpose and to judge of their merit. The present edition has been carefully revised and partly rewritten.

Copper Refining. By Lawrence Addicks. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 211 pp., illus., tables, $3.

Electrolytic copper refining was for so many years conducted under conditions of strict commercial secrecy that but little has been published regarding the principles of operation, as distinct from descriptions of individual plants. This little book, comprising a series of articles, each dealing with one of the problems of refining, which originally appeared in *Chemical and Metallurgical Engineering*, is almost entirely a record of the author's personal experience.

The Dynamics of the Airplane. By Kenneth P. Williams. John Wiley & Sons., Inc, New York, 1921. (Mathematical monographs, 21.) Cloth, 6 × 9 in., 138 pp., diagrams, $2.50.

This book, intended for students of mathematics and physics who are attracted by the dynamical aspect of aviation, grew out of a course of lectures on aerodynamics given by Professor Marchis, at the University of Paris in 1919. The treatment is elementary for the most part.

Electric Welding. By Ethan Viall. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 417 pp., illus., $4.

This volume is a compilation of the available literature on electric welding, selected and arranged by an experienced editor. It forms a convenient source of information on present methods, apparatus and applications.

Elements of Fuel-Oil and Steam Engineering. By Robert Sibley and C. H. Delany. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 466 pp., illus., tables, $5.

The theme of this book is a study of fuel-oil power-plant operation and the use of evaporative tests to increase their efficiency. It includes an exposition of the elementary laws of steam engineering, the use of oil for fuel in the modern power plant, and the testing of oil-fired boilers. This edition has been rewritten, and much new material added.

Employee Training. By John Van Liew Morris. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 8 in., 311 pp., $3.

This work presents the results of an inquiry into the program and organization machinery being utilized by various manufacturing concerns to train their own workers, both by apprenticeship courses and by vocational training. It shows industry's own solution of its training problems and should be suggestive to manufacturers as a collection of tried methods.

Hendricks' Commercial Register of the United States. Twenty-ninth annual edition (1921). S. E. Hendricks Co., Inc., New York, 1921. Cloth, 8 × 10 in., 2572 pp., $12.50.

This well-known classified directory of manufacturers and dealers in supplies used by engineering firms has been carefully revised, new firms have been added, and those no longer extant have been eliminated. As in previous issues, the directory includes a classified list of dealers, an alphabetical list, an index of trade names, and an index of commodities.

Installing Management in Woodworking Plants. By Carle M. Bigelow. The Engineering Magazine Co., New York, 1920. Cloth, 6 × 9 in., 323 pp., illus., $5.00.

The author's purpose has been twofold; first, to express in a general way his ideas as to the application of the principles of scientific management to an industry, and second, to outline in detail their application to the specific problems of the woodworking industry.

Kinematics and Kinetics of Machinery; a Text Book for Colleges and Technical Schools. By John A. Dent and Arthur C. Harper. John Wiley & Sons, Inc., New York, 1921. Cloth, 6 × 9 in., 383 pp., illus., tables, $3.50.

This treatise gives systematic methods, mainly graphical, of determining velocities, accelerations and inertia forces which can be applied to practically all mechanisms. The text is based upon notes prepared by Professors G. A. Goodenough and F. B. Seeley, and used for instruction at the University of Illinois. These notes have been revised and extended by the authors.

The Locomotive Up to Date. By Chas. McShane. Revised by author. Griffin & Winters, Chicago, 1920. Cloth, 6 × 9 in., 893 pp., illus.' plates, $5.

The first edition of this book appeared over twenty years ago, and found popularity as a clear explanation of the construction, operation and repair of the locomotive, suited to the needs of railway men without special engineering knowledge. The present edition has been revised, enlarged, and partly rewritten, to meet modern conditions.

The Manufacture of Pulp and Paper. Vol. 1. Arithmetic, Elementary Applied Mathematics, How to Read Drawings, Elements of Physics. By J. J. Clark. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 132 pp., illus, $5.00.

This book is the first of a series of five volumes, prepared under the auspices of the Canadian Pulp and Paper Association and the Technical Association of the Pulp and Paper Industry, which is intended to form a suitable course of study in the fundamentals of mathematics and science and the manufacturing operations involved in modern pulp and paper practice. The treatment is simple, as the books are intended for self-instruction, as well as for classroom use.

Marine Engineering. By A. E. Tompkins. Fifth edition, revised. Macmillan and Co., Ltd., London, 1921. Cloth, 6 × 9 in., 888 pp., illus., $11.25.

An extensive one-volume textbook covering a sound course in marine engineering, treating all the subjects usually included in that term. This edition has been extensively revised and many chapters have been rewritten. Much obsolete matter has been omitted and mercantile practice has been considered more fully than before.

Mechanical World Year Book, 1921. Manchester and London, Emmott & Co., Ltd. Cloth, 4 × 6 in., 318 pp., illus., 2s. 6d.

This inexpensive annual is intended as a convenient pocket

(Continued on page 359)

AN INVESTIGATION OF OXY-ACETYLENE WELDING AND CUTTING BLOWPIPES

(*Continued from page 310*)

It was evident that further information was essential if a satisfactory analysis of welding-blowpipe performance was to be made. The greatest discrepancy from what was expected appeared to be in the high gas ratios obtained, and the first attempt to answer the problem was made by a study of gas-ratio phenomena. This seemed particularly desirable as it has been very firmly held by almost all authorities that good welding cannot be done with blowpipes having a high gas ratio.

An extensive series of supplementary gas-ratio tests was accordingly carried out. As a result of these tests a phenomenon of exceeding interest was developed, and gas ratios approaching very nearly the theoretical value obtained. The results obtained accounted partly for the quality of the welding work secured. In some respects, though, they added increased confusion by lack of consistency.

In further study of the data secured by the prescribed tests it was noticed that blowpipes that seemed especially susceptible to flashback were those in which the oxygen was delivered to the blowpipe at a pressure very much in excess of that at which the acetylene was delivered. It was further noticed, that even among such blowpipes, inconsistencies appeared. Critical examination of tip design in these blowpipes suggested a possible explanation. On this basis another series of supplementary tests was made, from the results of which data were secured that clearly explain the cause of flashback phenomena.

The logical continuance of the theory evolved for flashback leads directly to the question of safety in operation and correct gas ratio and will explain, in large part, the reason for so large a proportion of oxy-acetylene welds being of inferior grade.

The essential qualifications for a satisfactory welding blowpipe as enumerated above are therefore very intimately connected with the conditions governing flashback. It seems desirable, then, to begin the discussion of the results obtained in the tests of the investigation by the critical analysis of the conditions conducive to the development of flashbacks in welding blowpipes.

Any obstruction to the gaseous flow at the tip exit produces a back pressure that pushes back within the tip in the most direct line. An acetylene passage entering the oxygen tube at right angles has its flow cut off very quickly, especially when the oxygen pressure is much higher than the acetylene pressure and the point of admission of the oxygen is as it is in most of the tip designs beyond the point of admission of the acetylene. The checking of the acetylene flow is further assisted by the collapse of the partial vacuum and the infiltration of oxygen within the acetylene passage when the developed back pressure retards the aspirating effect existent in all tips of present design. Further, as Fig. 7 (p. 309) shows, in practically all designs the contracted throat is used in the acetylene passage, with the result that even in those blowpipes in which the acetylene is delivered at excess pressure or in which both gases are supposed to operate under equal pressures, a section of reduced or unbalanced pressure exists which is readily affected by the back pressure caused by obstructions at the tip end. It is perceived that under such conditions there are constant changes within the blowpipe tip in the desired one-to-one volume ratio of gases, with the result that a mixture leaner in acetylene is developed and flashback takes place.

The results of a series of gas-ratio tests, especially those run with diffraction gratings to examine the flame spectroscopically, are shown in Table 1 (p. 309), and it will be noticed that the use of gratings shows very marked changes in values. This table shows that practically any of the present blowpipes can be made to produce a neutral flame and burn equal volumes of oxygen and acetylene if the flame can burn undisturbed in the air. But, as indicated above, none of them can maintain such a flame during the welding process.

Referring to the strengths of the welds executed during these tests (see Table 2), it will be seen that the second plate welded during each test invariably showed the higher strength. It will be remembered that to counteract the effects of expansion the 2-ft. test welds were made by welding two 1-ft. lengths of plate. These plates were supported on a heavy iron casting that contained a channel throughout its length parallel to and directly under the line of welds. This channel caused the flame of the blowpipe to return under the plates being welded and thus preheated to some extent the second plate. Further, it caused a decided heating of the near end of the base casting. The explanation for the higher strength shown by the second plate probably lies in the more uniform preheating of the second plate and the greater annealing effect produced by the heated base casting, the latter causing a release of the tensile strains resulting from the contraction of the metal along the line of the weld.

The average strengths and average included angle of bend are given in the above-mentioned table (Table 2) for what they are worth. It is very probable in the light of present knowledge of the requirements of blowpipe design that some new ideas will be forthcoming concerning the average strength of oxy-acetylene welds. Finally in Fig. 8 are exhibited photomicrographs showing the effect upon the grain structure of the material, in this case mild steel, of the autogenous welding process, effects not necessarily detrimental when properly performed, but, as exhibited by the photomicrographs, instructive.

BOOK NOTES

(*Continued from page 358*)

reference book for mechanical engineers and shop superintendents. The most-used data are given on steam engines and boilers, gas and oil engines, gas producers, the properties of metals, structural iron and steel work, toothed gearing, bearings, belting, friction and lubrication, steam fitting, screws and similar subjects. A buyer's directory is included.

A Treatise on Airscrews. By Whyrill E. Park. E. P. Dutton & Co., New York, 1921. (The Directly-Useful Technical Series). Cloth, 6 × 9 in., 308 pp., illus., diagrams, charts, tables, $8.

This book considers the problems of airscrew-propeller design and construction from the viewpoint of designers, draftsmen and others engaged in the practical design of aircraft. In general, it follows the methods developed by Lang Propeller, Ltd. It is intended to supply directly useful information, accompanied by a proper amount of scientific explanation. The theory presented is one that has proved convenient for drafting-room use.

A Treatise on Reinforced Concrete. By W. Noble Twelvetrees. Sir Isaac Pitman & Sons, Ltd., New York, 1920. Cloth, 6 × 8 in., 264 pp., plates, $7.50.

In this volume the author has endeavored to set forth as clearly as possible the general characteristics and distinctive properties of reinforced concrete and its constituents, to discuss in a systematic manner the principles underlying the design of homogeneous members, and to show how these principles may be applied to the evolution of formulas for the design of reinforced-concrete members of different classes. It is restricted to fundamental principles and presents a complete series of formulas for the principal classes of members employed in engineering and building construction. The book is the first to employ the standard notation adopted by the Concrete Institute. This notation is given in full, with an explanatory foreword.

Schmiede und Schmiede-Technik. By C. Oetling. Band 1. R. Oldenbourg, München und Berlin, 1920. Paper, 8 × 11 in., 621 pp., illus., diagrams, 90 Marks.

This volume is the outgrowth of a work submitted in 1911 to the Verein deutscher Maschinen-Ingenieure in competition for a prize offered for systematic study of the value of new methods and apparatus for forging. The report has been expanded, at the request of the prize committee, into an exhaustive examination of forge-shop methods. The present volume, the first of two, was printed in 1914, but has only now been published. It discusses fuels, heating furnaces, methods of controlling heat, forging hammers and presses, shears, saws, welding, measuring instruments, cranes and conveyors.

THE ENGINEERING INDEX

(Registered U. S. Patent Off.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Dust Explosions. Some Electrical Causes of Dust Explosions, David J. Price. Jl. Electricity & Western Industry, vol. 46, no. 5, Mar. 1, 1921, pp. 240–242, 3 figs. Experiments and observations revealed that dust explosions may be produced by electrical bulbs broken in dust clouds, dust collecting on electrical lamps and static electricity produced by friction of finely divided materials.

AERODYNAMICS

Laws. Aerodynamics at Very High Speed, A. Guidoni. Aerial Age, vol. 13, no. 2, Mar. 21, 1921, pp. 31–32, 4 figs. Aerodynamic laws governing design of aeroplanes for extra fast service.

AEROPLANE ENGINES

Compression Ratio and Thermal Efficiency. Compression Ratio and Thermal Efficiency of Airplane Engines, S. W. Sparrow. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 266–268 and 281, 6 figs. Tests conducted by National Advisory Comm. for Aeronautics. Results showed that efficiency of combustion is influenced but little by change in density so long as temperature is maintained constant.

Development. Some Possible Lines of Development in Aircraft Engines, H. R. Ricardo. Aeronautical Jl., vol. 25, no. 123, Mar. 1921, pp. 130–145, 20 figs. Employment of kerosene mixtures as fuel, limiting size of cylinder, and possibilities of working with short compression and long expansion stroke are among chief possibilities considered.

Efficiencies. Aero Engine Efficiencies, A. H. Gibson. Aviation, vol. 10, no. 8, Feb. 21, 1921, pp. 238–240, 2 figs. Experimental examination of manner in which mechanical, volumetric and thermal efficiencies are effected by design and conditions of operation of engine. (Abstract.) Paper read before Royal Aeronautical Soc.

See also Thermal Efficiency.

Fuel-Feed Systems. Fuel Feed Systems for Airplanes, L. B. Lent. Aviation, vol. 10, no. 10, Mar. 7, 1921, pp. 294–298, 6 figs. Developments in planes operated by U. S. Air Mail Service. Critical study and suggestions in regard to improvements.

Mounting. The Installment of an Aeroplane Engine, A. J. Rowledge. Aeronautical Jl., vol. 25, no. 123, Mar. 1921, pp. 145–158 and (discussion) pp. 158–165, 9 figs. Typical mountings of aeroplane engines. Mounting with a view to simplifying attention of engine and making important parts accessible for repair and inspection.

Napier Lion. Some New Napier "Lion" Necessities and "The Cub." Flight, vol. 13, no. 6, Feb. 10, 1921, pp. 93–95, 6 figs. Accessory details on Napier "Lion" such as armouring of ignition cables with material that earths induced currents due to extreme high voltage, brass distributor shielding, and cut-out cock in return lead to pump from carburetor water-jacketing for flight in tropical climates.

Packard. An American Engine for Altitude Work, Jesse G. Vincent. Aviation, vol. 10, no. 9, Feb. 28, 1921, pp. 260–262, 5 figs. Packard type designed for work in high altitudes and recently completed for U. S. Army Air Service.

Special Packard Aero Engine for Altitude Work, Jesse G. Vincent. Aerial Age, vol. 12, no. 25, Feb. 28, 1921, pp. 631–633 and 643, 7 figs. Compression ratio is $6^1/_2$ to 1 and cylinder displacement 1237 cu. in. Throttle is provided as safety stop which is thrown off when altitude of 5000 ft. has been reached.

Panhard-Levassor. Panhard-Levassor 12-Cylinder Airplane Motor, F. P. Mann. Gas Engine, vol. 23, no. 3, Mar. 1921, pp. 75–76, 2 figs. Engine is V-type and develops 240 hp. at speed of 1350 r.p.m.

Steadiness Factor. The Steadiness Factor in Engine Sets, W. Margoulis. Aerial Age, vol. 12, no. 26, Mar. 7, 1921, pp. 659–661, 2 figs. Derivation of formula. Comparison of steadiness factor of engine sets and of engines having constant brake torque as function of speed rotation.

Thermal Efficiency. Means of Materially Increasing Thermal Efficiency, H. R. Ricardo. Automotive Industries, vol. 44, no. 8, Feb. 24, 1921, pp. 456–462, 10 figs. Use of stratified charges and other means for improving efficiency are outlined. Paper read before Royal Aeronautical Soc. of Great Britain.

See also Compression Ratio.

AEROPLANE PROPELLERS

Parachutal Uses. Study of the Resistance Furnished by an Aeroplane Propeller Rotating in a Current of Air (Étude sur la résistance fournie par les hélices tournant dans un courant d'air), M. Lamé. Aérophile, vol. 29, nos. 1–2, Jan. 1–15, 1921, pp. 5–7, 4 figs. Experiments were performed at Eiffel laboratory, Paris, to determine parachutal value of supporting propellers. Empirical formulas and laws are formulated from results obtained.

Performance. Experimental Research on Air Propellers—IV, W. F. Durand and E. P. Lesley. Nat. Advisory Committee for Aeronautics, no. 109, 1921, 11 pp., 12 figs. Investigations of performance of aeroplane propellers.

AEROPLANES

Design. Loads and Calculations of Army Aeroplanes, Ing. Stelmachowski. Aerial Age, vol. 13, no. 1, Mar. 14, 1921, pp. 9–11, 3 figs. Standards for calculation of aeroplane structures. Translated from Technische Berichte.

Downwash. The Determination of Downwash, Walter S. Diehl. Aerial Age, vol. 12, no. 26, Mar. 7, 1921, pp. 655–656, 6 figs. Derivation of downwash formula from Göttingen theoretical and Nat. Physical Laboratory empirical formulas. Technical note of Nat. Advisory Committee for Aeronautics.

Helicopters. See HELICOPTERS.

Manufacture. Details of Large Airplane Work. Am. Mach., vol. 54, no. 9, Mar. 3, 1921, pp. 357–359, 8 figs. Fixtures used in wing construction. Increasing application of metal framing. Installing motors in planes. Methods of assembling fuselages.

Speed Measurement. Note on Measurement of Speed of Airplanes, S. Herbert Anderson. Aviation, vol. 10, no. 8, Feb. 21, 1921, pp. 233–234, 2 figs. Methods for finding true airspeed of airplane when there is wind, from data secured by timed flights over measured course.

Stabilizers. Visible Stabilization of Aeroplanes (Sichtbare Stabilisierung von Luftfahrzeugen), Friedrich Budig. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 2, Jan. 31, 1921, pp. 22–26, 5 figs. Auxiliary supporting plane, attachment indicating course of flight to aeroplane passengers as well as to pilot.

Wings. Some Experiments on Thick Wings with Flaps, C. D. Hanscom. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 271–276, 31 figs. Tests made in wind tunnel of Mass. Inst. of Technology with different models and designs of wings. The Handley-Page Aeroplane Wings, F. Handley Page. Engineering, vol. 111, no. 2879, Mar. 4, 1921, pp. 274–276, 21 figs. Paper read before Royal Aeronautical Soc.

The Handley Page Wing, F. Handley Page. Aeronautics, vol. 20, no. 384, 385 and 386, Feb. 24, Mar. 3 and 10, 1921, pp. 128–130, 16 figs., 153–154, 10 figs., and 167–168, 3 figs. Also Flight, vol. 13, no. 8, Feb. 24, 1921, pp. 130–137, 29 figs; Aerial Age, vol. 13, no. 2, Mar. 21, 1921, pp. 37–38, 16 figs. Record of experimental work carried out with a view to overcoming phenomenon of "burbling." Experiments with slotted aerofoil. Paper read before Royal Aeronautical Soc.

[See also AIRCRAFT, Development during War.]

AIRCRAFT

Developments During War. The Evolution of Aeronautics During the War (L'evolution de l'aéronautique pendant la guerre), M. Renard. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 133, no. 1, Jan. 1921, pp. 21–51, 9 figs. Developments in design and construction of airships and aeroplanes.

German Giant. Development of Giant Aircraft in Germany. Aeronautical Jl, vol. 25, nos. 122–123, Feb. and Mar. 1921, pp. 100–116, 3 figs., and 166–188, 5 figs. Comparative study of types developed during the war. Economics of giant machine from military point of view. Visualization of best type from records of performance of giant German machines during war.

Maintenance. Ground Engineering, H. W. S. Outram. Aeronautics, vol. 20, no. 392, Feb. 10, 1921, pp. 96–98. British air navigation regulations for maintenance of aircraft at airdrome. Paper read before Royal Aeronautical Soc.

AIRCRAFT CONSTRUCTION MATERIALS

Lugs. Design of Standard Lugs, B. C. Boulton. Aerial Age, vol. 12, no. 25, Feb. 28, 1921, pp. 634–637, 8 figs. Summary of work done to determine correct design for standard lugs, notably by Material Section of McCook Field.

Plywood. See PLYWOOD.

AIRSHIPS

Mooring and Handling. A Stabilizing Raft for Mooring Airships Over the Sea, P. H. Sumner. Aeronautics, vol. 20, no. 382, Feb. 10, 1921, pp. 99, 4 figs. Raft fitted with stabilizing planes. Airship Mooring and Handling. Aeronautical Jl., vol. 25, no. 122, Feb. 1921, pp. 71–84 and (discussion) pp. 85–93, 13 figs. Survey of developments in Great Britain.

Note on the Mooring of Airships by "Free" Wire Systems, R. A. Frazer and L. F. G. Simmons. Aeronautical Jl., vol. 25, no. 122, Feb. 1921, pp. 94–99, 6 figs. Experiments conducted at Nat. Physical Laboratory, England.

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Piloting. Airship Piloting. Aeronautical Jl., vol. 25, no. 122, Feb. 1921, pp. 47–71, 5 figs. Controllability under severe weather conditions. Technique of piloting. Methods of aerial navigation.

[See also AIRCRAFT, Development during War; HANGARS.]

ALCOHOL

Industrial. A New Alcohol from Oil—Not Potable. Compressed Air Mag., vol. 26, no. 3, Mar. 1921, pp. 10.005. "Petrohol" manufactured by the Standard Oil Co. of New Jersey from gases given off in cracking process of refining crude oil.

Alcohol Production from Molasses, George M. Appell. Chem. Age (N. Y.), vol. 92, no. 2, Feb. 1921, pp. 53–57, 1 fig. Diagram of classes of raw material and procedure of treatment for production of alcohol.

Industrial Alcohol Status in Canada. Can. Chem. & Metallurgy, vol. 5, no. 3, Mar. 1921, pp. 79–81. Legislation concerning manufacture of industrial alcohol.

Manufacture of Ethyl Alcohol from Wood Waste, E. C. Sherrard. Chem. Age (N. Y.), vol. 29, no. 2, Feb. 1921, pp. 76–79. Plant requirements.

ALLOYS

Standardization. Canadian Mechanical Standards Paper, vol. 27, no. 26, Mar. 2, 1921, pp. 21–27 and 40, 12 figs. Report of Committee on Mechanical Standards of Canadian Paper & Pulp Assn. on standardization of metal alloys used in machinery employed for manufacture of paper. Investigations were conducted on acid-resisting bronze, properties of copper-tin-lead bronze, and antimonial lead, and also on a number of bearing metals.

ALUMINUM

Castings. Machining a Combined Bearing Housing and Control Bracket. Eng. Production, vol. 2, no. 20, Feb. 17, 1921, pp. 219–223, 13 figs. Quantity production of aluminum castings for automotive bearing housing and control bracket.

Conductors. The Use of Aluminum Conductors on Transmission Lines, Theodore Varney. Elec. News, vol. 30, no. 5, Mar. 1, 1921, pp. 30–34, 6 figs. Relative merits of steel-cored aluminum and copper conductors on level and rough courses discussed before Toronto Section, Am. Inst. Elec. Engrs.

Ingots, Piping of. Causes of Piping in Aluminum Ingots, Junius David Edwards and Harold T. Gammon. Chem. & Metallurgical Eng., vol. 24, no. 8, Feb. 23, 1921, pp. 338–340, 12 figs. Measurements of piping and solidification shrinkage show that volume of pipe is dependent on four or even more definite factors, and that it is not specific property of metal or alloy.

Nickel Plating of. Nickel Plating of Aluminum (Le nickelage de l'aluminium), Léon Guillet. Mémoires et Compte rendu des Travaux de la Société des Ingénieurs civils de France, vol. 73, nos. 7, 8 and 9, July–Sept. 1920, pp. 453–470, 10 figs. Procedure.

Sheet. Stages in the Recrystallization of Aluminum Sheet on Heating: With a Note on the Birth of Crystals in Strained Metals and Alloys, H. C. H. Carpenter and Constance F. Elam. Advance Paper, no. 1, meeting of Inst. Metals, Mar. 9, 1921, 22 pp., 38 figs. Results of experiments.

The Recrystallization of Aluminium on Heating, H. C. H. Carpenter and Constance F. Elam. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 302–307, 38 figs. Stages in recrystallization of aluminum sheet on heating, with note on birth of crystals in strained metals and alloys. Interpretation of photomicrographs. Paper read before Inst. of Metals.

Soldering. A Great Progress in the History of Aluminum (Un grand progrès dans l'histoire de l'aluminium), Ch. Faroux. Vie automobile, vol. 17, no. 724, Feb. 25, 1921, pp. 66–67, 2 figs. Soldering aluminum by means of stagneol, an alloy which permits soldering of aluminum in the same manner and with same instruments as for tin soldering.

ALUMINUM ALLOYS

Castings. Analyze Loss in Aluminum Shops—VI, Robt. J. Anderson. Foundry, vol. 49, no. 5, Mar. 1, 1921, pp. 188–191. Reasons for losses in production of aluminum alloys and castings.

Blowholes, Porosity, and Unsoundness in Aluminium Alloy Castings, Robert J. Anderson. Foundry Trade Jl., vol. 23, no. 237, Mar. 3, 1921, pp. 205–207, 8 figs. Data on six heats made on aluminum alloy, no. 12 (92 per cent aluminum and 8 per cent copper), to determine temperature effects.

AMMONIA COMPRESSORS

Mean Effective Pressures. Mean Effective Pressures John E. Starr. Refrigerating World, vol. 56, no. 3, Mar. 1921, pp. 11–12. Tables of multipliers of back pressure and temperature to obtain mean effective pressure and final gas temperatures in compressing gases.

APPRENTICES, TRAINING OF

Systems. Programs of Apprenticeship and Special Training in Representative Corporations—XI, J. V. L. Morris. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 505–507, 3 figs. Practice of Goodyear Tire & Rubber Co., Akron, Ohio. Instruction of many kinds is provided by industrial university.

ARTILLERY

Matériel Developments. The Development of Artillery Matériel, G. F. Jenks. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 167–172, 13 figs. Consideration of artillery-matériel development before war and effect of war upon it, both in U. S. and European countries. Efforts since war have been devoted chiefly to developments of pieces of greater range, greater elevation and greater mobility. Survey of developments of anti-aircraft matériel and coast-defense work is included.

AUTOMOBILE ENGINES

Diesel Type. Diesel Type of Engine for Motor Vehicle Work. Automotive Industries, vol. 44, no. 9, Mar. 3, 1921, pp. 501–509. 2 figs. Built by Deutsche Automobil Constructions Gesellschaft. Engine has two pistons in same cylinder and works on two-stroke cycle. Injection results from explosion in ignition chamber connected with combustion chamber by narrow passage.

Manifold. The L.O.A. Fuel Economiser. Autocar, vol. 46, no. 1321, Feb. 12, 1921, p. 295, 2 figs. Patented manifold where fuel charge is heated by exhaust gases.

Manifolds, Intake Flow. Intake Flow in Manifolds and Cylinders, P. S. Tice. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 282–284, 9 figs. Records of photographic measurements.

Manufacture. Special Machines and Tools in a Motor-Car Works. Machy. (London), vol. 17, no. 438, Feb. 17, 1921, pp. 609–612, 6 figs. Equipment used for milling crankcases, boring and reaming crankshaft and camshaft bearings and other operations.

Packard Fuelizer. The Packard Fuelizer, L. M. Woolson. Jl Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 240–248, 6 figs. Device used as substitute for hot-spot.

Radiators. The Manufacture of Radiator Gills, A. W. Allen. Machy. (London), vol. 17, no. 438, Feb. 17, 1921, pp. 606–607, 4 figs. Types of radiator gills. Tools used in their manufacture.

Spring. Rigid Construction and Clear Appearance Feature of New Engine, J. Edward Schipper. Automotive Industries, vol. 44, no. 9, Mar. 3, 1921, pp. 493–494, 3 figs. Four-cylinder engine designed by Frank S. Spring of Detroit. High power output and good fuel economy are claimed for engine.

Valves. The Graphical Analysis of Valve Gear. Automobile Engr., vol. 11, no. 147, Feb. 1921, pp. 66–67, 4 figs. Simplified method of investigation.

AUTOMOBILE FUELS

Alcohol. Possibilities of Alcohol for Fuel, A. H. Gilbert. Agricultural Eng., vol. 2, no. 1, Jan. 1921, pp. 5–6. Summary of research conducted by technical institutions and government agencies. Committee report presented at meeting of Am. Soc. of Agricultural Engrs.

[See also ALCOHOL, Industrial.]

Characteristics. The Character of Various Fuels for Internal Combustion Engines,—I. H. T. Tizard and D. R. Pye. Automobile Engr., vol. 11, no. 147, Feb. 1921, pp. 55–57. Theoretical investigation of influence of specific heat and dissociation of working fluid, made preliminary to experimental investigation conducted by H. R. Ricardo.

Tests. The Character of Various Fuels for Internal Combustion Engines,—II H. T. Tizard and D. R. Pye. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 98–101, 2 figs. Influence of specific heat and dissociation of working fluid. Calculation of maximum temperature allowing for dissociation.

The Influence of Various Fuels on the Performance of Internal Combustion Engines—II, H R. Ricardo. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 92–97, 7 figs. Experimental investigation into behavior of various automobile fuels. Graphs are given which show relation between air cycle standard efficiency and compression ratio, also variation in mean effective pressure and thermal efficiency with different compression ratios for fuel detonating normally at compression of 5 to 1.

Vegetable Oils. Vegetable Oils as Fuel for Internal Combustion Engines Engr., vol. 121, no. 3402, Mar. 11, 1921, pp. 255–256. Experiments on utilization of palm oil as engine fuel. Reports submitted to Assn. for the Improvement of Belgian Colonies.

[See also ALCOHOL; BENZOL; GASOLINE.]

AUTOMOBILES

Axles. Stub-Axle Stresses, J. L. Napier. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 82–83, 2 figs. Study on stresses and their relation to side-slip.

Design. Need for Greater Service Accessibility in Car Design, T. F. Cullen. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 257–264, 13 figs. Survey of automobiles in regard to accessibility of parts for repairs. Suggestions for increasing accessibility.

Why American, British and Continental Car Designs Differ, M. Olley. Automotive Industries, vol. 44, no. 10, Mar. 10, 1921, pp. 547–553. Writer discusses effect of customs, climate, road conditions, taxes, operating costs, size of industry, point of view and competition upon size, cost, appearance and design of passenger cars. Motoring here is characterized as transportation, while in Europe spirit of adventure still dominates. Considers American braking systems defective.

Landing Gear. The Klemin Amphibious Gear, Donald W. McIlhiney. Aviation, vol. 10, no. 9, Feb. 28, 1921, pp. 271–272, 2 figs. Landing gear composed of ordinary wheel structure and tail skid, both of these parts being retractable.

Manufacture. A Modern Chassis Assembly Plant. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 102–104, 6 figs. Methods of Standard Motor Co., England.

Methods in a Continental Works. Eng. Production, vol. 11, no. 19, Feb. 10, 1921, pp. 195–203, 32 figs. Belgian factory manufacturing motor cars, motorcycles, small arms, small-caliber ammunition and pedal cycles.

Radiators, Alcohol-Water Mixtures for. Report Giving Tables Showing the Freezing Points and Specific Gravity of Alcohol-Water Mixtures. Air Service Information Circular, vol. 12, no. 178, Jan. 20, 1921, 6 pp., 2 figs.

Transmissions. Developments in Transmission, S. Bramley-Moore. Automobile Engr., vol. 11, no. 147, Feb. 1921, pp. 70–75, 33 figs. Developments in clutch and gear-box design.

Gear Box vs. Electrical Transmission. Autocar, vol. 46, no. 1319, Jan. 29, 1921, pp. 189–192, 11 figs. Relative merits of various transmission systems. It is claimed that electric transmission affords greater comfort and longer tire life. Curves are given showing comparative efficiencies of electrical and other methods of power transmission.

Wheel Hubs, Standardization. Move to Unify All Interest in Hub Standardization Work, J. Edward Schipper. Automotive Industries, vol. 44, no. 11, Mar. 17, 1921, pp. 592–594, 1 fig. Standardization for ball-bearing front-axle hubs proposed by representatives of ball-bearing manufacturers at joint meeting with Soc. Automotive Engrs.

AVIATION

Aerial Transportation. Aeroplane & Seaplane Transport Efficiency, H. White-Smith. Aeronautics, vol. 20, no. 385, Mar. 3, 1921, pp. 151–152. Mobility, safety, reliability and economy of working of aerial transportation. (To be continued.) Paper read at Olympia Efficiency Exhibition.

The Cost of Aerial Transportation (Die Kosten der Luftreise). Alexander Baumann. Zeit. fur Flugtechnik u. Motorluftschiffahrt, vol. 12, nos 2 and 3, Jan. 31 and Feb. 15, 1921, pp. 17–20 and 33–35. Points out that if air traffic is to become firmly established, the costs must be reduced. This is possible in a slight degree through constructive methods referred to, but in a far greater degree through establishment of effective traffic routes, proper emergency landings, etc.

Civil. America's First Model Airway. Aviation, vol. 10, no. 9, Feb. 28, 1921, pp. 267–270, 1 fig. Proposed model airway from Washington, D. C., to Dayton, Ohio.

Status of Commercial Aircraft Shown by Company Development. Automotive Industries, vol. 44, no. 10, Mar. 10, 1921, pp. 559–561. List of flying companies operating in U. S. There are 88 companies operating about 400 aircraft units.

The Operation of Civil Aircraft in Relation to the Constructor, H. White-Smith. Flying, vol. 10, no. 2, Mar. 1921, pp. 47–59. Costs of operating commercial air services. Present position of seaplanes, flying boats and amphibians.

U. S. Commercial Aircraft Companies. Aviation, vol. 10, no. 10, Mar. 7, 1921, pp. 299–301. List of commercial aircraft operating companies in the United States and Canada, with account of air port facilities and aircraft owned and rates of service.

Commercial. Norway's Experience of Commercial Aviation. Flight, vol. 13, no. 6, Feb. 10, 1921, pp. 96–97, 3 figs. Records of air service in Norway.

Winged Transportation, Ladislas d'Orcy. Sci. Am., vol. 124, no. 9, Feb. 26, 1921, pp. 168–169, 3 figs. Survey of commercial air service in U. S., Europe and South America. List of world's air transport services.

Soaring Flight. Soaring Flight, M. A. S. Riach. Aeronautics, vol. 20, nos. 383–384, Feb. 17 and 21. 1921, pp. 117–118, 7 figs., and 132–134, 1 fig. Study of forces acting.

B

BEARING METALS

See ALLOYS, Standardization.

BEARINGS, BALL

Housings. Manufacturing a Ball Bearing Housing Eng. Production, vol. 11, no. 19, Feb. 10, 1921, pp 180–184, 10 figs. Jigs and tools for manufacturing small ball-bearing housings in quantities.

BENZOL

Specifications. New Purity Standard for Benzole. Autocar, vol. 45, no. 1323, Feb. 26, 1921, pp. 369. Specifications adopted by British Eng. Standards Assn.

BLAST-FURNACE GAS

Cleaning Process. Recovery Process for Flue Dust, George B. Cramp. Blast Furnace & Steel Plant, vol 9, no. 3, Mar. 1921, pp. 198–202, 1 fig. Claims that first cost of direct-recovery plant is smaller than that of any other process, and also that operating expenses are very low.

Gas Balances. The Relative Distribution of Blast-Furnace Gases as Fundamental Basis of the Heat Economics of Mixed Steam and Gas Power Installations (Die bilanzmässige Verteilung der Gichtgase als Grundlage der Wärmewirtschaft gemischter Werke), G. Schulz. Stahl u. Eisen, vol. 41, no. 5, Feb. 3, 1921, pp. 145–149 and (discussion) pp. 149–150, 5 figs. Results of work of a special commission of engineers in drawing up a gas balance for blast-furnace gases.

Measurement. Measurement of Blast-Furnace Gas, D. L. Ward. Min. & Metallurgy, no. 170, Feb. 1921, pp. 33–34, 1 fig. Study to determine how much surplus power could be produced through proper utilization of entire gas flow from two furnace

stacks at Federal Furnace Plant, South Chicago, Ill., Method of measuring flow of gas.

BLAST FURNACES

Air Preheaters. Air Preheaters (Kritische Bemerkungen über Winderhitzer), Emil Wurmbach. Stahl u. Eisen, vol. 41, no. 3, Jan. 20, 1921, pp. 74–76, 1 fig. Critical discussion of heat transmission from the heating gas to the bricks and from these to the blast.

600-Ton New Blast Furnace Recently Completed. Iron Age, vol. 107, no. 9, Mar. 3, 1921, pp. 570–575, 7 figs. 600-ton furnace furnished with 92-ft. stack, 18-ft. hearth, 22-ft. 6-in. bosh and 16-ft. diameter stock line.

BOILER FEEDWATER

Treatment. Control of Salt Content in Boiler Water, Claude C. Brown. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 264–266, 4 figs. Chart showing amount of blowdown necessary for varying degrees of salinity and varying boiler ratings.

Degassing and Purification of Boiler Feed Water, Paul Kestner. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 291. Process of continuous blowing down used in conjunction with hot purification. (Abstract.) Paper read before joint meeting of Instn. Mech. Engrs. and Soc. Chem. Industry.

Kestner Apparatus for Removal of Gases from Feedwater (L'appareil dégazeur Kestner), M. Perdrizet. Revue générale de l'Electricité, vol. 9, no. 6, Feb. 5, 1921, pp. 185–187, 4 figs. Mechanical and chemical degasification.

"Pure" Water for Locomotives, Paul M. LaBach. Ry. Rev., vol. 68, no. 12, Mar. 19, 1932, pp. 456–460. Suggestions in regard to making calculations involved in computing amount of ingredients to use in treatment processes.

BOILER INSPECTION

Legislation. Uniform Boiler Inspection Laws, C. O. Meyers. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 288–289. Advantages sought and difficulties encountered in enforcement. Experience in Ohio.

BOILER OPERATION

Gas-Fired Boilers. Investigation of Gas-Fired Steam Plant, R. L. Ellis. Power, vol. 53, no. 12, Mar. 22, 1921, pp. 472–473, 1 fig. Study in operating efficiencies and control methods in 48,000 sq. ft. boiler plant using coke oven gas as fuel. Results show CO_2 flue-gas content reliable efficiency indicator, and excess air not requisite for practically complete combustion.

Instruments. A Continuous Densimeter for Boilers. Engr., vol. 131, no. 3398, Feb. 11, 1921, pp. 157–158. Patented apparatus for ascertaining density of boiler water. Principle of operation is that column of distilled water is balanced against column of water contained in boiler.

BOILERS

Baffling. Recent Practice in Baffling Boilers, Kingsley L. Martin. Power Plant Eng., vol. 25, no. 6, Mar. 15, 1921, pp. 135–137, 4 figs. Typical installations of baffles.

Capacity Limitations. Ultimate Boiler Capacity Limited by Stoker Conditions, Joseph Harrington. Elec. Rev. (Chicago), vol. 78, no. 12, Mar. 19, 1921, pp. 451–453, 2 figs. Size and distribution of air openings through grates. Forced draft required to overcome resistance in fuel bed. Formation of clinker influenced by character of coal and other factors.

Feed Regulator. "Anthony" Patent Feed Regulator. Steamship, vol. 32, no. 380, Feb. 1921, pp. 196–198, 2 figs. Patented regulator in which no additional valve for regulating feed water admission need be used, as the special valve provided with apparatus is in itself an automatic check valve, and can be fitted with an isolating valve.

BOILERS, WATER-TUBE

Marine. Water-Tube Marine Boiler (Chaudière marine à tubes d'eau). Bulletin technique du Bureau Veritas, vol. 3, no. 2, Feb. 1921, pp. 55–56, 2 figs. Patented boiler with lateral superheater composed of tubes running in longitudinal direction of boiler. Built by Schmidt'sche Heissdampf Gesellschaft.

BRASS

Cobalt. Cobalt Brasses, Leon Guillet. Chem. & Metallurgical Eng., vol. 24, no. 10, Mar. 9, 1921, pp. 439–443, 11 figs. Experimental comparison of role of cobalt with that of nickel in manufacture of copper-zinc alloys.

Season Cracking. The Season-Cracking of Brass and Other Copper Alloys, H. Moore, S. Beckinsale and Clarice E. Mallinson. Advance Paper, no. 5, meeting of Inst. Metals, Mar. 10, 1921, 91 pp., 23 figs. Experimental investigation of causes of season-cracking at Research Dept., Woolwich, England.

BROACHING MACHINES

Vickers. A New Broaching Machine. Eng. Production, vol. 2, no. 23, Mar. 10, 1921, p. 3289, 2 figs. Machines manufactured by Vickers Works, London, England.

BUILDING CONSTRUCTION

Metal Lath Application. The Correct Application of Metal Lath to Avoid Plaster Cracks. Am. Architect, vol. 119, no. 2358, Mar. 2, 1921, pp. 246–250, 12 figs. Results of tests recently conducted at Armour Institute, showing best forms of application.

C

CABLES, HOISTING

Metallic, Resonance in. Resonance in Metallic Hoisting Cables (La résonance dans les cables d'extraction métalliques), R.-A. Henry. Revue universelle des Mines, vol. 8, no. 3, Feb. 1, 1921, pp. 173–186, 4 figs. Graph is constructed for determining loading and speed which will prevent resonance vibrations in cables of various dimensions.

CAMS

Design. Harmonic Cams With Flat Followers, R. J. Cousins. Automobile Engr., vol. 11, no. 147, Feb. 1921, p. 42, 3 figs. Principles involved in design of cam acting directly on flat-ended tappet.

CAR CONSTRUCTION

Support on Truck. New Type of Support for Railway Cars (Nouveau type de suspension pour voiture à bogies). Génie Civil, vol. 78, no. 8, Feb. 19, 1921, pp. 178–179, 1 fig. Pendulum support. From Revue générale des Chemins de fer.

CAR COUPLERS

Failure. Causes of the Rupture of Railway Car Couplings (Les causes des ruptures d'attelages de chemins de fer). Génie Civil, vol. 78, no. 10, Mar. 5, 1921, pp. 212–215, 14 figs. Interpretation of photomicrographs of ruptured specimens. Failure is attributed to carelessness in forging and insufficiency of elastic resistance in traction springs.

CAR WHEELS

Chilled Cast-Iron. Instruction for Grinding Chilled Cast Iron Car Wheels. Ry. Mech. Engr., vol. 95, no. 3, Mar. 1921, pp. 181–183. Practice of Atchison, Topeka and Santa Fe Railroad. Tables giving grinding diameters for slid flat wheels.

CARS

Automatic Connector. The Futrell Automatic Train Line Connector. Ry. Age., vol. 70, no. 9, Mar. 4, 1921, pp. 516–518, 6 figs. Features are arrangements for locking heads and taking care of movement between couple cars.

Container. Container Car in Express Service on, N. Y. C. Lines. Ry. Mech. Engr., vol. 95, no. 3, Mar. 1921, pp. 171–172, 4 figs. Experimental container car operated by Am. Ry. Express between New York and Chicago. Car consists of nine separate containers or steel boxes firmly secured on car to prevent shifting during train movement. Each container is removable so that it may be transported by motor truck between stores or factories and railroad.

Diesel-Electric. The Diesel Engine in Railroad Service. Ry. Mech. Engr., vol. 95, no. 3, Mar. 1921, pp. 156–159. Diesel-electric cars on Swedish railways.

CARS, FREIGHT

Cost of Reproduction. The Cost of Reproduction of New Steel Freight Cars. Ry. Age., vol. 70, no. 10, Mar. 11, 1921, pp. 553–556, 4 figs. Report issued by Equipment Committee of Presidents' Conference Committee on Federal Valuation. Gondola, hopper, coke and tank cars are taken up. Price is based on weight of so-called base car to which price are added certain net figures to cover cost of specialties.

Six-Wheel Truck. The Lamont Six-Wheel Truck for Freight Cars. Ry. Age, vol. 70, no. 11, Mar. 18, 1921, pp. 729–731, 4 figs. Side frames are continuous over three journals. Special design of equalizing system used.

CASE-HARDENING

Cyanide Action. True Action of Cyanide in Case Hardening Steel, G. R. Brophy and S. B. Leiter. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 330–338, 13 figs. Interpretation of photomicrographs.

Cyanogen Case Carburizing. A New Method of Case-Hardening Steel, W. J. Merten. Can. Machy., vol. 25, no. 9, Mar. 3, 1921, pp. 77–80, 1 fig. Steel and iron alloy articles are case-hardened in stream of cyanogen gas evolved from container filled with an alkali cyanide salt, heated by electrical energy or other means to accomplish vaporization of salt.

Ingots During Casting. The Composite Process of Carburisation of Steel During Casting, Major Waddington. Iron & Coal Trades Rev., vol. 102, no. 2766, Mar. 4, 1921, p. 311, 3 figs. Ingot mold was lined on one side only with amorphous carbon blocks. Rail was subsequently rolled from ingot, running surface of rail corresponding to side with greater carbon content.

Tests. A Research in Case Carbonizing, G. S. McFarland. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 297–305, 24 figs. Comparison of 5 per cent nickel steel, carbon steel and chrome-vanadium steel when used for case carbonizing. Nickel steel proved superior to other two.

CAST IRON

Tests. Mechanical Tests for Cast Iron—Part 1, F. G. Cook. Foundry Trade Jl., vol. 23, no. 234, Feb. 10, 1921, pp. 132–134. Survey of tests usually required by engineers' specifications and of those adopted as guide to efficient working in foundry. (To be continued.) Paper read before London Branch, Instn. British Foundrymen.

CEMENT

Slag. Slag Cement (Béton de scories), B. Jeanneret. Bulletin technique de la suisse romande, vol. 47, no. 3, Feb. 5, 1921, pp. 27–29, 2 figs. Tests of strength of blast-furnace slag cement.

CENTRAL STATIONS

Economical Advantages. Progress of the Superpower Survey. Elec. World, vol. 77, no. 10, Mar. 5, 1921, pp. 539–540. Annual saving to railroads of $90,000,000 through electrification and of 4,000,000 tons of coal by the utilities, together with legislative and financial program, stated in superpower survey being made under auspices of United States Dept. of the Interior.

Progress Report of Superpower Survey. Power, vol. 53, no. 10, Mar. 8, 1921, pp. 395–396. Preliminary report covering investigations of superpower survey being made under auspices of United States Dept. of Interior.

Progress Report on the Superpower Survey. Ry. Age, vol. 70, no. 11, Mar. 18, 1921, pp. 727–728. Cost of electrifying railroads within Boston-Washington industrial region estimated at $40,000 per mile. Progress report on work of superpower survey submitted to president by Secretary of Interior.

Superpower and Its Relation to Industry, Henry Flood, Jr. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 3, Mar. 1921, pp. 192–197, 3 figs. Intense industrial development results from central station practice in large demand for power to operate industries and to provide transportation both for raw material into region and for finished products to people outside of it.

Super-Power Stations for Central Indiana, Frederick L. Ray. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 262–264, 1 fig. General outline of needs, advantages and possibilities of system of generating stations, located in coal mining districts, supplying power to entire central part of state.

Steam Hydraulic Relay Service. Steam Stations for Hydraulic Relay Service, E. B. Powell. Power Plant Eng., vol. 25, no. 6, Mar. 15, 1921, pp. 310–315, 6 figs. Consideration of design factors of various types of supplementary power schemes available. Paper presented at joint meeting of Boston Sections of Am. Soc. Mech. Engrs., Am. Inst. Elec. Engrs., and Boston Soc. Civil Engrs.

Superpower. Industries and Superpower, Harold Goodwin, Jr. Jl. Engrs. Club of Phila., vol 38, no. 194, Feb. 1921, pp. 63–68, 5 figs. Survey of power consumption in northeastern part of U. S., including greater part of New England and New York, New Jersey and Delaware, and part of Pennsylvania and Virginia. Figures of 1914 census indicate that there are about 10,000,000 hp. in zone, and that coal consumption amounts to 60,000,000 tons per annum. Advantages of centralizing power generation are pointed out.

CLOTHS

Mechanical Uses. Cloths for Mechanical Uses, James W. Cox, Jr. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 177–180 and 220. Classification of cloths, enumeration of industries in which they are used, and exposition of their specific uses as absorptives, and for belting, conveying, filtering, etc.

COAL

Briquetting. Briquetted Coal for Household Fuel, J. H. Kennedy. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 2, Mar. 1921, pp. 101–106. European practice.

Cannel. Cannel Coal in Southern Utah, C. A. Allen. Reports of Investigations, Bureau of Mines, Dept. of Interior, Feb. 1921, serial no. 2221, 3 pp. Possibilities of commercial utilization. Over 68 gal. of oil were recovered per ton of coal in experiments.

Recovery from Furnace Refuse. Recovery of Coal from Furnace Refuse. (Kohlengewinnung aus den Feuerungsruckständen). Zeit. für die gesamte Giessereipraxis, vol. 42, no. 3, Jan. 15, 1921, pp. 36–38, 1 fig. "Kolumbus" coke separator based on principle of separation of coke and slag through specific weight.

COAL DEPOSITS

Pennsylvania. Pennsylvania Coals and Shales Greatly Vary in Their Content of Oil, Geo. H. Ashley and Chas. R. Fettke. Coal Age, vol. 19, no. 9, Mar. 3, 1921, pp. 401–403. Comparison of coal deposits and oil resources of Pennsylvania with those of other states.

COAL DUST

Precautions against. Precautions Against Coal Dust. Iron & Coal Trades Rev., vol. 102, no. 2765, Feb. 25, 1921, p. 283. Orders issued by British Secretary of Mines regarding tests to be adopted in connection with precautions against coal dust.

COAL HANDLING

Brown Electric Shovel. By Making Boom Horizontal, Surface Type of Shovel is Adapted to Mine Work, D. C. Ashmead. Coal Age, vol. 19, no. 9, Mar. 3, 1921, pp. 395–396, 2 figs. Brown electric shovel provided with horizontal boom, automatic dipper trip and conveyor.

COAL WASHING

Froth Flotation. Purification of Coal by Froth Flotation. Colliery Guardian, vol. 121, no. 3136, Feb. 4, 1921, pp. 337. Process for recuperating coal dust from refractory fines.

COKE OVENS

Linings. Silica Bricks for Coke Ovens. Iron & Coal Trades Rev., vol. 111, no. 2764, Feb. 18, 1921, pp. 232–233. Comparison of silica and firebrick linings.

COMBUSTION

Control. Control of Combustion (La comburimétrie industrielle), A. Grebel. Génie Civil, vol.

78, nos. 4 and 5, Jan. 22 and 29, 1921, pp. 78–82, 4 figs., and 103–104, 3 figs., Jan. 22. Grebel-Velter apparatus for controlling combustion. Jan. 29: The Frère air recorder.

Stephens Process. Grateless, Smokeless, Automatic Furnace for Steam Power Production at the Mines. Blast Furnace & Steel Plant, vol. 9, no. 3, Mar. 1921, p. 229, 1 fig. Downward sweep of air coming through front of furnace carries measured quantities of fuel consisting of dust and fine particles up to pieces 3/4 in. in size. Dust and fine particles burn in suspension. While burning particles are agitated in vortex maintained within furnace chamber.

CONCRETE

Proportioning Aggregates. New Methods of Proportioning Concrete. Can. Engr., vol. 40, no. 9, Mar. 3, 1921, pp. 263–265. Specifications adopted by Hydroelectric Power Commission of Ontario.

Use in Sea Water. Report of Committee VIII—On Masonry. Bul. Am. Ry. Eng. Assn., vol. 22, no. 233, Jan. 1921, pp. 543–564, 11 figs. Disintegration of concrete and corrosion of reinforcing materials in connection with use of concrete in sea water. Effect upon strength and durability of concrete not having sufficiency of moisture present throughout period of hardening.

Waterproof. How Concrete is Made Waterproof, James Scott. Contract Rec., vol. 35, no. 8, Feb. 23, 1921, pp. 198–199, 4 figs. Analysis of microscopical actions and chemical modifications taking place on addition of "pudlo" to concrete.

Wear Under Water. Water Content Affects Wear of Concrete Test Pieces, Dan Patch. Eng. News-Rec., vol. 86, no. 9, Mar. 3, 1921, pp. 373, 1 fig. Report of behavior of test pieces placed in Boston harbor in 1909.

CONCRETE CONSTRUCTION, REINFORCED

Calculation. Short Cuts for Calculating and Estimating Reinforced Concrete, Milo S. Farwell. Am. Architect, vol. 119, no. 2358, Mar. 2, 1921, pp. 251–254, 14 figs. Graphs for computing costs.

CONDENSERS, STEAM

Cooling of Water in Canal. The Cooling of Water in a Canal, L. C. Kemp. English Elec. Jl., vol. 1, no. 5, Jan. 1921, pp. 210–222, 8 figs. Experiments carried out at Lero Road Power Station, Leicester, England. Situated on banks of canal upon which it relies entirely for cooling of circulating water for condensers.

Incrustation. The Scam-Balcke Process for Preventing Incrustation in Surface Condensers (La "vaccination" des eaux de circulation des condenseurs à surface par le procédé Scam-Balcke). Génie Civil, vol. 78, no. 7, Feb. 12, 1921, pp. 153–157, 12 figs. Addition of hydrochloric acid to transform carbonates into chlorides is basis of process.

Tests. Test Results of a 50,000 Square-Foot Surface Condenser. Power, vol. 53, no. 11, Mar. 15, 1921, pp. 414–416, 4 figs.

COPPER ALLOYS

Copper-Tin. The Constitution of the Alloys of Copper with Tin. Parts III and IV, John L. Haughton. Advance Paper no. 6, meeting of Inst. Metals, Mar. 10, 1921, 22 pp., 23 figs. Experimental study of transformations other than formation of eutectic occurring below 250 deg. cent.

Plastic Deformation. Plastic Deformation of Some Copper Alloys at Elevated Temperatures, C. A. Edwards and A. M. Herbert. Advance Paper, no. 3, meeting of Inst. Metals, Mar. 9, 1921, 25 pp., 11 figs. Experimental investigation.

CORROSION

Browning Rust-Prevention Process. Rust Prevention by Browning Process, W. C. Marshall. Automotive Industries, vol. 44, no. 10, Mar. 10, 1921, pp. 556–558. Specifications for preparation of solutions and methods of application.

Steel Containing Copper. Corrosion Tests with Steel Plates Containing Copper (Rostversuche mit kupferhaltigen Eisenblechen), O. Bauer. Stahl u. Eisen, vol. 41, nos. 2 and 3, Jan. 13 and 20, 1921, pp. 37–45 and 76–83, 11 figs. Account of tests carried out in a pure atmosphere (on roof of material-testing station in Berlin-Dahlem), at the seashore (North Sea), and in industrial district in Westphalia. It is shown that a small addition of copper to iron is a good protection against unfavorable effect of sulphuric acid; phosphorus greatly increases the susceptibility of iron to sulphuric acid and addition of copper neutralizes to certain extent the unfavorable action of phosphorus.

COST ACCOUNTING

Indirect Costs. Aligning the Power Plant with the Cost Department, Malcolm C. W. Tomlinson. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 171–172. Suggestions in regard to reducing power, light and heat costs.

Relation to Production. Costing Methods and Increased Productivity, H. W. Allingham. Eng. & Indus. Management, vol. 5, no. 7, Feb. 17, 1921, pp. 196–198. Discussion held under auspices of British Instn. of Cost and Works Accountants.

CRANE HOOKS

Stresses in. The Strength of a Hook or "Clivvy," Charles D. Mottram. Colliery Guardian, vol. 121, no. 3137, Feb. 11, 1921, pp. 411–412, 4 figs. Measurement of stresses in crane hook where maximum load was 5 tons.

CRANES

Shipyards. Shipyard Cranes, H. H. Vernon. Gen. Elec. Rev., vol. 24, no. 3, Mar. 1921, pp. 230–233, 11 figs. Typical installations of electrically-operated cranes at American shipyards.

CRANKSHAFTS

Manufacture. Crankshaft Turning Practice, J. V. Hunter. Am. Mach., vol. 54, no. 11, Mar. 17, 1921, pp. 456–458, 7 figs. Cheeks, pins and bearings turned in special lathes. Shafts driven from both ends by pot-chucks. Special tooling methods employed.

Quantity Making of Crankshafts. Abrasive Industry, vol. 2, no. 2, Feb. 1921, pp. 49–52, 6 figs. Methods at plant of Automobile Crank Shaft Corp., Detroit.

CYLINDERS

Boring. Methods in a Tractor Engine Plant. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 641–644, 8 figs. Method of machining cylinder liners on rotary type of boring machine at plant of Avery Co., Milwaukee.

D

DIES

Curling. Curling Die Construction, J. Bingham. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 651–652, 4 figs. Punch and die designed to flange out bottom of drinking cup shell and to curl top.

Drop-Forging. Life of Drop Forge Dies, J. S. Glover. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 120–123, 1 fig. Suggests general systematic handling scheme.

Electrical Fixtures. Dies for Electrical Terminals and Connectors, John A. Honegger. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 626–629, 10 figs. Dies employed in manufacture of connectors or terminals for wires of electric lighting units.

Manufacture. Dies for Hemispherical, Conical and Other Flanged Shells, J. Bingham. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 546–548, 8 figs. Details of manufacture and methods of operation.

Piercing. The Design and Construction of Press Tools—II. Eng. Production, vol. 2, no. 20, Feb. 17, 1921, pp. 212–214, 7 figs. Types of piercing dies.

DIESEL ENGINES

Burmeister-Wain. First Details of New Burmeister and Wain Engine for Single Screw Motorships. Motorship, vol. 6, no. 3, March 1921, p. 216, 2 figs. Long-stroke Diesel engines with piston removable from below.

Canadian-Built. The First True Diesel Made in Canada. Power House, vol. 14, no. 5, Mar. 5, 1921, pp. 21–24, 8 figs. Also Can. Machy., vol. 25, no. 11, Mar. 17, 1921, pp. 41–44, 8 figs. Description of 100-b.hp. four-cylinder Diesel engine built by Dominion Steel Products Co.

Double-Acting. The Double-Acting Diesel Engine, A.P. Chalkley. Pacific Mar. Rev., vol. 18, no. 3, Mar. 1921, pp. 149–150, 4 figs. Installation in motorship "Assyrian."

Installations in United States. The Diesel-Engine Industry, L. H. Morrison. Power, vol. 53, no. 9, Mar. 1, 1921, pp. 336–340, 6 figs. Table giving Diesel-engine installations in U. S. by industries, also statistics on installations by states.

Marine. Cooling of Cylinders and Pistons of Marine Diesel Engines, Louis R. Ford. Power, vol. 53, no. 11, Mar. 15, 1921, pp. 426–429, 3 figs. Study of causes of typical piston failures.

Diesel Engine Crankshafts, Joseph Hecking. Mar. Eng., vol. 26, no. 2, Feb. 1921, pp. 147–153, 9 figs. Investigation made in connection with classification rules of Am. Bur. of Shipping.

Standardization. Standardized Diesel Engines, H. R. Setz. Mar. Eng., vol. 26, no. 3, Mar. 1921, pp. 222–228, 6 figs. Suggestions in regard to standardization of four-cycle type. (To be continued.)

DRAWING

Machine Parts. The Relative Economic Value of Drawn Machine Parts and Those Machined from Solid Materials (Wirtschaftlicher Vergleich zwischen gezogenen und aus Vollmaterial hergestellten Maschinenteilen), K. Brendle. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 207–210, 8 figs. A typical example, with preliminary calculations and comparative tables, are given to show that parts machined from solid material could often be produced at much lower cost through drawing.

DRILL CHUCKS

Interchangeable Manufacture. Application of Interchangeability to Drill Chuck Manufacture, Fred. R. Daniels. Machy. (N. Y.), vol. 27, nos. 6 and 7, Feb. and Mar. 1921, pp. 509–515, 9 figs., and 674–679, 18 figs. Tooling and gaging equipment used by Marvin & Casler Co., Canastota, N. Y., in manufacturing Casler twin-screw drill chuck.

DRILLING MACHINES

Multiple. A Machine for Multiple Drilling and Tapping. Automotive Industries, vol. 44, no. 11, Mar. 17, 1921, pp. 611. Employs automobile type friction clutch in main driving pulley to enable power to be shut off when change in direction of rotation of spindles is made.

DRILLS

Pneumatic. Four-Cylinder Pneumatic Drill. Engineering, vol. 111, no. 2879, Mar. 4, 1921, p. 253, 4 figs. Light design with aluminum castings.

DUST

Determination in Air. Efficiency of the Sugar-Tube Method for Determining Dust in Air, A. C. Fieldner, S. H. Katz and E. S. Longfellow. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 2, Mar. 1921, pp. 119–123, 2 figs. Experiments at U. S. Bur. of Mines.

Removal from Grinding Plants. Investigation of Dust in the Air of Granite-Working Plants, S. H. Katz. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2213, 2 pp. Methods used by U. S. Bureau of Mines in coöperation with Granite Manufacturers' Assn. for determining dustiness in granite-working plants.

Reducing Grinding Hazards. Abrasive Industry, vol. 2, no. 2, Feb. 1921, pp. 37–41, 9 figs. Tests conducted in various manufacturing plants by the U. S. Public Health Service revealed that grinders' consumption is prevalent to a great extent in wet grinding plants. Methods of disposing of dust are surveyed.

DYNAMOMETERS

Proude Hydraulic. The Froude Hydraulic Dynamometer, C. H. Peabody. Mar. Eng., vol. 26, no. 3, Mar. 1921, pp. 244–247, 4 figs. Reversible and non-reversible types built in standard sizes up to 6000 hp. by C. H. Wheeler Manufacturing Co.

E

EDUCATION, ENGINEERING

Industries and. What Our Engineering Colleges Owe Our Industries, Robertson Matthews. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 155–158. More character-building, even at expense of specialized training, urged to supply industry with leaders who have human touch.

ELECTRIC CONDUCTORS

See ALUMINUM, Electric Conductors.

ELECTRIC DRIVE

Machine Tools. Standardizing Motors for Tools, H. R. Weedon. Iron Trade Rev., vol. 68, no. 8, Feb. 24, 1921, pp. 555–557, 3 figs. Urges coöperation between motor manufacturers and machine-tool makers in securing possible application of general types of electric motors to machine tools. Paper read before Nat. Machine Tool Builders' Assn.

Mounting Motors. Mounting Motors to Afford Convenience, J. S. Thomas. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 594–597, 3 figs. Methods of mounting motors to increase free space in shop. Typical installations.

Paper Machines. Automatic Speed Control for Sectional Paper Machine Drive, Stephen A. Staege. Elec. Jl., vol. 18, no. 3, Mar. 1921, pp. 78–82, 5 figs. Schematic plan and wiring diagram of Westinghouse system of sectional individual motor drive.

Rubber Industry. The Application of Electric Power to the Rubber Industry. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 1, Jan. 1921, pp. 35–47. Possibilities of electric power. Application of 40-degree and 50-degree motors. Steam versus electrically heated drying ovens. Steam versus electric heat treatment of vegetable compounds.

Textile Mills. Continental Practice in the Electrical Driving of Textile Factories, W. Dundas Fox. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 165–168, 6 figs. Experiments with electric drive at works of Max Schorch & Co., Germany.

Modern Methods of Driving Machines in Jute Manufacture, T. Woodhouse and P. Kilgour. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 159–165, 9 figs. Advantages of electric drive.

Some Considerations in the Application of Electricity to Textile Mills, J. T. Randles. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 153–156, 6 figs. Estimates of power requirements.

The Individual Electric Drive, Frank Nasmith. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 157–159, 6 figs. Developments in application of electric drive in textile mills in U. S.

The Individual Gear Drive for Heavy Looms, G. F. Sills. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 150–153, 8 figs. Typical installations.

The Use of Gears and High Speed Motors in Textile Mills, George S. Sharman. Elecn., vol. 84, no. 2229, Feb. 4, 1921, pp. 168–171, 6 figs. Practice in English mills.

Tinplate Mills. Electricity in the Tinplate Industry, L. Rothera. English Elec. Jl., vol. 1, no. 5, Jan. 1921, pp. 190–198, 10 figs. Typical installations and records of their operation.

ELECTRIC FURNACES

Héroult. First Heat From Naval Electric Furnace. Iron Age, vol. 107, no. 10, Mar. 10, 1921, pp. 617–619, 2 figs. Forty-ton Héroult furnaces operated by U. S. Naval Ordnance plant at So. Charleston, West Va., for refining and finishing steel for gun forgings, armor plate, armor piercing projectiles, and other high-grade miscellaneous forgings.

Iron Founding. Cost of Synthetic Gray Iron Low, R. C. Gosrow. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 242–243. Tables giving cost of electrically melted gray iron produced from iron and from steel.

Electric Furnace Improves Gray Iron, Richard Moldenke. Foundry, vol. 49, no. 6, Mar 15, 1921, pp. 216–218. Sulphur lowered by treating cupola metal or melting direct on basic bottom. Paper read before Am. Inst. Min. & Metallurgical Engrs.

The Electric Furnace in the Iron Foundry, Richard Moldenke. Min. & Metallurgy, no. 170, Feb. 1921, p. 32. Advantages of basic-hearth electric furnace. (Abstract.)

Steel Manufacture. Electric Furnace for High-Speed Steel. Iron Age., vol. 107, no. 11, Mar. 17, 1921, pp. 691–692. Newkirk furnace of two tons capacity, with graphite electrodes and specially constructed bottom electrode.

ELECTRIC LOCOMOTIVES

German. Cars for the Electric Operation of the Berlin Railways (Die Fahrzeuge für den elektrischen Betrieb der Berliner Bahnen), H. Wechmann. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 7, Feb. 12, 1921, pp. 170–174, 14 figs. The locomotive of the German General Electric Co. (AEG) is driven by a series commutator motor of 450 to 460 kw. capacity at speeds of 36 to 60 km. per hr.; weight on driving axle, 17 tons. Notes on recent trial operation of short-train with passenger locomotive of the Siemens-Schuckert Works (SSW); each short has two locomotives each equipped with two motors of 260 kw. capacity.

ELECTRIC RAILWAYS

Operation. The Use of Helpers in Electric Train Operation, W. F. H. Hamilton. Ry. Age, vol. 70, no. 8, Feb. 25, 1921, pp. 455–458, 2 figs. Speed-tractive effort curves on resistance for electric freight locomotives used on Chicago, Milwaukee & St. Paul.

ELECTRIC WELDING

Machines. Electric Welding. Automobile Engr., vol. 11, no. 148, Mar. 1921, pp. 105–109, 18 figs. Methods and machines employed. Tests of welds.

ELECTRIC WELDING, ARC

Foundry Equipment. Arc Welding Equipment in the Foundry, W. W. Reddie. Elec. Jl., vol. 18, no. 3, Mar. 1921, pp. 96–99, 10 figs. Equipment for cutting heavy risers and sink heads from steel or iron castings or for filling blow holes of castings.

Metal Deposition. Phenomena of Arc Welding, O. H. Eschholz. Thirty-ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 8, pp. 59–71, 16 figs. Discussion of metal deposition, fusion and arc stability during electric welding.

Studding. Studding for Arc Welding, C. J. Holslag. Welding Engr., vol. 6, no. 2, Feb. 1921, pp. 25–28, 6 figs. Studding is used where weld is in such position that parts are not free to align themselves to contracting strains which result during cooling. Paper read before Metropolitan Section, Am. Welding Soc.

Tests. Solving Some Arc Welding Problems, A. M. Candy. Foundry, vol. 49, no. 5, Mar. 1, 1921, pp. 179–185, 19 figs. Experiments on strength of welds, current values under varied conditions and rates of cutting different materials. Paper read before Am. Foundrymen's Assn.

EMPLOYMENT MANAGEMENT

Interviewing Applicants. Interviewing for Selection, Earl B. Morgan. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 159–164. Qualifications required for interviewing successfully.

Selection of Employees. Hiring and Placing Men. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 705–706. Methods followed at works of Am. Rolling Mill Co.

ENGINEERS

Registration. The Licensing of Engineers. Min. & Sci. Press, vol. 122, no. 9, Feb. 26, 1921, pp. 297–298. Bill has been introduced in Montana Legislature proposing to create State Board of Engineering Examiners for purpose of licensing engineers. Article gives report on bill prepared by committee of Montana Section, Am Inst. Min. & Metallurgical Engrs. Committee are adverse against passing of bill on ground that it is not necessary and that it will impose burden in time and money on engineers.

Remuneration. Incomes in Engineering Profession Compared with Others. Eng. News-Rec., vol. 86, no. 9, Mar. 3, 1921, p. 387, 2 figs. Iowa Engineering Society investigation of net income of doctors, lawyers and dentists indicates engineers low.

EVAPORATORS

Power Test Code. Test Code for Evaporating Apparatus. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 184–187. Preliminary draft of third of series of nineteen codes in preparation by Am. Soc. Mech. Engrs. Committee on power test codes. Code is intended primarily for apparatus heated by steam such as vacuum pans, or single and multiple-effect evaporators.

EXECUTIVES

Qualifications. Getting Executive Leadership, W. R. Basset. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 492–496. Danger of over-organization. One-man versus committee form of control. Advantages of competitive decentralization.

EXHAUST STEAM

Utilization of. Power from Exhaust Steam. Power Plant Eng., vol. 25, no. 6, Mar. 15, 1921, pp. 303–307, 10 figs. Installation of turbo-generators driven by exhaust steam at plant of Western Drop Forge Co., Marion, Ind.

F

FACTORIES

Layout. Plant of The James Leffel & Co. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 253–257, 10 figs. Layout of plant manufacturing water turbines generates steam for power, light and heat.

Reinforced-Concrete. Extension to Dunlop Tire Co.'s Plant, Toronto. Can. Engr., vol. 40, no. 9, Mar. 3, 1921, pp. 259–263, 9 figs. Flat-slab reinforced concrete construction. Four-way system and hooped interior columns.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FANS, CENTRIFUGAL

Performance. Centrifugal Fans or Blowers, Their Performance and Functions, Fred R. Still. Jl. Engrs. Club of Phila., vol. 38, no. 194, Feb. 1921, pp. 72–76. Notes on design, performance and application.

Steel Works. Fatigue and Efficiency in an Iron and Steel Works, H. M. Vernon. Eng. and Indus. Management, vol. 5, no. 7, Feb. 17, 1921, pp. 201–208, 5 figs. Data compiled by British Ind. Fatigue Research Board.

FERROALLOYS

Iron-Nickel. Iron- Nickel Alloys, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 375–378, 7 figs. Properties and behavior of iron-nickel alloys.

[See also FERROMANGANESE; FERROSILICON.]

FERROMANGANESE

Manufacture in Electric Furnace. Manufacture of Ferromanganese in the Electric Furnace, Robert M. Keeney and Jay Lonergan. Min. & Metallurgy, no. 170, Feb. 1921, pp. 30–31, 2 figs. Electric-furnace production of ferromanganese in 1920 amounted to 10,000 tons. There are now installed 33 electric furnaces of from 350 kva. to 5000 kva. capacity with total installed transformer capacity of 58,000. (Abstract.)

FERROSILICON

Properties. Influence of Silicon Upon the Properties of Ferrosilicon, A. T. Lowzow, Chem. & Metallurgical Eng., vol. 24, no. 11, Mar. 16, 1921, pp. 481–484, 9 figs. Investigation of samples of ferrosilicon containing from 49.1 per cent to 77.46 per cent silicon. Physical and chemical properties were determined. Translated from Tidskrift for Kemi.

FITS

Forced. Chart of Pressures for Forced Fits. Machy. (London), vol. 17, no. 439, Feb. 24, 1921, p. 648, 1 fig. Chart for determining pressure required to assemble parts having forced fit. Computed from standard formulas.

FLAME PROPAGATION

Closed Cylinder. The Nature of Flame Movement in a Closed Cylinder, C. A. Woodbury, H. A. Lewis and A. T. Canby. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar. 1921, pp. 209–218, 21 figs. Experimental work undertaken to determine characteristic flame movement of automobile fuels and physical and chemical properties which influence it. Theory is developed that arrests occurring in mixture fired without turbulence and consequent vibrations observed in burning gases are due to high density developed in gases ahead of flame front. Knock is explained by auto-ignition of high density gases ahead of flame front.

FORGING

Hydraulic-Press Operations. Hydraulic Forge Press Operations. Am. Mach., vol. 54, no. 11, Mar. 17, 1921, pp. 467–469, 3 figs. Data on work required for punching operation. Examples of forging various types of shells and tubes.

FOUNDING

Research. The Value of Scientific Research to Iron Founding, J. G. Pearce. Foundry Trade Jl., vol. 23, no. 234, Feb. 10, 1921, pp. 123–124. Experience of British Cast Iron Research Assn.

FOUNDRIES

Electrically Operated. Foundry is Electrically Operated, H. E. Diller. Iron Trade Rev., vol. 68, no. 8, Feb. 24, 1921, pp. 559–563, 8 figs. Current is utilized for melting furnace charges, annealing castings and for baking molds and cores. Annealing operation is intermittent. How light steel castings are made.

Layout. Types of Foundry Buildings. Foundry Trade Jl., vol. 23, no. 236, Feb. 24, 1921, pp. 170–171, 1 fig. Suggested layout for foundries.

Waste Reclamation. The Reclamation of Metals from Foundry Waste, J. P. Norrie. Can. Chem. & Metallurgy, vol. 5, no. 3, Mar. 1921, pp. 77–79, 3 figs. Reclaiming and smelting process of Rome Brass & Copper Co., Rome, N. Y.

FUELS

Industrial Uses. Form Value of Energy in Relation to Its Production, Transportation and Application, Chester G. Gilbert and Jos. E. Pogue. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 139–144, 2 figs. Factors covering selection of fuel for industrial heating. Comparative cost per B.t.u. at unit prices for bituminous and anthracite coal, natural gas, city gas, oil fuel, kerosene oil, gasoline and electricity.

Liquid and Gaseous from Coal. Coal as a Future Source of Oil Fuel Supply, Arthur Duckham. Jl. Instn. Petroleum Technologists, vol. 7, no. 25, Jan. 1921, pp. 3–12 and (discussion), pp. 13–26. Scheme for manufacture of liquid and gaseous fuels from coal is suggested which involves total gasification of coal in one vessel, and condensation and recovery of volatiles in liquid form, distillation being carried out at such temperatures and in such manner that minimum of cracking takes place.

Thermalene. New Fuel. Power House, vol. 14, no. 4, Feb. 20, 1921, p. 29. Mixture of acetylene and vaporized oil named thermalene, consisting of alternate layers of calcium carbide and crude oil absorbed in sawdust.

[See also AUTOMOBILE FUELS; COAL; LIGNITE; OIL FUEL; PEAT; PULVERIZED COAL; WATER GAS.]

FURNACES, BOILER

Rotating-Hearth. A New Type of Mechanical Furnace—The Rotating Hearth Romanet Furnace (Un nouveau type de foyer méchanique: la grille à sole tournante), A. Colomb. Chaleur et Industrie, vol. 2, no. 1, Jan. 1921, pp. 27–34, 7 figs. Fire grate is circular and rotates continuously in horizontal plane.

FURNACES, FORGING

Gas-Fired. The Application of Gas Fuel to Forging. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 703 and 745–746. Requirements for satisfactory forging-furnace fuel. Comparison of gas with oil and coal.

Siemens. Small Forge Furnace of Regenerative Type, F. J. Denk. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 107–108 and 111, 4 figs. European progress in design of Siemen's regenerative type of forging furnace.

FURNACES, HEAT-TREATING

Car vs. Car-and-Ball Type. Car Type and Car-and-Ball Type Furnaces. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 112–119, 9 figs. Factors determining selection of type of heat-treating furnace.

FURNACES, HEATING

Gas-Burning. The Possibilities of Gaseous Heating, W. Newton Booth. Gas Jl., vol. 153, no. 3011, Jan. 26, 1921, pp. 223–227, 4 figs. Data on efficiency of gas-burning furnaces. Paper read before London & Southern District Junior Gas Assn.

Stoker-Fired. Stoker Fired Heating Furnace Installation, Nelson G. Phelps. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 123–126, 7 figs. Data on performance of heavy-duty plate and angle-heating furnaces installed by New York Shipbuilding Corporation.

FURNACES, INDUSTRIAL

Gas-Fired. Gas Furnaces for Melting Non-Ferrous Metals, M. A. Combs. Chem. & Metallurgical Eng., vol. 24, no. 12, Mar. 23, 1921, pp. 515–516, 1 fig. Economical comparison of gas-fired furnaces with electric furnaces and oil-fired furnaces.

G

GAGES

Block. New Precision Measuring Device. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 657–658, 2 figs. Device for measuring within hundred-thousandth part of an inch by use of only six precision measuring blocks, designed by B. M. W. Hanson, Hartford, Conn.

Interference Bands. The Hilger Interference Gauge. Engr., vol. 131, no. 3398, Feb. 11, 1921, p. 157, 3 figs. Shows with certainty differences of 0.00001 in. and permits estimation of differences of 0 000001 in.

GAS

Industrial Uses. Conserving Coal through the Use of Gas, W. A. Ehlers. Coal Age, vol. 19, no. 9, Mar. 3, 1921, pp. 397–400, 3 figs. Elimination of waste through easy regulation and control of heat within narrow limits is cited as advantage of gas over coal for industrial uses.

GAS MANUFACTURE

Dayton Process. The Dayton Process, F. C. Binnall. Jl. Indus. & Eng. Chem., vol. 13, no. 3, Mar. 1921, pp. 242–246, 5 figs. Air-oil gas process in which partial combustion of certain constituents of oil takes place within retort or reaction chamber itself, thus supplying internally all heat necessary for thermal decomposition of hydrocarbons.

Mixing Various Coals. Mixed Coal Experiments, Wm. C. Butterworth. Gas Rec., vol. 19, no. 5, Mar. 9, 1921, pp. 11–13. Tests of mixing various coals for gas making. Scheme has been developed to improve quality of coke and reduce coal costs.

GAS TURBINES

Holzwarth. A New Gas Turbine. Engr., vol. 131, no. 3398, Feb. 11, 1921, pp. 143 and 145. Resumption at works of Thyssen & Co. of experiments with gas turbine invented by H. Holzwarth, described in Engr., Dec. 8, 1911 and Jan. 5, 1912. Tests are being directed to obtaining of more economical pressure of exploding gas, and it is reported that they have been largely successful in so far as effective pressure of 170 lb. to 200 lb. per sq. in. is now obtained, as against 70 lb. to 85 lb. per sq. in. formerly.

GASOLINE

Production in United States. Quality of Gasoline Marketed in the United States, H. H. Hill and E. W. Dean. Dept. of Interior, Bur. of Mines, bul. 191, 1920, 275 pp., 22 figs. Production in U. S. has increased approximately 7,000,000 bbl. for calendar year of 1918. Quantity of crude oil handled in refineries has increased from 67,000,000 bbl. in 1904 to 326,000,000 bbl. in 1918. Yield of gasoline 42-gal. bbl. of crude oil has increased from 413 gal. in 1904 to 11 gal. in 1918.

GEAR CUTTING

Machine for. Machine for Cutting Small Spur or Bevel Gears. Machy. (London), vol. no, 17. 439,

Feb. 24, 1921, pp. 647–648, 3 figs. Knee-type horizontal machine built by T. Ratcliffe, Manchester, England.

Reinecker Turbine Reduction-Gear Hobbing Machines. Am. Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 416–417, 4 figs. Three large German mcahines for hobbing gears up to $19^1/_2$ ft. in diameter. Traversing hob used.

Rapid. Some Examples of Fast Gear Cutting, S. A. Hand. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 503–504, 4 figs. Practice at shop of Gould & Eberhardt, Newark, N. J.

GEARS

Bevel. Generating Bevel Gears, H. E. Kitchen. Machy. (London), vol. 17, no. 440, Mar. 3, 1921, pp. 669–670, 4 figs. Attachment manufactured by Matterson, Ltd., England, for generating bevel gears on shaping machine.

Inspection. Proposed Methods of Automotive Gear Inspection. Automotive Industries, vol. 44, no. 11, Mar. 17, 1921, pp. 609–610. Gear Makers' Assn. developing standard practice for inspection of their product. Size of hole, wear of gages, tapered holes, keyways, tooth bearing, splined shafts and methods of test are some of items considered.

Involute. The Involute Gear, Francis W. Shaw. Machy. (London), vol. 17, no. 438, Feb. 17, 1921, pp. 617–618, 10 figs. Fisher segmental involute tooth.

The Maag System of Gearing. Machy. (Lond.), vol. 17, no. 437, Feb. 10, 1921, pp. 575–581, 13 figs. System developed by Max Maag, Zurich. Standards for pitches, relations between addenda and dedenda and pressure angle are subsidiary, that is, any pitches are possible.

Spiral. Chart for Selecting Spiral Gears, C. W. Mapes Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 569–570, 1 fig. Chart developed to aid in selecting and calculating spiral gears with shafts at right angles to each other.

GRINDING

Cylindrical. Cylindrical Grinding in 1920, W. H. Chapman. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 173–176, 2 figs. Study of laws involved in cylindrical grinding and analysis of grinding action both for draw-in cuts and traversed cuts. Formulas are derived for wheel wear in terms of known variables such as grain size of wheel, work speed, wheel speed, feed, etc. Production costs are also discussed as well as factors that should be considered in securing highest possible grinding efficiency.

Diamonds. Diamonds for Industrial Purposes, Maurice S. Dessau. Abrasive Industry, vol. 2, no. 1, Jan. 1921, pp. 8–9, 8 figs. Machine and processes for grinding diamonds.

Dust Removal. Reducing Grinding Hazards. Abrasive Industry, vol. 2, nos. 2 and 3, Feb. and Mar., 1921, pp. 37–41, 9 figs., and 101–105, 8 figs. Constant inhalation of abrasive dust causes serious pulmonary affections. Causes of excessive dust and its disposal are explained. Attention to work rests, it is claimed, will eliminate many accidents.

H

HANDLING MATERIALS

Factories. Intra-Factory Transportation, L. R. Clapp. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 195–197. Practice of Ford Motor Co.

Monorail System in German Shell Plant, Hubert Hermanns. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 117–119, 22 figs. Overhead trolley system for transportation of shells.

Putting the Factory Floor on Wheels. Factory vol. 26, no. 4, Feb. 15, 1921, pp. 475–479, 18 figs. System of handling materials installed in plant of Automatic Electric Washer Co.

Railways. Problems of Handling Material and Freight on Railroads, Charles N. Winter. New England Railroad Club, Feb. 8, 1921, pp. 289–323. Equipment used.

HANGARS

Reinforced-Concrete. Reinforced Concrete Hangars for Housing of Two Dirigible Balloons at Lucon, France (Hangar enbéton armé pour deux dirgieables à Lucon (Vendee), Ch. Dantin. Génie Civil, vol. 78, no. 7, Feb. 12, 1921, pp. 145–148, 7 figs. Dimensions: Length, 220 meters; width, 109.6 meters; total height, interior, 53 meters.

Wire-Rope Roof. Use of Wire Rope for the Construction of Work Shops and Aircraft Hangars with Suspension Roof (L'application des cable à la construction d'ateliers et de hangars pour avions ou dirigeables, à toiture suspendue), G. Leinekugel Le Coco, Génie Civil, vol. 78, no. 10, Mar. 5, 1921, pp. 205–211, 20 figs. partly on supp. plate. Typical installations at Cherbourg, France, and at Karouba, Tunis. Considerations of design of such structures.

HEALTH

Industrial. Health Service in Industry. Nat. Indus. Conference Board, report no. 34, Jan. 1921, 61 pp., 2 figs. Survey of developments in organization of medical department in industries, and discussion of method of procedure which have been applied advantageously in individual establishments.

HEATING, ELECTRIC

Advantages. Electric Heating and the Importance of Its Developments in France (Le chauffage électrique et les advantages de son développement en France). Génie Civil, vol. 78, no. 7, Feb. 12, 1921, pp. 148–151, 2 figs. Economic comparison of electric heating with other heating processes. Survey of developments in industrial electric heating in U. S., Canada, Scandinavian countries, Switzerland, etc.

Household Uses. Thermal Characteristics of Electric Ovens and Hot Plates. Engineer, vol. 131, no. 3399, Feb. 18, 1921, pp. 176–177. Tests at National Physical Laboratory, England, on efficiency of hot plates for roasting, baking, frying and boiling.

HEATING, HOT-AIR

Research. Progress Report of Committee on Furnace Heating, A. C. Willard and A. P. Kratz. Jl. Am. Soc. Heat & Vent. Engrs., vol. 27, no. 2, Mar. 1921, pp. 124–132, 4 figs. Proposed furnace-testing codes for both pipeless and piped furnace systems as developed in warm-air furnace research work at University of Illinois.

HEATING, HOT-WATER

Forced-Circulation System. Forced Hot-Water Circulation Heating System, Girard Estate, Philadelphia, Robert Hughes. Jl. Am. Soc. Heat & Vent. Engrs., vol. 27, no 2, Mar. 1921, pp. 107–108, 7 figs.

HEAVY-OIL ENGINES

Ingersoll-Rand. A New Development of the Heavy Oil Engine, F. A. McLean. Power House, vol. 14, no. 4, Feb. 20, 1921, pp. 26–29, 4 figs. Ingersoll-Rand, Price Rathbun type.

HELICOPTERS

Experimental. A Series of Flights Effected with Helicopter on the 15, 28 and 29 of Jan. 1921 (Une série de vols en helicoptère libre monté effectués les 15, 28 et 29 janvier 1921), Etienne OEhmichen. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 7, Feb. 14, 1921, pp. 366–368. Apparatus has two propellers about 21 ft. in diameter, rotating in opposite directions. Horsepower of engine is 25. In experiments helicopter was raised vertically up to height of 10 ft.

Military. A Helicopter for Military Purposes. Sci. Am., vol. 124, no. 9, Feb. 26, 1921, p. 173, 1 fig. Pescara helicopter being tried by French Military Commission. Each of two propellers comprises six spokes which carry wings of biplane design. Propellers revolve at 200 r.p.m.

HOBBING MACHINES

See GEAR CUTTING, Machines for.

HOISTING ENGINES

Mine. World's Largest Hoisting Engines, R. C. Demary. Nat. Engr., vol. 25, no. 3, Mar. 1921, pp. 108–111, 3 figs. Engines at Michigan mine 5300 ft. deep. Four steam cylinders, 36 in. x 72 in. driving 36-ft. diameter conical drum.

HOISTS

Electrically Operated. Marine Railways, C. B. Connely. Gen. Elec. Rev., vol. 24, no. 3, Mar. 1921, pp. 240–243, 8 figs. Typical installations of electric hoists at American drydocks.

Skip. Skip Hoisting for Coal Mines, Andrews Allen and John A. Garcia. Min. & Metallurgy, no. 170, Feb. 1921, pp. 35–36. Advantages of skip hoisting are: Hoisting capacity capable of taking care of all coal and rock that can be mined; smaller shaft; and large ratio of lading to gross weight.

Why Some Operators are Substituting Skips for Cages in the Hoisting of Coal, Andrews Allen and John A. Garcia. Coal Age, vol. 19, no. 11, Mar. 17, 1921, pp. 485–489, 4 figs. Modifications in design necessary where large coal must be produced. Paper read before Am. Inst. Min. & Metallurgical Engrs.

HOSE COUPLINGS

Air Brakes. Repairing Air-Brake Hose Connections, J. V. Hunter. Am. Mach., vol. 54, no. 9, Mar. 3, 1921, pp. 377–378, 6 figs. Pneumatic devices used at Decatur car shops of Wabash Railway Co.

HOUSING

Concrete Dwellings Ltd., Westminster. The "C. D. L." System of Concrete Construction. Concrete & Constructional Eng., vol. 16, no. 2, Feb. 1921, pp. 118–123, 7 figs. Solid walls, or hollow walls with concrete ties are constructed by means of traveling mold. In case of hollow-wall mold is provided with core; if solid wall is desired, core is absent.

Hayes, England. Concrete Cottage Building. Hayes Housing Scheme. Concrete & Constructional Eng., vol. 16, no. 2, Feb. 1921, pp. 105–111, 9 figs. Houses erected with solid concrete walls and timber shuttering.

Industrial, U. S. Housing by Employers in the United States, Leifur Magnusson. U. S. Dept. of Labor, Bur. of Labor Statistics, no. 263, Oct. 1920, 283 pp., 111 figs. Representative examples of manufacturing towns and mining communities.

HYDRAULIC TURBINES

Water Measurement. New Method of Water Measurement in Efficiency Tests of 37,500-hp. Turbines, N. R. Gibson. Power, vol. 53, no. 12, Mar. 22, 1921, pp. 452–458, 17 figs. Efficiency tests of three units in station of Niagara Falls Power Co. are described with particular reference to application of Gibson method and apparatus for measuring flow of water in penstocks. Paper read at joint meeting of Engrs. Club of Phila. & Phila. Sections of Am. Soc. Civil Engrs., Am. Inst. Elec. Engrs. & Am. Soc. Mech. Engrs.

New Method of Water Measurement in 37,500-hp. Turbine Tests. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 591–593, 8 figs. Discharge is measured by pressure developed in penstock when turbine gates are closed. Method has been applied at Niagara Falls.

Wheel for. New Type of Wheel for Hydraulic Turbine (Tipo nuevo de rueda para turbina hidràulica), Forrest Nagler. Ingenieria Internacional, vol. 5, no. 4, April 1921, pp. 206–208, 2 figs. Four-bladed propeller rotating at 50 r.p.m.

HYDROELECTRIC PLANTS

Austria. The Construction of the Power Station at Waterfalls on the Mur River (Austria) (Der Bau des Murfallwerkes), Otto Judtmann. Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 73, nos. 1–2, Jan. 14, 1921, pp. 5–6, 4 figs. Construction details of nearly completed light and power station begun in 1919.

Automatic. Automatic Hydroelectric Plants for Power and Lighting. T. A. E. Belt. Elec. Rev (Chicago), vol. 78, no. 11, Mar. 12, 1921, pp. 417–420, 5 figs. Types of control and regulating equipment available for use with stations operating without individual attendants.

Bavaria. Hydroelectric Development in Bavaria (Ueber den Ausbau der Wasserkräfte in Bayern), Phillip Forchheimer. Zeit. des Oesterr. Ingenieur-u. Architekten-Vereines, vol. 73, nos. 1–2, Jan 14, 1921, pp. 1–3. Summary of projects to be financed by State and private industries, totaling 223,700 hp., which is greatly in excess of total (112,838 hp.) already developed.

California. Hydro-Electric Plant Built in 15 Months, R. C. Starr. Elec. World, vol. 77, no. 9, Feb. 26, 1921, pp. 461–474, 8 figs. Methods that were employed to hasten 50,000-hp. Kerckhoff development (California) which was undertaken to relieve power shortage resulting from postponement of construction during war period.

Economical Operation. Note on a System for Accumulation of Energy Which Permits more Economical Operation of a Hydroelectric Central Station (Di un sistema di accumulazione d'energia, per una migliore utilizzazione delle centrali idroelectriche), Alfredo Mauceri. Elettrotecnica, vol. 8, no. 4, Feb. 5, 1921, pp. 73–75. Thermal electric installation at Olten, Switzerland.

England. The Lochaber Hydro-Electric Scheme. Engr., vol. 131, no. 340, Mar. 4, 1921, pp. 226–227, 2 figs. Scheme for production of from 70,000 to 75,000 hp. continuously.

Muscle Shoals. Completion of Muscle Shoals Plant Urged. Elec. World, vol. 77, no. 11, Mar. 12, 1921, pp. 587–590, 6 figs. Proposed dam and power house is structure 4200 ft. long situated on Tennessee River above Florence, Ala. As part of installation there will be locks providing for navigation past dam with total lift of 90 ft. above level of proposed lower pool.

Hydro-Electric Project at Muscle Shoals, A. S. McBride. Power, vol. 53, no. 11, Mar. 15, 1921, pp. 422–424, 3 figs. Five-hundred-thousand-horsepower project at Wilson Dam, to supply power at 4 mills per kilowatt-hour for continuous, and 1 2 mills for surplus, energy.

North Wales. Actual and Projected Water Power Developments in North Wales, John B. C. Kershaw. Engr., vol. 131, no. 3400, Feb. 25, 1921, pp. 195–198, 10 figs. Developments contemplated will furnish an additional 35,000 kw. at 34,600 volts.

Norway. The Hydro-Electric Power Scheme at the Nore Falls. Engineering, vol. 11, no. 2879, Mar. 4, 1921, pp. 248–249, 5 figs. Developments by Norwegian government of hydroelectric power scheme near Christiania. (To be continued.)

Pressure Shafts. The Calculation of Pressure Shafts (Zur Berechnung von Druckschächten), J. Büchi. Schweizerische Bauzeitung, vol. 77, nos. 6, 7 and 8, Feb. 5, 12 and 19, 1921, pp. 61–63, 73–76 and 88–91, 11 figs. Notes on investigation of an Austrian pressure shaft through rock, dealing with general construction procedure and the separate problems; calculation of influence of the internal water pressure; influence of contraction of the concrete, and of temperature; insufficient laying on of concrete; longitudinal and round joints; drainage of pipe; pressure of soil; rust deterioration; comparison of costs.

Weedon, P. Q. Hydro-Electric Plant at Weedon, P. Q., for City of Sherbrooks. Contract Rec., vol 35, no. 10, Mar. 9, 1921, pp. 229–230, 4 figs. Plant will develop 4000 hp. and deliver energy at 50,000 volts along transmission line 28 miles long.

[See also WATER POWER.]

I

ICE PLANTS

Electrically Operated. Electrically Operated Ice Plants, Reginald Trautschold. Refrigerating World, vol. 56, no. 3, Mar. 1921, pp. 12–13. Development of electric drive for ammonia compressors.

INDUSTRIAL MANAGEMENT

Administrative Research. Industrial Research in the Art of Man Management, Erwin H. Schell. Am. Mach., vol. 54, no. 9, Mar. 3, 1921, pp. 364–367. Administrative research recommended for standardization of policies. Questionnaire suggested.

Chemical Plants. Taking Industrial Chemistry Into Partnership—I, Frederic Dannerth. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 151–154. Standard practice for chemical industry process management.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 8, Jan. 25, 1921, p. 58. Proposal of the Committee for Economic Production for

instruction sheet for the ordering and delivery of machine tools.

Legislation. The Future of Industrial Management, F. M. Lawson. Jl. Royal Soc. of Arts, vol. 69, no. 3559, Feb. 4, 1921, pp. 164–171 and (discussion) pp. 171–175. Discusses enacting of future legislation for promotion of industrial peace.

Planning Departments. Practical Organization Principles, G. Sumner Small. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 183–186. Principles underlying practical organization of industrial departments.

Production Systems. Color Cycle Production Control, Carle M. Bigelow. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 168–170, 4 figs. Method adopted in knitted underwear plant.

Controlling the Flow of Production, H. K. Hathaway. Indus. Management, vol. 61, no. 5, Mar. 1 1921, pp. 175–179, 5 figs. How to keep track of split or broken lots on single route-sheet.

Increasing Production by a Rational Piece-Work System, John C. Spence. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 519–520. Experiences of manufacturers with piece-work system.

Modern Production Methods—XV, W. R. Basset. Am. Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 398–402, 7 figs. Forms for accounting for supplies.

Production Methods of Rolls-Royce Plant. Iron Age, vol. 107, no. 9, Mar. 3, 1921, pp. 555–559, 4 figs. Experience of automobile factory built in America along lines of English works.

System for Production Control. Machy. (N.Y.), vol. 27, no. 7, Mar. 1921, pp. 647–650, 8 figs. Methods employed in plant of Am. Multigraph Co., for recording progress of work.

Safety. Safety Organization in Machine Shops. Eng. & Indus. Management, vol. 5, no. 8, Feb. 24, 1921, pp. 232–233. Safety organization of typical firm.

Safety Methods Applied in the Ryerson Steel-Service Plants. Chem. & Metallurgical Eng., vol. 24, no. 8, Feb. 23, 1921, pp. 351–354, 6 figs. Outline of general organization for safety promotion in plants and of results leading to better relationship between management and workers and to ultimate reduction of plant-operating costs and higher efficiency.

Shop Methods. Sharpening Up Dull Periods. Factory, vol. 26, no. 6, Mar. 15, 1921, pp. 718–723. From results of questionnaire to 325 plants asking them for description of their practices in slack times.

Storing Materials. Stores Engineering, M. T. Montgomery. Proc. Engrs. Soc. Western Pennsylvania, vol. 36, no. 10, Jan. 1921, pp. 641–673 and (discussion) pp. 674–682, 26 figs. Storekeeping practice of Pittsburgh Railways Co.

Systems. Idealism as a Factor in Management, Herbert Rollin White. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 165–167. Application of "golden rule" in industrial management. Examples of successful management.

Toolroom Organization. A Tool System That Speeds Production, William J. Burger. Factory, vol. 26, no. 4, Feb. 15, 1921, pp. 458–460, 6 figs. Toolroom organization of Warner & Swasey Co.

INDUSTRIAL RELATIONS

Department of. Industrial Relations Departments, James W. Brown. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 229–231. Advantages derived from promoting family spirit in industrial life of employees. Paper read before Am. Foundrymen's Assn.

Open Shop. Twin Cities Team for Open Shop, A. J. Hain. Iron Trade Rev., vol. 68, no. 11, Mar. 17, 1921, pp. 762–768. Association organized by St. Paul Manufacturers to coöperate with Minneapolis Citizen's Alliance.

[See also TIME STUDY.]

Syndical Control, Italy. Syndical Control of Industries in Iatly (À propos du controle syndical des industries en Italie). Revue générale de l'Electricité, vol. 9, no. 9, Feb. 26, 1921, pp. 289–296. Text of projects submitted to Italian Government by Italian Federation of Intellectual Workers and by Italian General Federation of Industry, together with text of project devised by Italian Government.

INLAND NAVIGATION

Electric Hauling on Canals. New Systems of Electric Hauling on Canals (Nouveaux systèmes de halage électrique sur les canaux), Ed. Imbeaux. Nature (Paris), no. 2441, Jan. 15, 1921, pp. 33–37, 5 figs. Developments in France.

INSULATORS, HEAT

Tests. Heat Insulating Properties of Cork and Lith Board, A. A. Porter, J. P. Coulderwood, A. J. Mack and L. S. Hobbs. Power Plant Eng., vol. 25, no. 5, Mar. 1, 1921, pp. 285–286. 4 figs. Tests made in Engineering Experiment Station of Kansas State Agricultural College. Cork board showed heat insulating property approximately 5 per cent greater than lith board.

Relative Heat Conductivities of Some Insulating and Building Materials, James J. Lichtin. Chem. & Metallurgical Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 388, 2 figs. Experimental measurements.

INTERNAL-COMBUSTION ENGINES

Efficiency Determination. Determination of the Mechanical Efficiency of Internal-Combustion Engines, V. L. Maleev. Gas Engine, vol. 23, no. 3, Mar. 1921, pp. 53–58, 7 figs. Type of brake constructed by writer for testing high-pressure Diesel engine of 140 b.hp.

Indicator Diagrams. A High-Speed Engine Pressure Indicator of the Balanced Diaphragm Type, H. C. Dickinson and F. B. Newell. Nat. Advisory Committee for Aeronautics, no. 107, 15 pp., 14 figs. Principle involved is balancing of engine cylinder pressure against measured pressure on opposite sides of metal diaphragm of negligible stiffness. Phase of engine cycle to which pressure measurement corresponds is selected by timing device.

Two-Stroke. The Record Two-Stroke Engine. Engr., vol. 121, no. 3402, Mar. 11, 1921, pp. 270–271, 2 figs. Absence of poppet valves is feature of internal-combustion engines manufactured by Record Eng. Co., London. Valves are replaced by arrangement of twin working pistons and piston valve, latter being operated by means of eccentric formed solid with crankshaft and being utilized for distributing explosive mixture to cylinders.

Water Coolers. The Heenan Water Cooler. Engineering, vol. 111, no. 2877, Feb. 18, 1921, p. 193, 6 figs. Cooler consists of single casting containing two vertical screens formed of brass or phosphor bronze, metallic wool and placed one behind the other. Water from engine jackets is distributed from troughs on top of cooler over screens through perforated brass plates, and is then recirculated by rotary pump.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; HEAVY-OIL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES; TRACTOR ENGINES.]

J

JIGS

Manufacture. Building Jigs and Fixtures on Manufacturing Basis, W. H. Vockell and H. C. Uihlein. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 632–635, 11 figs. Standardization of details to permit production in quantity at reduced cost. Practice of Cincinnati Eng. Tool Co.

Using Compound Slide in Jig and Die Making. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 630–631, 4 figs. How Johansson compound slide is used in toolroom work, especially in laying out of accurately spaced holes.

L

LABOR

College Movement. What the Workers Want to Know, William Leavitt Stoddard. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 208–210. Objects and methods of labor college movement.

Hours of Work. Practical Experience With the Work Week of Forty-Eight Hours or Less. Nat. Indus. Conference Board, research report no. 32, Dec. 1920, 88 pp. Based on experience of manufacturers extending over varying periods. It was desired to determine whether or not 48 hr. schedule would yield the same, or practically the same, weekly output per worker as previous longer schedule in same plants and under substantially same conditions.

[See also INDUSTRIAL RELATIONS; INDUSTRY.]

LADLES

Stopper. Proved Design for Ladle Stopper. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 219–222, 3 figs. Means provided for taking care of expansion of sleeve. Taper of bottom sleeve for acid practice.

LATHE TOOLS

Multiple Inserted Cutters. Efficiency Tests with Tools with Multiple Inserted Cutters (Leistungsversuche mit Stäblen mit mehrfacher Schneide), Hermann Brösamlen. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 213–215, 1 fig. Described tests show that by use of profile tools (Jäger tools, patented), an increase in production without increase of means of production can be obtained, due to the combined arrangement of the tools and especially to reduction of the unproductive working period.

LATHES

Bench. Tools and Methods for Manufacturing Precision Bench Lathes—I, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 668–672, 8 figs. Practice of S. A. Potter Tool & Machine Works, New York City, in manufacture of bench lathes.

Cadillac. The Cadillac Vertical Lathe, J. V. Hunter. Am. Mach., vol. 54, no. 12, Mar. 24, 1921, pp. 489–491, 5 figs. Semi-automatic compact machine intended for single-purpose work.

Lead-Screw Variator. Lathe Lead Screw Variator Device. Iron Age, vol. 107, no. 9, Mar. 3, 1921, pp. 569, 2 figs. Device consists of bracket unit clamped to ways of lathe, lead-screw mechanism and rods connecting variator nut with lathe carriage. Manufactured by Precision & Thread Grinder Mfg. Co., Philadelphia.

Stud and Bolt. Automatic Stud and Bolt Machine. Engineering, vol. 111, no. 2879, Mar. 4, 1921, pp. 252, 5 figs. Machine designed for straight forward stud and bolt work. Machine is provided with automatic chuck for machining bolts $1^1/_2$ in. in diameter; range of studs dealt with is from $^1/_2$ in. to $1^1/_4$ in., with maximum length of 9 in.

Turret. Obtaining Production on the Vertical Turret Lathe. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 534–540, 18 figs. Application of Bullard vertical turretlathe to machine-shop practice, including typical examples and description of tooling used.

Turret Lathe Applications, J. H. Moore. Can. Machy., vol. 25, no. 6, Feb. 24, 1921, pp. 38–41, 16 figs. Tooling necessary for machining axle housing, motor frame, and piece of work weighing over 600 lb.

LIGHTING

Illumination Standards. Practical Illumination Design Method and Data, Earl A. Anderson. Elec. Rev. (Chicago), vol. 78, no. 11, Mar. 12, 1921, pp. 411–415, 8 figs. Table giving present standards for illumination for various services. (To be continued.)

Industrial. Industrial and Factory Lighting. Jl. Electricity & Western Industry, vol. 46, no. 4, Feb. 15, 1921, pp. 186–187, 4 figs. Investigation in 446 industrial plants brought out that average of approximately 25 per cent of work done is carried on under artificial illumination.

The Human Factor in Industrial Lighting, James R. Cravath. Jl. Electricity & Western Industry, vol. 46, no. 4, Feb. 15, 1921, pp. 181–183, 2 figs. Tests showing effect of improved artificial lighting on output in number of industrial plants.

LIGNITE

Briquetting. The Manufacture of Lignite Briquettes. Eng. Progress, vol. 2, no. 2, Feb. 1921, pp. 25–28, 7 figs. Description of briquetting factory.

Drying. Lignite (Le lignite), Jean C. Verdier. Revue de l'Ingenieur, et Index Technique, vol. 28, no. 1, Jan. 1921, pp. 9–16, 4 figs. Formula and graph for determining quantity of water to be removed by grinding. (Continuation of serial.)

LOCOMOTIVE BOILERS

Insulation. The Insulation of Locomotive Boilers, Wm. N. Allman. Ry. Rev., vol. 68, no. 10, Mar. 5, 1921, pp. 349–350, 2 figs. Efficiency curves of 85 per cent magnesia lagging.

LOCOMOTIVES

Electric. See ELECTRIC LOCOMOTIVES.

European Designs. Recent Trend in Locomotive Design in Europe. Mech. Eng., vol. 43, no 3, Mar. 1921, pp. 189–192, 8 figs. Three-cylinder fast-freight locomotive in operation in English railway, and German internal-combustion mine locomotives.

Feedwater. See BOILER FEEDWATER, Treatment.

Freight, Tests. Design and Tests of Freight Locomotives on the Pennsylvania Railroad, Lawford H. Fry. Engineering, vol. 111, no. 2877, Feb. 18, 1921, pp. 190–191, 2 figs. Graphs showing speed and drawbar pull of various types. (To be continued.)

Fuel Consumption. Train Schedules and Locomotive Fuel Consumption, Edwin Winfield. Can. Ry. & Mar. World, no. 277, Mar. 1921, pp. 124–126, 4 figs. Graphs indicating variation in coal consumed with power exerted.

Oil-Burning. Results of Traction Tests of Locomotives Equipped for Burning Oil (Risultati degli esperimenti e delle prove di trazione eseguite con alcune locomotive attrezzate per bruciare la nafta nei forni delle loro caldaie), Alessandro Mascini. Rivista tecnica delle Ferrovie Italiane, vol. 18, no. 5, Nov. 15, 1920, pp. 161–189, 5 figs. Experiments conducted by Italian State Railways. (Concluded.)

Pulverized-Coal-Burning. Locomotive Burning Pulverized Coal (L'application du charbon pulverisé aux locomotives) Outillage, vol. 5, no. 4 Jan. 27, 1921, pp. 98–101, 50 figs. Italian locomotives equipped to burn pulverized lignite, also Swedish locomotives with Fuller system for burning pulverized peat.

Shop Equipment. Locomotive Shop Equipment on Wheels. J. V. Hunter. Am. Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 403–404, 6 figs. Locomotives transferred to repair pits by traveling crane. Time saved by taking portable workbenches and machine tools to work.

Superheaters, Schmidt. The New Tender Locomotives of the Danish State Railroad with Narrow-Tube Superheaters (Statsbanernes nye Tenderlokomotiver med Smaarörsoverheder). Ingenioren, vol. 30, no. 1, Jan. 1, 1921, p. 3. Locomotives (switchers) are provided with the Schmidt system of smoke-tube superheaters consisting partly of enlarged and partly of narrow fire tubes.

LUBRICATING OILS

Centrifugal Cleaner. Centrifugal Oil Cleaner. Oil News, vol. 9, no. 4, Feb. 20, 1921, pp. 21–22, 2 figs. Apparatus under development at McCook Field. Oil is led from oil tanks to inside of bowl which is rotating at 2550 r.p.m. when engine is turning up 1700 r.p.m.

Dilution. Dilution of Crankcase Oil, Wm. F Parish. Jl. Soc. Automotive Engrs., vol. 8, no. 3, Mar 1921, pp. 231–237 and 254. 3 figs. Results of tests made on aeroplane engines to determine effect of dilution of crankcase oil. Comparative characteristics of used and reclaimed oil. Paper read before Am. Petroleum Inst.

Selection. Friction and Fuel, Wm. N. Berkeley. Power, vol. 53, no. 10, Mar. 8, 1921, pp. 390–392. Comparison of constants of asphalt-base and paraffin-base lubricating oils. Table indicating best uses for different classes of lubricating oils.

M

MACHINE SHOPS

Layout. New Plant of the Foote-Burt Company. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 528–530, 6 figs. Features of modern factory planned with view to convenient handling and progressive routing of work.

MACHINE TOOLS

Duplicating Machines. The Manufacture of Duplicating Machines. Eng. Production, vol. 2, no. 22, Mar. 3, 1921, pp. 289–294, 16 figs. Manufacturing methods employed in Roneo Works, London.

German. German Machine Tools. Eng. & Industrial Management, vol. 5, no. 6, Feb. 10, 1921, pp. 174–175. Report of general meeting of British Machine Tool Trades Assn. giving arguments for and against handling of German machine tools in England.

Heavy. Some Examples of Heavy Modern Machine Tools, K. Ehmcke. Eng. Progress, vol. 2, no. 2, Feb. 1921, pp. 33–38, 15 figs. Giant portal-type milling machine with two vertical spindles and four horizontal boring and milling machines; giant milling machine with three double spindles and seven electromotors; lathe with 8.5 ft. height of centers; vertical lathe for turning diameter of 39.4 ft.

Spacing Tables. Improved Design of Spacing Table. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 707, 3 figs. Semi-automatic machine manufactured by Cleveland Punch & Shear Works Co.

Special-Purpose. Special Machines and Tools in the Chandler Plant. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 565–568, 6 figs. Equipment used by Chandler Motor Car Co., Cleveland, Ohio, for milling crankcases, boring and reaming crankshaft and camshaft bearings, and numerous other operations.

Variable-Speed Motors for. Machine Tools and Variable-Speed Motors (Werkzeugmaschine und Reguliermotor), Othmar Pollok. Werkstattstechnik vol. 15, no. 4, Feb. 15, 1921, pp. 81–85, 7 figs. Their use in connection with large and small machine tools. Direct-current versus 3-phase-current variable-speed motors.

MACHINERY

Manufacture. Building Heavy Machinery. Eng. Production, vol. 2, no. 23, Mar. 10, 1921, pp. 321–325, 6 figs. Works and methods of Hick, Hargreaves, England, manufacturers of locomotives, marine engines, Lancashire and other type boilers, stationary engines of all classes, water turbines and mill-gearing.

MALLEABLE IRON

Experiments. Experiments in Malleable Iron, F. H. Hurren. Foundry Trade Jl., vol. 23, no. 234, Feb. 10, 1921, pp. 125–128 and (discussion) pp. 136–138, 6 figs. Analyses of samples and photomicrographs.

Foundries. Equips for Malleable Jobbing Work, H. E. Diller. Foundry, vol. 49, no. 5, Mar. 1, 1921, pp. 171–175, and 185, 8 figs. Foundry at Temple, Pa., where $2^1/_2$ lb. of castings are annealed with 1 lb. of coal.

Strength of. American Malleable Cast Iron—V, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 9, Mar. 3, 1921, pp. 628–631 and 633. Stress-strain diagrams of malleable cast iron in compression and in shear.

METALS

Thermal Capacities. Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 2, Feb. 1921, pp. 109–111, 4 figs. Graph showing heat content of pure metals at various temperatures, constructed from figures obtained in experiments conducted by the Society of German Engineers.

METRIC SYSTEM

Arguments Against Adoption in United Kingdom. Scientific England and the Metric System. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, p. 154. Abstract of report submitted by Metric Committee appointed by conjoint board of Scientific Societies of United Kingdom. It is recommended that British system of units of weights and measures be retained in general use in United Kingdom.

Arguments Against Adoption in U. S. The Metric Equivalent Scheme, Frederick A. Halsey. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 665–667, 1 fig. Arguments against contention of T. H. Miller in Machinery 1920 that it is feasible to adopt metric measurements for machines already being manufactured in English units.

MILLING MACHINES

Fixtures. Milling Machine Methods. Eng. Production, vol. 2, no. 23, Mar. 10, 1921, pp. 330–331, 11 figs. Typical fixtures designed for production milling.

MOLDING MACHINES

Pneulec Electrically Operated. The "Pneulec" Moulding Machine. Foundry Trade Jl., vol. 23, no. 232, Jan. 27, 1921, p. 76, 1 fig. Electrically operated machine which can simply be placed on firm foundation and connected up to nearest electric supply main; it is said to be possible to obtain between 40 to 210 molds per day.

Squeezer Machine. Invents a New Type of Squeezer Machine. Foundry, vol. 49, no. 6, Mar. 15, 1921, pp. 249–250, 1 fig. Patented machine operated by compressed air.

MOLYBDENUM STEEL

Tests. A Discussion of Molybdenum Steels, Charles McKnight. Trans. Am. Soc. for Steel Treating, vol. 1, no. 6, Mar. 1921, pp. 288–296. Tensile tests of molybdenum steels.

Uses. Molybdenum Steels, John A. Matthews. Chem. & Metallurgical Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 395–396. Also Min. & Metallurgy, no. 170, Feb. 1921, pp. 39–40. Development of molybdenum steel in America. Early experiments with this element in complex alloys for tools. Recent successful utilization in mechanical and structural steels of high strength and great adaptability.

MORTARS

Cement, Shrinkage. Shrinkage of Portland Cement Mortars and Its Importance in Stucco Construction. J. C. Pearson, Eng. & Contracting, vol. 55, no. 8, Feb. 23, 1921, pp. 187–190, 6 figs. Results of measurements on about 200 mortar slabs. Investigation conducted at U. S. Bur. of Standards. Paper read before Am. Concrete Inst.

MOTOR TRUCKS

Farm Service. Corn-Belt Farmers' Experience with Motor Trucks, H. R. Tolley and L. M. Church. U. S. Dept. Agriculture, bul. no. 931, Feb. 25, 1921, 34 pp., 3 figs. Study of 831 reports from farmers who own motor trucks.

MOTORSHIPS

Steamships vs. Advantages of Motorships Compared with Steamships. Motorship, vol. 6, no. 3, March 1921, pp. 210–211, 1 fig. Saving in space, which amounts to 30 per cent for machinery alone in favor of Diesel plant; saving of fuel, figures for motorship being about 0.33 lb. per i.hp. per hr., and for geared turbines steamship seldom below 0.990 lb. per i hp. per hr.; no standby losses in motorships; and less cost for cleaning and repairs in motorship.

N

NICKEL

Wire. The Change in the Rigidity of Nickel Wire with Magnetic Fields, William Brown and Patrick O'Callaghan. Sci. Proc. Royal Dublin Soc., vol. 16, no. 8, Aug. 1920, pp. 98–104, 2 figs. Records of measurements. Initial increase in rigidity of nickel was less for alternating than for direct longitudinal magnetic fields, while subsequent decrease was greater for alternating longitudinal fields than for direct fields.

NICKEL STEEL

Tests. Static and Dynamic Tension Tests on Nickel Steel, J. J. Thomas and J. H. Nead. Min. & Metallurgy, no. 170, Feb. 1921, p. 34. Relation between static and dynamic tension tests as measured by work required to break test specimens slowly in tensile testing machine, and rapidly, by means of falling weight. (Abstract.)

NOZZLES

Diesel-Engine. Nozzle Design for Diesel Engines—Influence of Air Pressure and Engine Speed, J. A. Wallard. Power, vol. 53, no. 12, Mar. 22, 1921, pp. 469–471, 2 figs. Effect of variable load and speed.

Losses in. On the Losses in Convergent Nozzles, A. L. Mellanby and Wm. Kerr. North-East Coast Instn. Engrs. & Shipbuilders (advance paper), 40 pp., 22 figs. Investigation of results given for convergent nozzle types in Pressure Flow Experiments on Steam Nozzles, Proc. Inst. Engrs. and Shipbuilders in Scotland, Nov. 16, 1920, and account of results obtained in further tests on steam nozzles. Empirical formula for total loss at any point along jet within boundary form is developed.

Tests. Pressure-Flow Experiments on Steam Nozzles, A. L. Mellanby and William Kerr. Engineering, vol. 111, no. 2879, Mar. 4, 1921, pp. 269–274, 20 figs. Determination of pressure at various points of nozzle by means of "search tube" moved along jet. Paper read before Instn. Engrs. & Shipbuilders in Scotland.

O

OIL

Distillation. A New Oil Distilling Process. Petroleum Times, vol. 5, no. 110, Feb. 12, 1921, p. 185. Process of mineral-oil distillation under high vacuum by means of which mineral oils or heavy mineral-oil residues are distilled non-destructively to solid coke. Process was developed by Leo Steinschneider, Bruenn-Koenigsfelder Maschinenfabrik, Czecho-Slovakia.

[See also PETROLEUM.]

OIL ENGINES

Cold-Starting. Cold-Starting Oil Engine. Gas Engine, vol. 23, no. 3, Mar. 1921, pp. 73–74, 2 figs. Fuel consumption curves of 250 b.hp. twin-cylinder Ruston high-compression oil engine.

Hot-Bulb. A Six-Cylinder Hot Bulb Engine. Engr., vol. 131, no. 3400, Feb. 25, 1921, pp. 212–214, 4 figs. Marine engine of 450 b.hp. constructed by Vickers-Peters, Ipswich, England.

OIL FIELDS

Borneo. The Sanga Sanga Oil Field of Borneo, W. H. Emmons and J. W. Gruner. Eng. & Min. Jl., vol. 111, no. 10, Mar. 5, 1921, pp. 431–432, 2 figs. Production in 1911 was 495,124 tons.

Exploitation by Shafts and Galleries. Working Petroleum by Means of Shafts and Galleries, Paul deChambrier. Petroleum Times, vol. 5, no. 111, Feb. 19, 1921, pp. 209–211, 1 fig. Practice at Pechelbronn, Alsace. Economical advantage of method. (Abstract.) Paper read before Instn. Petroleum Technologists.

OIL FUEL

Bunkering Station. Oil Fuel Bunkering Station at Marseille (Installation d'un dépot de mazout a Marseille). Bulletin technique de Bureau Veritas, vol. 3, no. 2, Feb. 1921, pp. 36–37, 1 fig. Details of discharging and pumping station. English test is given on page 38.

Burners. The Fisher Oil Fuel Burner. Engineering, vol. 111, no. 2878, Feb. 25, 1921, p. 225, 4 figs. U. S. Navy design intended to maintain whirling motion of liquid fuel over wide range of consumption.

Industrial Uses. Heating by Fuel Oil for Manufacturing Processes, C. C. Hermann. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 199–202. Advantages and limitation of oil fuel for industrial uses, particularly in use in forge-shop and heat-treating furnaces. Methods of purchasing, testing and storing fuel. Example illustrating how air capacity is determined for given service.

Measurement. Measurement of Fuel Oil, J. D. Gilman. Mar. Eng., vol. 26, no. 3, Mar. 1921, pp. 234–237. Tables for reducing measurement to standard conditions.

Specifications. The Saybolt Furol Viscosimeter, E. W. Dean. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2215, 4 pp. Apparatus employed by Bureau of Mines in determining quality of oil fuel as required by specifications issued by U. S. Navy. Superiority of defining oil fuel in terms of viscosity rather than gravity is concluded from results of inspection work undertaken for U. S. Shipping Board.

Uses. Fuel Oil Burning in Various Parts of the World, Andrew F. Baillie. Jl. Royal Soc. of Arts, vol. 69, no. 3563, Mar. 4, 1921, pp. 232–243 and (discussion) pp. 243–246. Survey of uses, and records of comparative tests with coal and oil in similar boilers.

OIL SHALES

Pennsylvania. See COAL DEPOSITS, Pennsylvania.

Pyrolytic Distillation. Plant Design for Hot-Gas Pyrolytic Distillation of Shale, Louis Simpson. Chem. & Metallurgical Eng., vol. 24, no. 8, Feb. 23, 1921, pp. 341–345, 2 figs. Description and plan of 2000-ton-per-day shale-oil plant operating on indirect heating process employing hot gases for conveying reacting heat and resultant oil vapors from pyrolysis of shale.

Spent Shale, Uses of. Possible Uses for the Spent Shale from Oil Shale Operations, Kirby Thomas. Chem. & Metallurgy Eng., vol. 24, no. 9, Mar. 2, 1921, pp. 389–390. Uses as fuel, as non-conductor material for electrical applications and as material for making brick.

Utilization. Some Items of Investment, Expense, and Profit in Commercial Shale-Oil Production, L. H. Sharp and A. T. Strunk. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2214, 3 pp. Equipment necessary for large-scale commercial utilization of oil shales.

P

PEAT

Use on Swedish Railways. Peat Proves Satisfactory Fuel on Swedish Railways. Commerce Reports, no. 46, Feb. 25, 1921, p. 1109. Peat is dried in open air and softest lumps are converted into powder or briquets. Tests have passed experimental stage and Railway Board of Sweden has constructed plant with capacity of 30,000 tons per annum.

PETROLEUM

World Production. World's Production of Petroleum. Eng. & Min. Jl., vol. 111, no. 10, Mar. 5, 1921, pp. 433. Production in 1920 was 688,474,251 barrels against 554,505,048 barrels in 1919. In 1920 the United States supplied 443,402,000 barrels.

[See also OIL.]

PHOTO-ELASTICITY

Uses in Machine Design. Photo-Elasticity for Engineers—The Use of Photo-Elastic Methods in the Design of the Elements of Machines and Structures, E. G. Coker. Gen. Elec. Rev., vol. 24, no. 3, Mar. 1921, pp. 222–226, 5 figs. Procedure suggested and illustrated by application to design of eye bars

PISTONS

Inspection. Inspecting Pistons and connecting Rods, Fred H. Colvin. Am. Mach., vol. 54, no. 10, Mar. 10, 1921, pp. 407–410, 14 figs. Importance of inspection methods to quality of product. Methods in use on Essex and Studebaker pistons and connecting rods.

Manufacture. Manufacture of the Jahns Semi-Finished Pistons. Metal Trades, vol. 12, no. 3, Mar. 1921, pp. 95–97, 10 figs. Practice at Los Angeles plant.

PLANING

Production Systems. Production Planing in Machine Tool Plants, Edward K. Hammond. Machy. (N. Y.), vol. 27, nos. 6 and 7, Feb. and Mar. 1921, pp. 552–559, 8 figs., and 659–664, 8 figs. Methods used in shops of representative engine-lathe and planer builders.

Production Planing in Machine Tool Plants. Machy. (London), vol. 17, nos. 438 and 440, Feb. 17 and Mar. 3, 1921, pp. 597–604, 13 figs., and 680–684, 5 figs. Planer practice in a number of plants building milling machines and lathes.

PLYWOOD

Tests. Strength Tests of Screw Fastenings of Plywood, H. S. Grenoble. Aviation, vol. 10, no. 8, Feb. 21, 1921, pp. 230. Tests conducted at Forest

ENGINEERING INDEX (Continued)

Products Laboratory, U. S. Forest Service, Madison, Wis. Size and kind of screw, use of washers, margin, spacing and species of plywood and of member to which fastening was made, were included.

PNEUMATIC TOOLS

Manufacture. The Manufacture of Pneumatic Tools. Machy. (London), vol. 17, no. 439, Feb. 24, 1921, pp. 636–645, 22 figs. Review of methods employed by Consolidated Pneumatic Tool Co., Scotland.

PORTS

New York. Plans for Organizing the Port of New York. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 211 and 220, 1 fig. Automatic electric subway to eliminate surface congestion and reduce handling cost. Report presented to governors of New York and New Jersey by New York-New Jersey Port and Harbor Commission.

POWER

Industrial Supply. Industry's Supply of Energy, George Otis Smith. Mech. Eng., vol. 43, no. 3, Mar. 1921, pp. 165–166 and 188. Survey of available supplies of coal, oil, and water, together with discussion of engineer's part in economic and efficient utilization of energy units.

POWER PLANTS

Helgoland Island. Power Stations with Diesel Engines on Helgoland Island (Kraftwerke mit Dieselmotoren auf der Insel Helgoland), H. Methling. Schiffbau, vol. 22, no. 16, Jan. 19, 1921, pp. 363–366, 6 figs. The two stations, supplying power, light and ventilation to all the plants and buildings of fortification works, are provided with five pumping works driven by Diesel engines of 345 hp. at 165 revolutions, besides which there are three Diesel dynamos, etc.

POWER TRANSMISSION

Hydraulic. Hydraulic Transmission of Power (La transmission hydraulique), A. Raudot. Revue générale de l'Electricité, vol. 9, nos. 6, 8 and 9, Feb. 5, 19 and 26, 1921, pp. 177–181, 18 figs., 239–243, 4 figs., and 279–284, 5 figs. System involving generator pump on rotary type with fixed cylinders arranged in star shape. Suggested design of 12-cyl. generating pump. Comparative study of characteristics of hydraulic and electric motion. Application of hydraulic transmission to railway traction.

PRESSWORK

Pressed-Steel Parts. Making Pressed Metal Parts Becomes Important Industry, E. L. Shaner. Iron Trade Rev., vol. 68, no. 9, Mar. 3, 1921, pp. 617–620, 6 figs. Development of manufacture of pressed steel in the United States.

PROFIT SHARING

Legal Aspect. Profit Sharing in Industry (La participation ouvrière aux bénéfices de la production), Paul Razous. Génie Civil, vol. 78, no. 4, Jan. 22, 1921, pp. 84–87. Arguments against legal compulsion of management to establish profit-sharing system. (Concluded.)

Norway. A Norwegian Plan for Profit Sharing. Monthly Labor Rev., vol. 12, no. 2, Feb. 1921, pp. 117–119. Plan worked out by Council of Nat. Workingmen's Assn., Norway.

Plans for. Encouraging Industrial Coöperation, A. H. Dittmer. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 549–551, 2 figs. Credit point system operated at plant of Dittmer Gear & Mfg. Corp., Lockport, N. Y.

PROPELLERS, SHIP

Erosion. The Erosion of Bronze Propellers, O. Silverrad. Jl. Soc. Chem. Industry, vol. 40, no. 4, Feb. 28, 1921, pp. 38T–45T, 8 figs. Also Shipbuilding & Shipping Rec., vol. 17, no. 7, Feb. 17, 1921, p. 183. Investigations into cause of deterioration. It is concluded that true cause of deterioration is mechanical, determining factors being frictional rub of water and impinging on propeller blades of water broken with evacuated spaces which subsequently collapse on propeller blades. Formation of erosion-resisting alloy.

Manufacture. The Manufacture of High-Class Marine Propellers. Eng. Production, vol. 2, no. 20, Feb. 17, 1921, pp. 227–236, 15 figs. Procedure at Charlton Works of J. B. Stone & Co., England. Paper read before Inst. of Mar. Engrs.

PULLEYS

Standard. Standard Belt Pulley, Chris Nyberg. Agricultural Eng., vol. 2, no. 1, Jan. 1921, p. 21, 1 fig. Chart for solution of pulley-spoke dimensions.

Standardization of Diameters. Standardization of Pulley Diameters (Normung der Riemenscheibendurchmesser), Ludwig Gück. Werkstattstechnik, vol. 15, no. 4, Feb. 15, 1921, pp. 87–90. Standardization of diameters based on standardized speeds which are presented in tabular form.

PULVERIZED COAL

Uses. A Series of Discourses on Use of Powdered Anthracite and Recovery and Use of River Coal, George H. Ashley, C. W. Webbert, Jonathan P. Edwards, G. R. Delamater, W. S. Guigley, Richard H. Vail, J. R. Wyllie, J. H. Kennedy, W. W. Pettibone and H. D. Savage. Jl. Engrs Club of Phila., vol. 38, no. 194, Feb. 1921, pp. 39–63, 8 figs. Statements by geological and mining authorities and engineers on best methods of pulverizing anthracite coal, together with results of boiler fires made at pulverized fuel plant at Lykens, Pa.

PUMPS

Humphrey. The Humphrey Pump. Engr., vol. 131, no. 340, Mar. 4, 1921, pp. 232 and 238, 4 figs. Installation of Humphrey pumps for Metropolitan Water Board at Chingford. Record of efficiency tests.

Lubricator for. A New Pump Lubricator. Engr., vol. 131, no. 3398, Feb. 11, 1921, p. 161, 2 figs. Prevention of airlock in oil passages when starting up is feature.

PUMPS, CENTRIFUGAL

Gasoline-Engine Drive. Gasoline-Engine Drive for Centrifugal Pumps, T. M. Heermans. Power, vol. 53, no. 10, Mar. 8, 1921, pp. 376–377, 5 figs. Types of engines used. Curves show that engine horsepower should be 25 per cent greater than water horsepower required.

PUNCHING MACHINES

Standardization. Power Punches and Dies. Ry. Jl., vol. 27, no. 3, Mar. 1921, pp. 13–16, 2 figs. Discussion of standardization of punching machines at Am. Ry. Tool Foremen's convention.

R

RADIOMETALLOGRAPHY

Examining Materials. X-Ray Examination of Materials, J. R. Clarke. Beama, vol. 8, no. 2, Feb. 1921, pp. 125–132. Experience obtained in research department of Metropolitan-Vickers Electrical Co., England.

RAILS

Manufacture. Steel Rails, C. W. Gennet, Jr. Jl. Western Soc. Engrs., vol. 26, no. 3, Mar. 1921, pp. 77–85. Comparative study of various processes for manufacturing steel rails.

Sink-Head Ingots. Steel Rails from Sink-Head and Ordinary Rail Ingots, Geo. K. Burgess. Dept. of Commerce, Technologic Papers of Bur. of Standards, no. 178, Dec. 15, 1920, 61 pp., 23 figs. Results obtained in experiments indicated decided superiority of sink-head ingots over ordinary ingots as made of three grades of steel.

RAILWAY ELECTRIFICATION

Chicago. The Illinois Central Electrification Project. Elec. Traction, vol. 17, no. 1, Jan. 1921, pp. 1–5, 4 figs. Ordinance regarding electrification of Chicago Terminals of Illinois Central Railroad was passed by Chicago city council July 21, 1919, and accepted by Illinois Central Railroad Co., Feb. 20, 1920. Details of project.

Europe. Electrification in Central Europe, E. C. Zehme. Elec. Ry. Jl., vol. 57, no. 10, Mar. 5, 1921, pp. 438–440. Résumé of conditions in Germany, Sweden, Norway, Holland and Italy.

Status of Foreign Electrification, E. C. Zehme. Elec. World, vol. 77, no. 10, Mar. 5, 1921, pp. 527–529. Developments in Germany, Austria, Sweden, Norway, Holland, Switzerland and Italy.

Sweden. The Electrification of the Swedish State Railways (L'électrification des chemins de fer de l'état suédois), M. Marchand. Industrie Electrique, vol. 30, no. 688, Feb. 25, 1921, pp. 68–72. Technical comparison of direct-current system with single-phase alternating-current system. Conditions in Sweden.

RAILWAY OPERATION

Economics. Report of Committee XXI—On Economics of Railway Operation. Bul. Am. Ry. Eng. Assn., vol. 22, no. 234, Feb. 1921, pp. 723–791, 13 figs. Methods for increasing efficiency of employees by furnishing them with reports and comparisons planned to inform and interest all concerned. Methods for increasing traffic capacity of railway, including analyses of costs and study of effect of speed of trains upon cost of operation.

RAILWAY REPAIR SHOPS

Design. A New Type of Erecting Aisle Saves Shop Headroom. Ry. Age, vol. 70, no. 9, Mar. 4, 1921, pp. 521–522, 3 figs. "Gap crane" erecting shop by which from 15 to 18 ft. of vertical height of shop building is saved.

RAILWAY TIES

Life. Tie Renewals in Relation to Average Life. Technical Note no. 130, Forest Products Laboratory, U. S. Forest Service, 2 pp., 1 fig. Comparisons of 43 groups included 42,000 ties of many species, some untreated and some treated.

Pneumatic Tamping. Determining the Cost of Pneumatic Tie Tamping. Ry. Maintenance Engr., vol. 17, no. 3, Mar. 1921, pp. 105–106. Records of tests conducted by Delaware, Lackawanna & Western Railroad.

Standards. Standard Specifications for Ties. Ry Rev., vol. 68, no. 9, Feb. 26, 1921, pp. 327–328. Specifications adopted by Nat. Assn. of Railroad Tie Producers, Jan. 18, 1921.

RESEARCH

Industrial. Industrial Research. Iron Age, vol. 107, no. 10, Mar. 10, 1921, p. 638. Program being carried out by Engineering Foundation. Industrial research on nation-wide scale, in which engineering organizations, universities, factories, individuals and private laboratories and other organizations are coöperating is under way. From annual report of Engineering Foundation.

The origin and Development of the Research Associations Established by the Department for Scientific and Industrial Research, A. Abbott. Jl. Royal Soc. of Arts, vol. 69, no. 3561, Feb. 18, 1921, pp. 181–205. Department has so far approved and licensed 23 industrial associations.

ROLLING MILLS

Universal Plate. New Universal Plate Mill, J. H. Moore. Can. Machy., vol. 25, no. 9, Mar. 3, 1921, pp. 65–69, 7 figs. Installation of Dominion Foundries & Steel, Ltd., at Hamilton, Ont. Mill will roll universal plate from 7 in. to 41 in., shear plate to 64 in., and will also roll slabs and billets.

Weirton, West Va. Rolling Mills of the Weirton Steel Co. Iron Age, vol. 107, no. 11, Mar. 17, 1921, pp. 693–702, 9 figs. Compact arrangement of 40-in. blooming mill with two Morgan continuous mills, 21-in. and 18-in., for producing sheet bars, billets and slabs.

ROOFS

Sawtooth. A New Type of Saw-Tooth Construction. Manufacturers Rec., 79, no. 10, Mar. 10, 1921, pp. 95–96, 3 figs. Super-span construction devised by Ballinger Co., Phila.

S

SAFETY

Bureau of Mines Schedules. Permissible Schedules Issued by the Bureau of Mines, L. C. Ilsley. Reports of Investigations, Bur. of Mines, Dept. of Interior, Feb. 1921, serial no. 2211, 3 pp. List of active schedules available to manufacturers. Schedules establish minimum standards for safety and details of test methods in manufacture of explosives, electric motors, safety lamps, mine-rescue apparatus, storage-battery locomotives, etc.

SAND BLAST

Apparatus and Uses. Sand-Blast Apparatus (Sandstrahlgebläse), Wilhelm Kaempfer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 7, Feb. 12, 1921, pp. 175–178, 16 figs. Their use during war; sand blasts with rotary table and revolving drum; free-jet blasts; special constructions for cleaning of shells, removal of hammer scale from steel helm, etc., sheet-metal and structural-steel sections. Possible peace-time uses.

SANDING MACHINES

Economical Speeds. Determine Economical Sanding Speeds, James F. Adams. Abrasive Industry, vol. 2, no. 2, Feb. 1921, pp. 52–53, 2 figs. Curves constructed from results of sanding tests.

SCHOOLS

Industrial. A University in an Industry, Edwin Kurtz. Indus. Management, vol. 61, no. 5, Mar. 1, 1921, pp. 191–193. Mutual university conducted by 6500 employees of Milwaukee Elec. Ry. & Light Co.

The Works School Exhibition of the German Committee for Technical Instruction in the Technical Academy, Berlin (Die Werkschulausstellung des Deutschen Ausschusses für Technisches Schulwesen in der Technischen Hochschule zu Berlin) H. Trost. Betrieb, vol. 3, no. 8, Jan. 25, 1921, pp. 21–26, 4 figs. Notes on exhibits from the apprentice schools of the Augsburg-Nürnberg Machine Factory (MAN); A. Borsig, Berlin-Tegel; German General Electric Co. (AEG); Bergmann Electrical Works, the Siemens concerns, etc.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Automatic. Magazine Feeds for Automatic Screw Machines. Machy. (N. Y.), vol. 27, no. 7, Mar. 1921, pp. 617–622, 10 figs. Equipments developed by Cleveland Automatic Machine Co., for handling second-operation work.

Straight Forming Tools. Dimension of Straight Forming Tools. Machy. (N. Y.), vol. 27, no. 6, Feb. 1921, pp. 560–564, 1 fig. Table giving depth of steps on straight forming tools measured at right angles to front face, corresponding to various differences between radii on work.

SEMI-DIESEL ENGINES

Air Admission. New Type of Mechanism for Air Admission in Semi-Diesel Motor (Nouveau type de commande d'admission d'air dans les moteurs semi-Diesel). Génie Civil, vol. 78, no. 7, Feb. 12, 1921, pp. 160, 1 fig. Rotary valve controls admission of air into cylinder in semi-Diesel engine manufactured by Ansald San Giorgio Corp.

SEMI-STEEL

Cast Iron vs. Cast-Iron vs. Semi-Steel, Ernest Wheeler. Foundry Trade Jl., vol. 23, no. 233, Feb. 3, 1921, pp. 99–100. Als. Eng. & Indus. Management, vol. 5, no. 8, Feb. 24, 1921, pp. 234–236. Tables are given showing results of tensile, physical, chemical and foundry tests of semi-steel and ordinary cylinder iron.

Tests. What is Semi-Steel? H. Field. Foundry Trade Jl., vol. 23, no. 237, Mar. 3, 1921, pp. 201–204. Records of chemical and physical tests. Paper read before Birmingham Branch, Instn. British Foundrymen.

SHEARS

Large High-Speed. Six-Foot High-Speed Shearing Machine. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 286–288, 7 figs. Driven by electric motor carried on bracket bolted to side frame, through cut gearing and treadle running whole length of front of machine.

SHIP PROPULSION

Hydraulic. The Hydraulic Propulsion of Ships.

ENGINEERING INDEX (Continued)

Torsion Strain Meter. A New Torsion Strain Meter, E. H. Lamb. Engineering, vol. 111, no. 2880, Mar. 11, 1921, pp. 279–280, 7 figs. Each of ends of bars is attached to one of two brass tubes which slide freely one within the other. Slide twist of bar is measured by determination of relative motions of two plain mirrors, each fixed on one of brass tubes.

THERMIT WELDING

Wrought-Iron Pipe. An Unusual Case of Thermit Pipe Welding, Edward A. Miller. Power, vol. 53, no. 9, Mar. 1, 1921, pp. 351–352, 8 figs. Experience in welding wrought-iron pipe.

TIDAL POWER

Severn Barrage Scheme. Severn Barrage Scheme. Engr., vol. 131, nos. 3400–3401, Feb. 25 and Mar. 4, 1921, pp. 210–211 and 230–231. Account of joint meeting held by Instns. of Civil Engrs., Elec. Engrs. and Mech. Engrs. to discuss Severn barrage scheme for utilization of tidal power on Severn, and particularly third interim report of Water Power Resources Committee of making a plan for utilization of such power by means of a dam across estuary and a high-level reservoir a certain distance up the river.

TIMEKEEPING

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[See also ELECTRIC WELDING; THERMIT WELDING.]

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MECHANICAL ENGINEERING

Volume 43 June, 1921 Number 6

The Hydraucone Regainer, Its Development and Applications in Hydroelectric Plants

By W. M. White,[1] Milwaukee, Wis.

Those familiar with hydroelectric power-house operation where curved draft tubes are employed cannot have failed to notice the boiling and disturbance of the water at the outlet from curved tubes, which disturbance is clearly an evidence of inefficiency and loss of energy. The device described in this paper—the hydraucone regainer—provides a means for efficiently recovering the energy discharged from the runner for useful effect on the water wheel within the limited space available in the power-house foundations.

This new method of regaining pressure from velocity of fluids in motion consists in causing the stream flow to impinge upon some definite shape, either flat, conical or concave, thus changing its direction, and then placing an envelope around this shape so formed upon the particular base used, which envelope conforms to the shape of the fluid at entrance and gradually recedes from what would be the normal or free shape of the non-enclosed fluid upon the particular base used; the effect of this gradually diverging envelope being to change the velocity head of a fluid flowing at high velocity into its entrance into pressure and low velocity at its exit.

The field of application of the hydraucone regainer, according to the author, will be greater on low-head plants, although it is now being installed in connection with two 40,000-hp. units which are to operate under a head of 421 ft. Hydraucone regainers are now in operation or in course of construction in a number of plants to operate under heads varying from 8 ft. to 421 ft. and with water wheels developing from 150 to 40,000 hp.

The paper gives very complete particulars of the long series of experiments resulting in the development of the hydraucone regainer, as well as data of a series of tests made at the Holyoke Testing Flume, showing the increase in power-plant efficiency obtained by its use.

"HYDRAUCONE" is a new word coined for convenience in referring to the new method of transforming velocity head of fluids in motion into pressure head. This method consists in causing the stream flow to impinge upon some definite shape, either flat, conical or concave, thus changing its direction, and then placing an envelope around the shape so formed upon the particular base used, which envelope conforms to the shape of the fluid at entrance and gradually recedes from what would be the normal or free shape of the non-enclosed fluid impinging upon the particular base used; the effect of this gradually diverging envelope being to change the velocity head of a fluid flowing at high velocity into its entrance into pressure and low velocity at its exit. The angle of divergence of the envelope from the normal or free shape of the impinging fluid is such as to bring about the same phenomena of flow conditions as result in an expanding straight-axis tube such as the discharge end of a venturi meter. The new method therefore provides a means for transforming velocity head into pressure head within a short distance measured along the axis of the inflowing stream, and has useful application in water-power plants, supplanting the usual curved draft tube and providing for higher efficiencies with a minimum of excavation. For clearness reference is made in this discussion only to the single-Francis-runner vertical water wheel unless otherwise stated.

[1] Manager and Chief Engineer Hydraulic Department, Allis-Chalmers Mfg. Co.

Abstract of a paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper may be obtained on application. All papers are subject to revision.

The draft tube of a water wheel serves two purposes. The first of these is to maintain at the discharge side of the runner passages a suction action equivalent to the difference in elevation between the runner and the level of the tail water, thereby providing for the use of the total head. The second purpose is to transform the velocity head in the water as it is discharged from the runner into pressure head by the time the water reaches the end of the draft tube, and thus maintain at the discharge side of the runner passages a suction action greater than that which would be caused by the difference in elevation between the runner and the level of the tail water.

At first thought it seems like attempting to lift oneself with

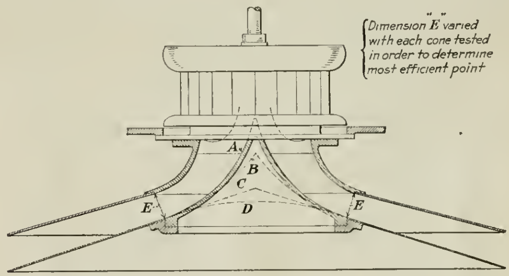

Fig. 1 Hydraucone Regainers with Cone Centers and Conical Plates

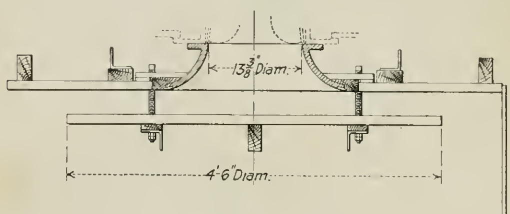

Fig. 2 Hydraucone Regainer with Flat Plate

one's bootstraps to endeavor to utilize the energy in water after it has left the water-wheel runner, but this utilization may be effected by an efficient transformation of the velocity head in the water discharged from the runner into pressure head, which causes an increased suction action at the runner and thus maintains a greater head acting on the runner than the total head as measured between the equivalent water level of the water at entrance to the water wheel and the level of the water in the tail race.

The necessity for an efficient means for regaining pressure from velocity of the water discharged from the water-wheel runner in modern power plants has been brought about by the ever-increasing demand for higher speeds of water wheels for given conditions of power and head. The cost of electric generators of such sizes and speeds as are usually employed in water-power plants varies inversely as the speed, hence the buyer maintains a constant urge for higher water-wheel speeds, to meet which many high-speed types of runners have been brought out. As the specific speed of a

runner increases, the percentage of energy it discharges also increases. A runner of moderate specific speed discharges water with such velocity that the energy contained in the water as velocity head is about 10 per cent of the energy of the total head; and runners of highest specific speeds discharge the water at such velocity that the energy contained in it as velocity head is from 20 per cent to 25 per cent of the energy due to the total head acting on the water wheel. In order to secure high efficiency with high-speed runners it is therefore vital to regain the major portion

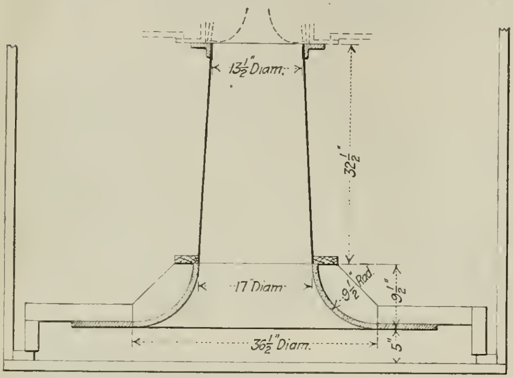

Fig. 3 Combination of Straight Draft Tube and Hydraucone Regainer with Flat Plate

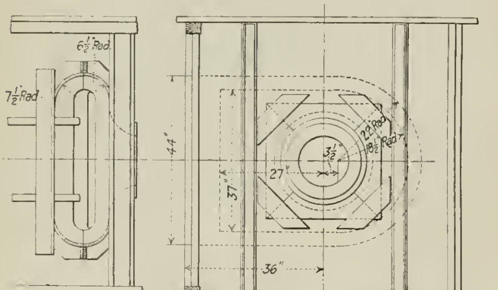

Fig. 4 Dimensions of Model of Hydraucone Regainer Used in a Number of Power Plants

of the energy contained in the water discharged from the runner for useful effect upon the water wheel, for as more of the energy which is discharged from the runner is regained, the efficiency of the water-power plant is increased.

A good illustration of the necessity for a better means of regaining the energy discharged from water-wheel runners is afforded by the installation at the Aluminum Company of America's plant at Massena, New York, where five 6000-hp. vertical two-runner water-wheel units are installed. Efficiency was of great importance, and the contract was placed with the manufacturer upon a bonus and penalty basis for efficiency, this being $6000 for each per cent of efficiency per unit. The contract value of 1 per cent increase in efficiency in this development was therefore $30,000. Very elaborate tests were conducted by the Aluminum Company of America to determine the efficiency of these water wheels, the final results of which showed that the guaranteed efficiency was exceeded by about 2 per cent, yet the efficiency could have been increased very much more had a better form of draft tube been installed.

Experimental Work Resulting in the Development of the Hydraucone Regainer

The necessity for a more efficient means of regaining pressure from velocity and changing the direction of flow from the water wheel within the limited space available in power-house foundations led the writer to undertake a long series of experiments resulting in the development of the hydraucone regainer as set forth in the following pages.

A hydraulic laboratory was installed in a garage near the corner of Second and Wright Streets, Milwaukee, the essential equipment of which was as follows:

A water box 6 ft. wide, 5 ft. 6 in. high, and 32 ft. long
A centrifugal pump of 14 in. discharge diameter, belt-driven by a 25-hp. motor which served to supply a maximum of 14 cu. ft. per sec. of water against a maximum head of about 15 ft.
A supply pipe leading from the centrifugal pump to a 42-in. diameter cylindrical plate-steel water-wheel casing with side inlet
A water wheel equipped with wicket guide vanes
A high-speed runner, being a 9-in. model of type No. 13, Allis-Chalmers Mfg. Co. The discharge diameter of the runner where it joins the draft tube is 13$^3/_8$ in. Specific speed, 90 (English system)
Also a prony brake, a tachometer, various pitot tubes, gages and manometers, etc.

The output of the water wheel under good testing conditions was about 8 hp., so that the size of the equipment was sufficient to give a practical demonstration of the relative efficiencies of the draft tubes, hydraucone regainers and other devices tested.

A great many tests were made with many objects in view, and comprised tests with no draft tube; tests of straight conical and short curved draft tubes; Argo and Mio curved draft tubes; hydraucone regainers with cone centers, with conical plates, and with flat plates; a combination of straight draft tube and hydraucone regainer with flat plate; and a power-house model of a hydraucone regainer.

The hydraucone regainers with cone centers are shown at *A* and *B* in Fig. 1, and the hydraucone regainer with conical plates at *C* of the same figure. The hydraucone regainer with flat plate is shown in Fig. 2.

Fig. 3 shows a combination of a straight draft tube with a hydraucone regainer having flat plates. This type, now frequently employed, was the one installed at Niagara Falls, as will be more fully described later. Fig. 4 gives the dimensions of a model of hydraucone regainer such as has been installed in several power plants now in operation.

Figs. 5 and 6 show respectively the test curves plotted from the results of data obtained in the tests of the models of the Argo draft tube No. 1 and the hydraucone regainer with flat plate. It will be noted that the test results were all reduced to a basis of 1 ft. head before the results were plotted. Examination of these curves should convince any one that the tests must have been carefully conducted, and that the results may be relied upon to give at least a fair comparison of the relative efficiencies of the various devices tested. The identical water wheel, equipment, and setting were used in all these tests.

Fig. 7 shows a series of efficiency curves plotted between horsepower and efficiency from test curves similar to those illustrated in Figs. 5 and 6. These curves give the efficiencies obtained at constant speed of the turbine throughout the range of the curves. The speed at 1 ft. head is indicated in the figure by the abbreviation r.p.m.$_1$. The speed at best efficiency is different for each curve.

It will be noted that the more efficient the regaining device, the higher the speed as well as the higher the power of the water wheel. It will further be noted that the increase of efficiency from "no draft tube" as shown in curve 1 to "hydraucone regainer" as

shown in curve 5 is from 77½ per cent to 86 per cent, with an increase in speed from r.p.m.$_1$ = 155 to r.p.m.$_1$ = 165, and with a maximum power from hp.$_1$ = 0.270 to hp.$_1$ = 0.310. The great gain, therefore, by the use of hydraucone regainers is not only in higher efficiency but is also in both speed and power.

Curve 1, Fig. 8, shows the efficiency of the short curved draft tube, which, it will be noted, is less than with no draft tube at all. There is no question but what many plants in operation today are losing power because of the poor curved tubes they use.

Curve 5, Fig. 8, shows the efficiency of the power-house model of hydraucone regainer whose dimensions are given in Fig. 4 and are approximately the same as those of the hydraucone regainer installed at the Hiram plant of the Cumberland County Power & Light Company, Portland, Maine.

Curve 4 gives the results of a test of a plate-steel curved draft tube that are very creditable, but it is very rare that there can be installed in a power house a draft tube of the same relative dimensions as those of the model employed, for the cost of excavation would be prohibitive.

Fig. 9 gives the results of tests with the hydraucone regainers shown in Fig. 1 and also with the straight tube and hydraucone regainer illustrated in Fig. 3. These curves are plotted from elaborate tests similar to those of Figs. 5 and 6 and show clearly that the hydraucone regainers with flat plates are slightly more efficient when tested with the model turbine than those with cone centers.

Fig. 10 presents the results of tests made on various shapes of conoidal chambers, from which it will be seen that the hydraucone regainer as here discussed is susceptible of a reasonable variation without materially affecting its efficiency.

The early tests at the laboratory were made to determine the effects on the model water wheel of radial passages extending outward but with a slight angle downward from the horizontal, and with passages leading directly from the runner. These early tests were not so successful as the later tests because it was not then realized that in order to change the direction of the water from axial as it flowed from the runner to radial and outward, it was necessary to take into consideration and provide for what was afterward called the "hydraucone action" of water, which requires a definite curvature to properly change the direction of the water from axial to radial if the greatest regain of velocity head is to be expected and consequent losses are to be avoided. In searching for a means for increasing the efficiency of regain the author recalled some experimental work done in connection with the determination of the pitot-tube formula in 1900, the results of which were published in Vol. 22 of the Journal of the Association of Engineering Societies (1901), page 284. Fig. 21 of that publication shows the stream lines and velocities of a jet impinging upon a plate, and by reason of the importance of the principle there disclosed in the new method of regaining pressure from velocity, it is reproduced here as Fig. 11.

The lines in this figure represent the stream lines of flow of the water, which were traced by injecting a small stream of blue water into the jet at various points along a diameter and noting and recording the flow line. The plate employed in this case was made of glass in order to afford ample light for making the observations. The figures given in the circles represent the velocities in feet per second at the various locations indicated. It will be noted that the water at the center of the jet slows up as it reaches the plate and delivers its velocity head into pressure head at the center of the plate. This pressure head at the center is transformed into velocity as

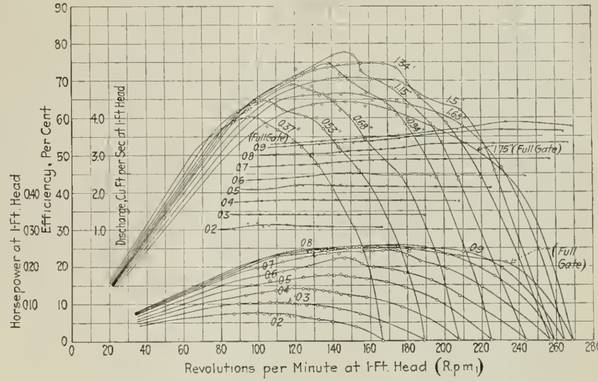

Fig. 5 Curves of Test of Model of Argo Curvrd Draft Tube No. 1

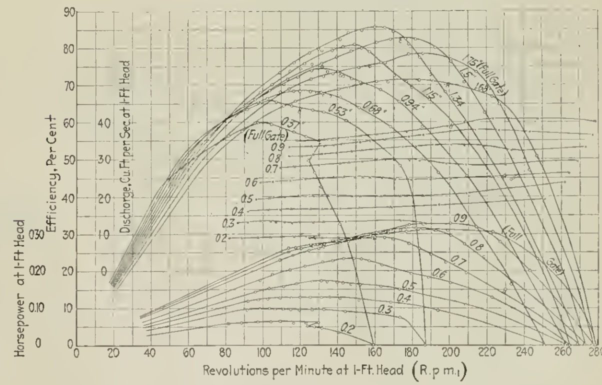

Fig. 6 Curves of Test of Model of Hydraucone Regainer with Flat Plate

(7½-in.-radius conoidal chamber, 4 ft. 6 in. in diameter)

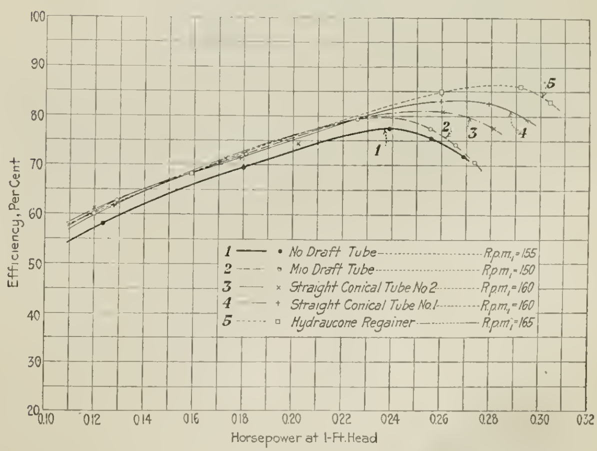

Fig. 7 Curves Showing Relation Between Efficiency and Horsepower at 1 Ft. Head

this stream flow passes from the center of the point of impingement to the point beyond the radius of curvature. Referring to

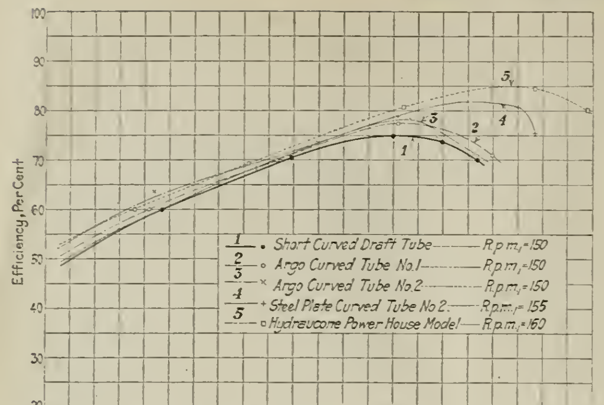

Fig. 8 Curves Showing Relation Between Efficiency and Horsepower at 1 Ft. Head

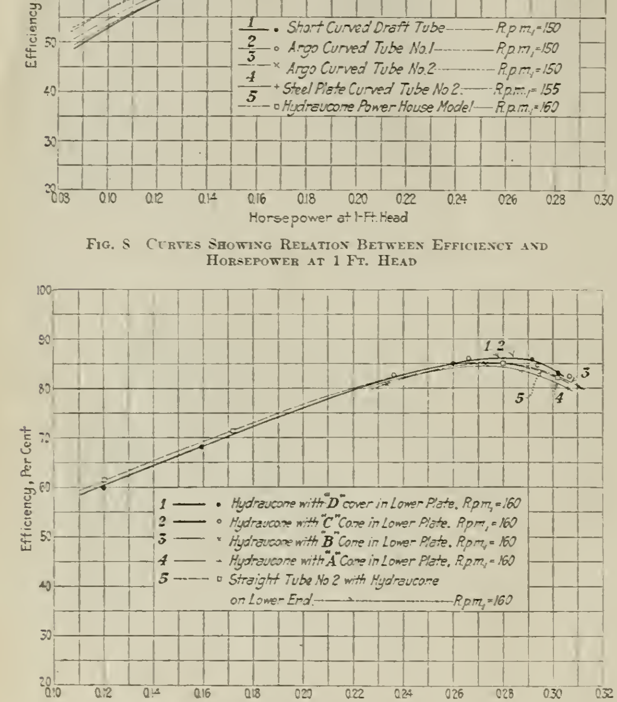

Fig. 9 Curves Showing Relation Between Efficiency and Horsepower at 1 Ft. Head

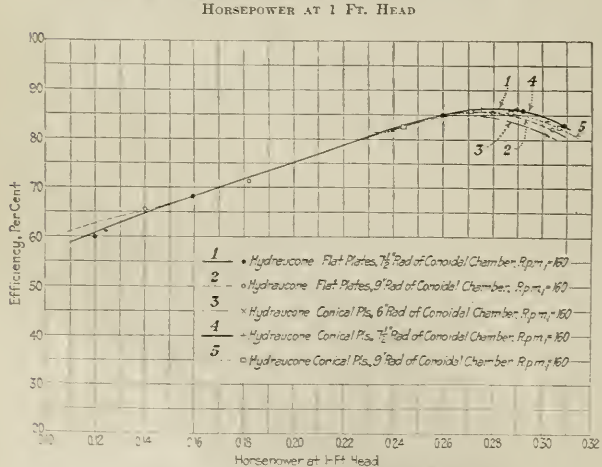

Fig. 10 Curves Showing Relation Bewteen Efficiency and Horsepower at 1 Ft. Head

Fig. 11, the radius of curvature of the water in making its change in direction is a definite curve and is the minimum which can be used in regaining devices and yet obtain the reactions within the point of impingement which will give smooth stream flow of discharge along the plate and consequently without eddies and attendant losses.

By the term "hydraucone action" of water is meant that action which occurs when an unenclosed stream impinges against and is deflected along a surface. Fig. 11 illustrates the hydraucone action of water when a jet impinges normally upon a flat plate. In considering the three outer stream filaments it was noted and recorded in 1900 that the cross-sectional area of the flow increased in making the turn and decreased at the exit from the turn. By placing a cone on the plate with its axis in line with the center line of the jet the outer shape of the curvature of the water is changed, but not to a great extent because of the low velocities within the center portion of the impinging jet.

When the hydraucone action of the water as illustrated in Fig. 11 was taken into consideration in the laboratory work, conoidal chambers were designed such as the one shown in Fig. 2, and when these were combined with the radial passages the desired results were immediately secured.

Tests of Smaller Models

The tests of the various model draft tubes and hydraucone regainers made at the laboratory with the small turbine illustrate the practical, economical and efficient application of the hydraucone principle for increasing the efficiency of water-power developments. Coincident with the series of tests in connection with the small turbine, a series of tests on smaller models were made without the use of a model water wheel. Sometimes these small models were tested before the large models were built and tested with the turbine, and sometimes afterward. These models were all made of such size that the entrance was 4 in. in diameter at the throat as compared with $13^3/_8$ in. at the throat of the larger models.

The apparatus used for testing the small models is shown in Fig. 12. The model water wheel was removed from the plate-steel cylindrical casing and in its place the curved wooden section *L* was bolted to the opening at the bottom of the casing. At the bottom of the curved piece *L* was connected a 4-in. diameter throat *T*, made of brass pipe with flanges, to the lower end of which the various small models were fastened. Four piezometer openings and as many gages were provided to indicate accurately the pressure at the throat. Gages *a*, *b* and *c* serve to illustrate more or less diagrammatically the method of computing the efficiencies of the small models. The difference in elevation between gages *a* and *c* was kept about the same. The reading of the throat gage *b* varied widely, depending upon the efficiency of the regainer device used. The efficiency of these small models was taken as *B* divided by *A*, or in other words, the velocity head regained divided by total velocity head in the water as it passed through the throat *T*. A small model hydraucone with large-diameter plate is shown attached to the throat in Fig. 12. The model hydraucone was detachable from the flange *F* of the throat, to which were bolted the various devices tested.

Tests were made with the hydraucone regainers having cones in the center of the chamber, and the distance between the plates was varied. With a tall cone in the center similar to *A*, Fig. 1, the efficiency obtained was less than 70 per cent. By substituting a low cone similar to that represented by *B* in the same figure, the

maximum efficiency by varying the distance between the plates was found to be 70 per cent.

One series of tests copied from the record book of a model hydraucone as shown in Fig. 12 having a $2^3/_4$-in. radius of curvature of the conoidal chamber, gave the following efficiencies as the distance between the plates was varied:

Distance between plates, in...	$\frac{1}{2}$	$\frac{17}{32}$	$\frac{9}{16}$	$\frac{19}{32}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
Efficiency, per cent...........	76.7	77	78.5	78.7	78	74	68

By cutting down the diameter of the upper and lower plates to 18 in., using the same radius of curvature of the conoidal chamber, namely, $2^3/_4$ in., and varying the distance between the plates, the following efficiencies were obtained:

Distance between plates, in........	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$
Efficiency, per cent................	61	65.5	67.5	67	68.8	59.3

Conoidal chambers of various radii of curvature were tested with cone centers, flat plates, and then with depressions or con-

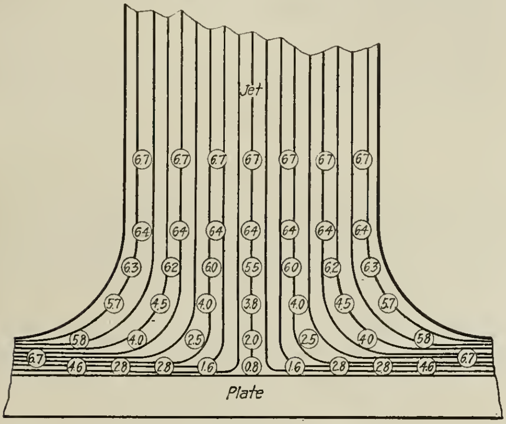

Fig. 11 Hydraucone Action of Water When a Jet Impinges Normally on a Flat Plate

cave surfaces, the latter being developed to secure shorter radius of curvature of the conoidal chamber. The efficiencies obtained with the concave surfaces were about equal to that obtained by the use of the flat plate when the proper curve of the conoidal chamber was used.

Tests were also made upon straight conical and curved draft tubes, and upon square expanding nozzles and elliptical-shaped nozzles as contrasted to the circular straight nozzles. Rectangular and conoidal bends were also tried out.

Holyoke Tests

At the completion of the tests of the various regainers and model draft tubes at the laboratory, a series of tests were made at the Holyoke Testing Flume on a large water wheel having a runner of 30 in. nominal diameter and a discharge diameter of 38 in. The objects of these tests were to verify the results already obtained at the laboratory, and to obtain records of the performance of the hydraucone regainer which could be presented to the engineering profession with the assurance that they were reliable, and could be used for comparison with the results obtained with other forms of draft tubes tested at Holyoke. The water wheel was first tested with a straight draft tube 8 ft. $3^1/_8$ in. in length and with diameters of 3 ft. $3^1/_2$ in. and 6 ft. 3 in. at the smaller and larger ends, respectively. This was the best tube of this type developed by the Allis-Chalmers Manufacturing Company for testing purposes. The results of the tests are shown in Fig. 13, Holyoke test No. 2445, dated Mar. 3, 1916.

The next test was made by placing the water wheel

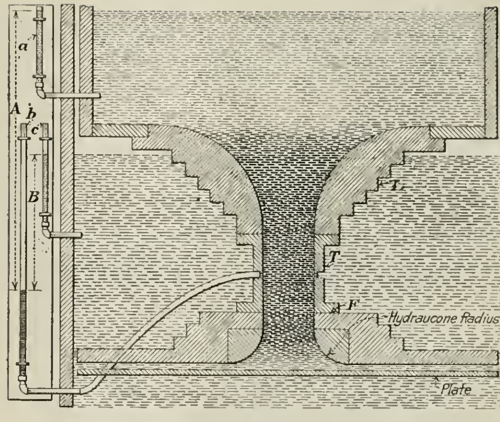

Fig. 12 Apparatus Used in Testing Small Model Draft Tubes and Hydraucone Regainers

directly on the hydraucone regainer as shown in Fig. 14, and the results are given in Fig. 15, Holyoke test No. 2460, dated May 5, 1916. Fig. 16 gives the results of a test of the water wheel when set on a short straight conical draft tube (3 ft. long), with the discharge of the tube connected with the hydraucone regainer. (Holyoke test No. 2461, dated May 16, 1916.)

Two shapes of conoidal chambers were made and tested; one of which is illustrated in Fig. 14. Tests were made with the plates of the hydraucone regainer set at various distances apart. These tests confirmed those made at the laboratory and showed that the hydraucone regainer could be relied upon for giving high efficiency with commercial water wheels under actual operating conditions. A maximum efficiency of 91.6 per cent was obtained with the use of the hydraucone regainer as shown by Holyoke test No. 2461, which was slightly greater than that obtained with the long straight draft tube in Holyoke test No. 2445. The test

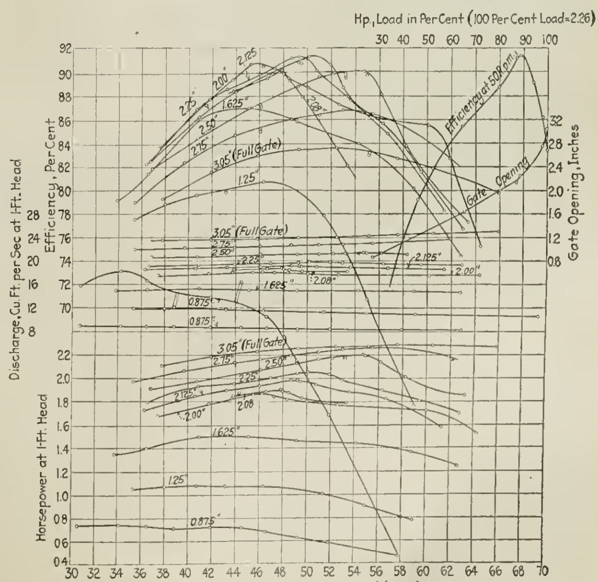

Fig. 13 Holyoke Test No. 2445 of 30-in. Runner with Long Straight Conical Draft Tube
(20 guide vanes; guide case $14^1/_4$ in. wide.)

of the water wheel with the hydraucone regainer showed better characteristics at speeds both below and above normal than the test with the straight draft tube, all of which might be expected in view of the radial passages of the hydraucone regainer in which

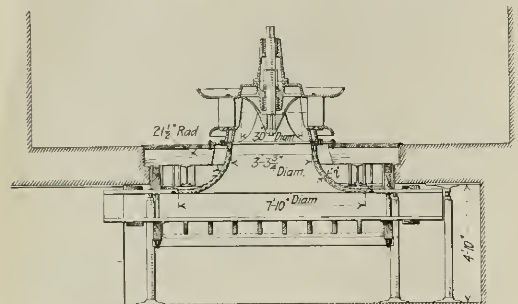

Fig. 14 Water Wheel Placed Directly on Hydraucone Regainer as in Holyoke Test No. 2460

the whirling action of the water is utilized for increasing the efficiency.

Hydraucone regainers with cone centers such as *A*, Fig. 1, were not tested at Holyoke because the laboratory experiments showed conclusively that hydraucone regainers with flat plates gave better efficiency. The friction of the water along the surface of a hard cone center is much greater than the internal friction when the water forms its own cone as shown in Fig. 11. This is one reason why the hydraucone regainer with flat plate gives better efficiency than the hydraucone regainer with cone center.

Results Obtainable by Using Hydraucone Regainers with Runners of Different Specific Speeds

The hydraucone regainer may be employed in any power plant operating under any head with a resulting increase in efficiency. Its actual value in power plants operating under different heads with runners of different specific speed may be seen from Table 1.

Runner No. 1 is a type identical with that used on one of the 37,500-hp. turbines recently put into operation in Station No. 3 Extension of the Niagara Falls Power Company. The specific speed of this runner is about 40 (English system). Runner No. 2 is a reasonably high-speed runner for low-head plants, such as that installed at the Argo Plant of the Eastern Michigan Power Company, and it is the same type as that used in the experiments made at the laboratory. Runner No. 3 is the Allis-Chalmers No. 404 high-speed type furnished to the Cheboygan Electric Light & Power Company, Cheboygan, Mich. This runner was described by Mr. Nagler in his paper presented at the 1919 Annual Meeting of the Society.[1] The axial component of the velocity of the water discharging from each runner is shown in column 6. The energy discharged from the runner in each case is shown to be respectively 4 per cent, 13.7 per cent, 22.4 per cent of the energy of the total head. Draft tubes on high-head plants are usually much more efficient than those on low-head plants. A draft-tube efficiency of 40 per cent may be obtained under ideal conditions in a suitable curved draft tube for use in connection with runner No. 1, but draft tubes on low-head plants are not so efficient, and the efficiency of a curved draft tube such as would be used with runner No. 2 would be about 20 per cent, and with runner No. 3 certainly not exceeding 20 per cent.

[1] A New Type of Hydraulic-Turbine Runner, Forrest Nagler, Trans. Am.Soc.M.E., vol. 41, p. 829.

Table 1 Increase in Power-Plant Efficiency Resulting from Use of Hydraucone Regainer

1 No. of runner	2 Specific Speed	3 Nominal diameter of the runner, in.	4 Discharge diameter of the runner, in.	5 Cu. ft. per. sec. discharged at 1 ft. head	6 Vertical component of water discharged from the runner	7 Energy in discharged water, per cent	8 Assumed efficiency of draft tube, per cent	9 Loss of energy with draft tube, per cent	10 Assumed efficiency of hydraucone regainer, per cent	11 Loss of energy by hydraucone, per cent	12 Increase of efficiency by use of hydraucone, per cent
1	40	30	28	1.97	1.65	4	40	2.40	70	1.2	1.2
2	90	30	44.5	32.05	2.97	13.7	20	11	70	4.1	6.9
3	160	30	30	18.5	3.8	22.4	20	17.9	70	6.7	11.2

The efficiency of the hydraucone regainer for use with each of the three runners would be at least 70 per cent. The greater efficiency of the hydraucone regainer over the curved draft tube results in increasing the power-plant efficiency by 1.2 per cent, 6.9 per cent, and 11.2 per cent, respectively, for runners Nos. 1, 2 and 3, as shown by column 12 of Table 1. From this it will be

(Continued on page 410)

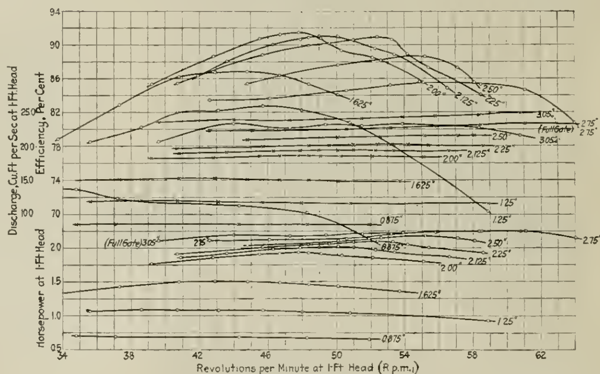

Fig. 15 Holyoke Test No. 2460 of Water Wheel Placed Directly on Hydraucone Regainer

(Radius of conoidal chamber, 21½ in.; distance between plates, 12½ in.)

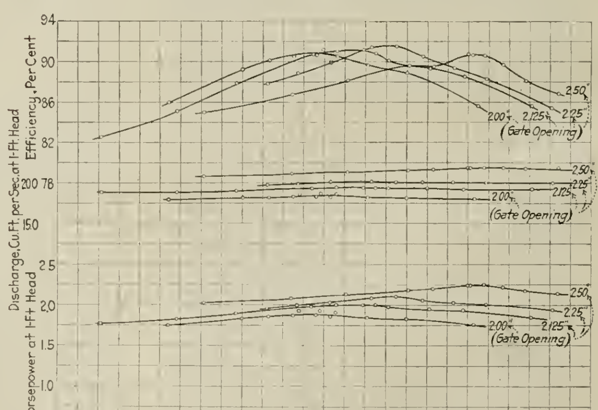

Fig. 16 Holyoke Test No. 2461 of Water Wheel Set on Short Straight Conical Draft Tube and Discharging through a Hydraucone Regainer

(Draft tube of 3 ft. section; radius of conoidal chamber, 25 in.; distance between plates, 12½ in.)

Recording Ash-Pit Loss From Chain-Grate Stokers

By E. G. Bailey,[1] Cleveland, Ohio

This paper presents certain preliminary data obtained from a device recently developed to record the ash-pit loss from chain-grate stokers and thus enable the fireman to effectively control this factor.

The device consists of a thermometer bulb filled with nitrogen and connected through a capillary tube to a recorder consisting of a mercury U-tube, one leg of which is open to the atmosphere and carries a float to which the recorder pen is attached. It has been found that when this bulb is properly located near the rear of a chain-grate stoker, its temperature will respond definitely to changes in the amount of combustible going to the ash pit and will vary in direct proportion to the heat thus lost.

Records of ash-pit loss, excess air, unburned gas, flue-gas temperature and boiler rating make it possible to plot characteristic performance curves for stokers showing the losses due to unburned combustible, unburned gases and excess air, and to determine the proper amount of excess air to be maintained and also the most efficient capacity. These curves can be used to compare relative efficiencies of different types of stokers, the suitability of different kinds of coal, and the effectiveness of the control by the fireman.

There has been more guesswork and less knowledge regarding ash-pit loss than any other thing of equal importance in the boiler plant. It pays to watch the ash pile from every kind of stoker or even hand-fired furnaces, though it be only visual inspection to note whether it is well burned out or full of combustible. To sample and analyze the ashes regularly and calculate the heat lost in that manner is better still, yet it is done in comparatively few plants and falls far short of accomplishing the desired result. A sample taken from the entire plant each day leaves the responsibility divided between the different firemen and different types of stokers. To take a sample from each boiler for each shift would still not accomplish as good results as if the ash-pit loss were continuously recorded for each boiler.

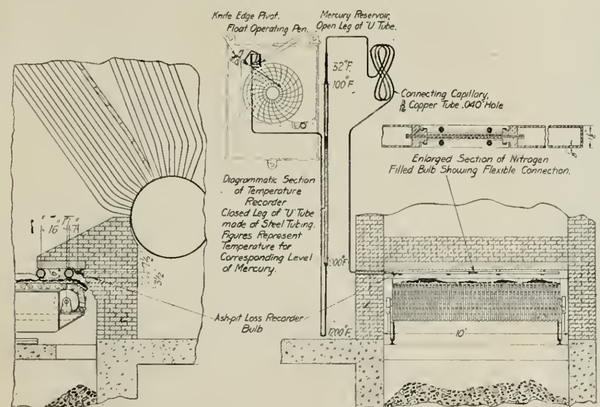

Fig. 1 Ash-Pit Loss-Recorder Installation on Natural-Draft Chain-Grate Stoker in Station B

Instantaneous readings of any kind are most valuable in aiding the fireman to obtain results. He can then see a faulty condition as soon as it takes place or even starts to take place, and remedy it promptly. If such readings are recorded continuously the fireman can see how quickly the remedy is effective. Such records also show the executive in charge of the plant just what took place at all times.

It is the purpose of this paper to present some preliminary data obtained from a device recently developed to record the ash-pit loss from chain-grate stokers. It may later be extended to some other types of stokers of either the present or modified design, but the great need for it on chain grates led to its being applied to these first.

Method of Recording Ash-Pit Loss

The fundamental principle used in recording the ash-pit lost by this method is to place a temperature-recorder bulb at a point

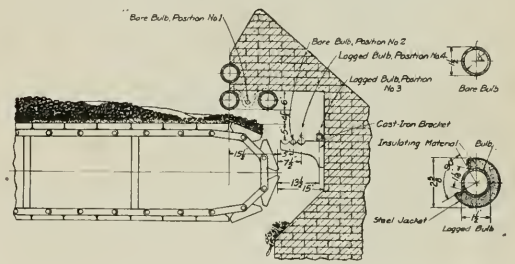

Fig. 2 Ash-Pit Loss Recorder on Forced-Draft Chain-Grate Stoker in Station A, Showing Different Bulb Constructions and Locations

near where the ashes are discharged from the active section of the grate or furnace. The bulb is not in contact with the ashes but receives only the radiant heat from the coke being discharged. The relation between this temperature and the amount of combustible in the refuse, and the heat loss due to it, is established by taking a series of samples corresponding to different temperature readings.

If the ashes are well burned out, so that there are no live coals, the temperature is comparatively low. Even though the ash has clinkered rather badly and retained a certain amount of temperature, it has usually lost its glow and is comparatively cold from a radiation standpoint. The coke coming over is still ignited and at a temperature of about 1800 to 2000 deg. fahr., so that its radiant heat to the bulb is sufficient to cause very decided changes in the temperature readings.

In selecting a location for the temperature-recorder bulb, it is necessary to have it shielded from any radiant heat of the furnace itself, and also as free as possible from changes in temperature due to the surrounding brickwork, circulation of air, etc. It is further necessary that the bulb extend across the entire width of the grate and be so constructed as to obtain an accurate average in case the amount of coke coming over is greater on one portion of the grate than an other.

Fig. 1 shows an installation on a natural-draft chain-grate stoker with a 9-ft. bulb located just beyond the water back, which shields it from the heat of the furnace. It is located about seven inches above the rear end of the grate so that the radiant heat from any coke passing under it will increase its temperature.

The Temperature Recorder

The temperature-recorder bulb itself is made very rugged to withstand this service. It is constructed of $1^1/_2$-in. steel tubing with $^1/_8$-in. wall and all joints welded. The bulb is charged with

[1] President, Bailey Meter Co., Mem. Am.Soc.M.E.

Abstract of a paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Copies of the complete paper may be obtained on application. All papers are subject to revision.

nitrogen and the gas pressure that is exerted by an increase in temperature is conducted through a $^3/_{16}$-in. copper capillary tube to the recorder. The recorder consists of a simple mercury U-tube, one leg of which is open to the atmosphere and carries a float to which the recorder pen is attached.

The other leg of the U-tube is made up of sections having different cross-sectional areas so that the pen movement is suppressed below and above the range to be recorded on the chart. It is also possible, if necessary, to have the area of one leg of the U-tube variable so that the percentage of heat loss will be recorded directly with uniform gradations on the chart in case the relationship between the ash-pit loss and temperature should not be a straight line.

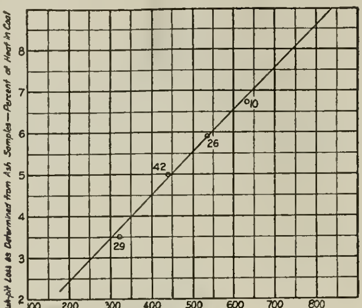

Fig. 3 Ash-Pit Loss and Temperature Relation for Bare Bulb in Position No. 2 (Fig. 2) on Forced-Draft Chain-Grate Stoker as Operated in Station A

(Figures represent number of individual tests averaged.)

The bulb can be made in sections short enough to be installed where the alley between two boilers is narrower than the width of the boiler itself. Each section, however, is welded permanently with $^1/_4$-in. No. 13 gage steel tube, making a flexible connection so that it can be folded up and then straightened out as it is installed in the furnace.

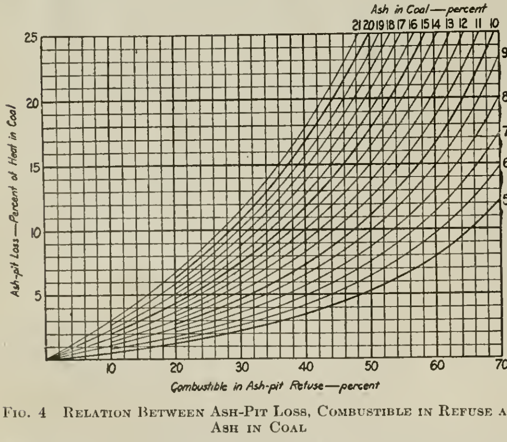

Fig. 4 Relation Between Ash-Pit Loss, Combustible in Refuse and Ash in Coal

Up to the present time the experiments have been largely confined to the selection of the best locations for the bulb with respect to the grate and also to determine the relative advantage of bare bulbs and those having lagging around a portion of their circumference so as to minimize the heat received from or given off to the surrounding walls, air, etc.

Fig. 2 shows the location of a bulb at the end of a forced-draft chain-grate stoker. A bare bulb was first located at position No. 1 with cast-iron supports. It was found that when the fuel was up to the bottom of the water back and there was a slight positive pressure in the furnace, a flame would envelop the bulb, sending the temperature up to more than 1500 deg. No data were obtained from this recorder in the No. 1 position.

The bare bulb was next placed on the cast-iron bracket in position No. 2, and after operating several days it was found to be satisfactory as to temperature range and continuous operation. A series of calibration tests was then started to learn what combustible losses corresponded to the different temperature readings.

Relation Between Temperature and Combustible Loss

Samples consisting of *all* the ash discharged from the stoker were taken hourly. The ash as it accumulated in the hopper was quenched immediately by means of a water spray. At the end of the hour the ash was dumped from the hopper, crushed, mixed and quartered by hand until it was reduced to about 20 lb. of 4-mesh size, and sent to the laboratory. The analyses show combustible on the dry basis.

The samples from Station A were collected from time to time between January 20 and March 2, 1921, at times when it was convenient to do the work. Usually five to eight samples were taken each day. In all, 107 samples were taken during 15 different days. About half of them were taken during certain stoker tests that were being made on this boiler and the remainder under everyday operating conditions.

No special effort was made to change operating conditions from normal except in the case of a few samples, when more combustible was run over than usual in order to get some high points to establish the upper part of the curve.

The essential results for the 107 samples taken are plotted in Fig. 3, where each small circle represents the average of all temperature readings grouped between 300 and 400, 400 and 500 deg. fahr., etc. It is noted that the ash-pit loss is about 3.5 per cent at 300 deg. and increases 1 per cent for each 100 deg. temperature rise.

It was first thought best to plot the results between temperature and percentage of combustible in the ashes, but it was found that the ash in the coal varied between 8.5 and 14 per cent. From the curves of Fig. 4 it is noted that with samples having 30 per cent combustible the heat loss is 3.9 per cent from the 8.5 per cent ash coal and 7 per cent from coal with 14 per cent ash, hence each test was figured on a basis of the heat loss due to unburned carbon, expressed in percentage of the heat in the coal.

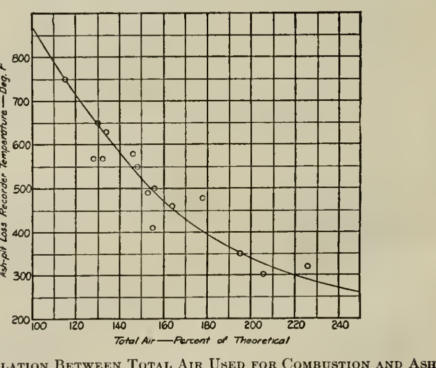

Fig. 5 Relation Between Total Air Used for Combustion and Ash-Pit Loss-Recorder Temperature Obtained from Forced-Draft Chain-Grate Stoker Operated in Station A

The relation between percentage of combustible in refuse, ash in coal, and ash-pit loss is given in the series of curves in Fig. 4. These curves are plotted from the formula:

$$\text{Combustible loss} = \frac{100\,ac}{(100-a)\,(100-c)}$$

where a is the percentage of ash in the coal and c the percentage of combustible in the refuse. This formula is based upon the assumption that all of the ash from the coal goes to the ash pit and

that the heating value per pound of combustible in the ash pit is the same as that of the combustible in the coal.

Emphasis is usually placed upon the percentage of combustible in the ashes as being the true measure of loss due to unburned carbon, but it is of equal importance to know the percentage of ash in the coal. There is more heat lost with 20 per cent combustible in the refuse from a coal with 20 per cent ash than with 40 per cent combustible in the refuse from a coal with 8 per cent ash.

One naturally questions whether the temperature of a bulb at such a location will vary with the percentage of heat lost or with the percentage of combustible in the refuse; whether either relation will hold true for different percentages of ash in the coal, or whether it varies with the boiler rating, grate speed, etc. The final answer to such questions can only be determined from results of actual tests. Fig. 3 is plotted from the 107 samples and it shows conclusively that the temperature varies directly with the percentage of the heat of the coal lost in unburned carbon. Various other plots and studies of the individual tests fail to show any tendency for the results to deviate from this curve due to changes in the percentage of ash in the coal, the grate speed, or the boiler rating.

This is very fortunate, as the temperature record can then be used directly in determining the heat loss without the necessity of bothering with percentage of ash in coal or any other modifying factors. In fact, the chart can be graduated direct in percentage of heat lost instead of temperature. Samples of coal and combustible are needed only for making the calibration tests, which

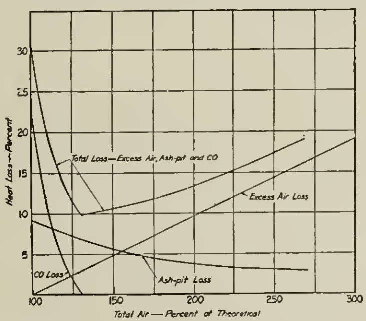

Fig. 6 Characteristic Loss Curves, on Basis of Total Air, of Forced-Draft Chain-Grate Stoker as Operated in Station A

should be determined for each type of installation. At least this will be necessary until more data have been obtained regarding location of bulb and the characteristics of different types of stokers, arrangements of water backs, etc., as these are likely to produce a different rate of temperature change as shown later in this paper.

Performance Results from Chain-Grate Stokers

It is well known that with a chain-grate stoker the ash-pit olss tends to increase as the excess air is decreased, and vice versa. It is only natural that more coal should be wasted over the end of the grate when the fuel bed is kept thicker and carried to the water back. When the fire burns short a reduction is made in the ash-pit loss, but there is a decided increase in the percentage of excess air. As a matter of fact this is generally true in all types of stokers, and even in hand firing. That is, a reduction in unburned coal usually means some increase in excess air, so that decreasing one loss increases another.

The problem is then to determine what method of operation will give the lowest total loss, and the ash-pit loss recorder makes it possible to plot out these relations as combustion characteristics of the stoker.

Relation Between Ash-Pit Loss and Total Air Used for Combustion

Fig. 5 shows a very definite relation between temperature as indicated by the ash-pit loss recorder and the total air used for combustion on a basis of the theoretical air being 100 per cent. In plotting the points the total air was taken from the ratio of air flow to steam flow as shown on chart records, using only periods when the steam flow, the air flow and the ash-pit loss-recorder temperature were each very uniform over stretches of two hours or more at one time, indicating that the conditions had settled to normal and were not varying continuously.

The values taken from the average curve of Fig. 5 are used to calculate the heat losses and are plotted in Fig. 6, showing the

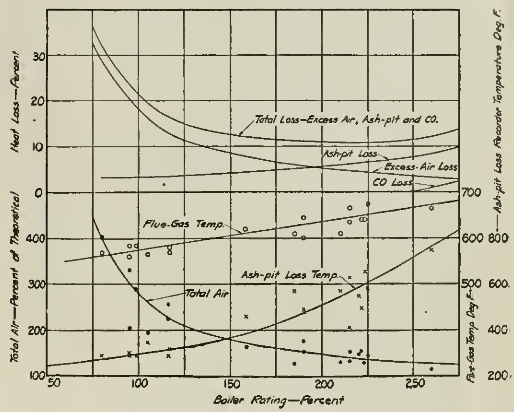

Fig. 7 Characteristic Loss Curves, on Basis of Boiler Rating, of Forced-Draft Chain-Grate Stoker as Operated in Station A

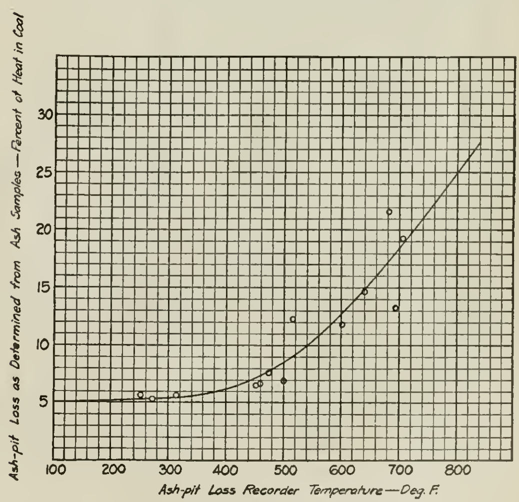

Fig. 8 Ash-Pit Loss and Temperature Relation, Bulb as in Fig. 1, on Natural-Draft Chain-Grate Stoker, Station B

(Each point represents an individual one-hour sample.)

characteristic loss curves for a forced-draft chain-grate stoker as operated in Station A. This set of curves shows that percentage of heat lost in excess of air (based on a 500-deg. temperature rise) increases from zero up to 19 per cent at 300 per cent total air. As the excess-air loss is reduced the ash-pit loss increases, but the rate of increase is less than the rate of decrease in the excess-air loss, so the total of these losses decreases until the total air is about 130 per cent. At this point CO and unburned gases appear, and the percentage of heat lost in consequence increases very rapidly as the amount of air is reduced to 100 per cent or the theoretical amount. It is therefore best to operate this stoker at about 130 to 140 per cent total air.

It is quite possible that, with a little better care upon the part of the fireman, the combustible loss could be considerably reduced on this type of stoker, even at this low percentage of excess air. This would then lower the total curves so that the combined loss would be still lower than the 10 per cent shown in Fig. 6 as the minimum point.

Relation Between Capacity and Stoker Losses

Fig. 7 shows the relations between the boiler rating and flue-gas temperature, excess air, unburned combustible, and CO, with the percentage of heat lost in each. The total of these three losses is seen to be at a minimum of 11 per cent at 225 per cent rating and to remain below 12 per cent at all ratings between 160 and 260 per cent.

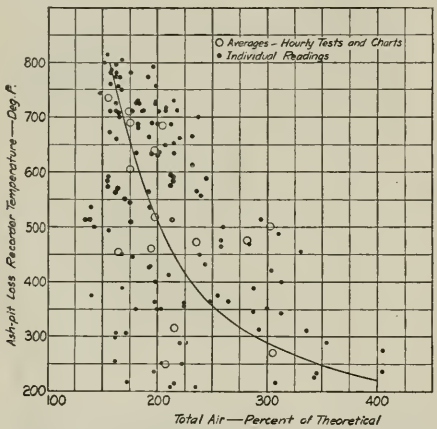

Fig. 9 Relation Between Total Air Used for Combustion and Ash-Pit Loss-Recorder Temperature Obtained from Natural-Draft Chain-Grate Stoker as Operated in Station B

The minimum loss in Fig. 6 is 10 per cent because the excess-air loss is calculated on the arbitrary bases of 500 deg. fahr. rise in flue-gas temperature, while in Fig. 7 it is calculated on the actual temperature, which is as high as 650 deg. at the higher rating.

If it were possible to operate this stoker with lower excess air at the lower ratings and lower ash-pit loss at the higher ratings, the total losses would be materially decreased and the curve would be flatter. In fact, the range of best efficiency as shown in Fig. 6 should be almost entirely independent of boiler rating if the same care is exercised by the fireman at the low ratings as he must exercise at the high ratings to produce the steam.

To obtain the total overall efficiency curves for stoker, furnace, boiler, and perhaps economizer, the other losses due to products of combustion and infiltration of air should be included according to the equipment used. There is also the question of overhead charges and repairs to stokers and brickwork that increase with higher rating or lower excess air.

Characteristic Curves of Stokers

This set of curves raises the question, can true characteristic curves be drawn showing the performance of the stoker itself? Very little has been done in this direction, but such data have been well established for centrifugal pumps, motors, turbines, fans and blowers.

In the operation of a stoker so much depends upon the character and quantity of coal being burned and also upon the human element of the fireman that the true characteristics of the stoker are usually so clouded that they do not appear in their true form.

Most boiler tests give combined efficiency of furnace and boiler as it is difficult to separate the two. In reality it is not necessary to separate these two efficiencies or even to determine the efficiencies at all, because a great deal more can be accomplished through studying the losses than can be obtained from knowing the overall efficiency alone. We know that if the losses are high the efficiency is low, and vice versa. It is also easy to separate certain of the losses and charge them directly to the furnace, while other losses may be chargeable entirely to the boiler and still others are beyond the control of either.

The three important losses existing in boiler and furnace operation that are chargeable directly to the stoker and furnace are unburned combustible in ashes, unburned gas, and excess air. The latter two losses may be influenced somewhat by the size of the furnace and combustion chamber, and the last one by the leakage of air through the boiler setting, but on the whole they depend almost entirely upon the stoker and its operation.

If the characteristics of the stoker are properly determined one can then see the best relation between these factors in order that the total of the three losses be a minimum. We are then assured the furnace efficiency is highest, even though we may not know the exact thermal efficiency of the furnace and stoker itself, separate from the boiler.

In operating stokers it has been considered that the character of the coal and the method of operation were far more important than the characteristics of the stoker itself. This, however, is only an admission that the stoker was not so designed that its characteristics would dominate over the other factors, namely, coal and fireman. Very great improvements have been made in stoker design and methods of operation, but there is need for still further advancement. A careful analysis of the problem by means of continuous graphic records of all the losses and characteristic performance curves like those shown in Figs. 6 and 7 will aid in further improvements in both design and operation as well as in selecting coal for the stoker or the selection of a stoker for the coal available.

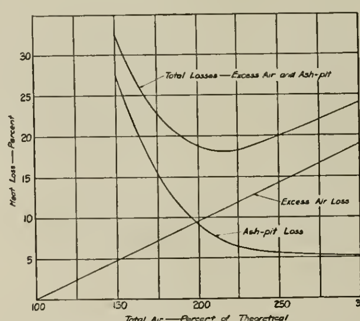

Fig. 10 Characteristic Loss Curves, on Basis of Total Air, of Natural-Draft Chain-Grate Stoker as Operated in Station B

Even where ash-pit loss recorders cannot now be easily applied to some types of stokers it is possible to take hourly samples of the refuse and plot the characteristic combustion and capacity curves like those in Figs. 6 and 7. For stokers with intermittent ash dumps the period for each test should be the same as the period between dumps, maintaining the operating conditions as uniform as possible during this period and taking the ash sample from each dump. As the value of these results does not depend upon coal weights and evaporation efficiencies, short tests are satisfactory for determining the losses due to excess air, unburned gas and unburned coal. All of the losses of the boiler heat balance, except radiation, can be determined almost if not quite as accurately as can be the evaporation.

Results from Natural-Draft Chain-Grate Stoker at Station B

Figs. 8 to 12 give the data from thirteen ash samples and tests on a natural-draft chain-grate stoker equipped with an ash-pit loss recorder as shown in Fig. 1. These data were obtained on three consecutive days from a boiler that was being operated in a stand-by station. The load conditions did not require careful attention to the stoker operation, hence the results should not be taken as indicative of the best performance with this type of

stoker. Neither should these results be used for comparing one type of stoker with another, because the operating factors, namely, coal and fireman, may be very different.

In Fig. 8 the ash-pit loss increases very slowly with the initial rise in temperature and then more rapidly at the higher temperatures. Referring to Fig. 1, it will be seen that the bulb is located at a different position with respect to the fuel bed than in Station A. In this case the bulb is directly over the end of the grate, and looks down upon the coke as it passes beneath it. With a very short fire the coke may "go out" or cease to burn before it reaches the water back and yet contain a considerable percentage of combustible, hence the minimum loss of 5 per cent with little or no radiant heat. As soon as a few pieces of hot coke are carried over, the effect upon the bulb is very marked and a considerable rise in temperature takes place until the grate is covered with coke. A greater amount of combustible will add only to the thickness of the layer and not increase the area of the hot coke within the vision of the bulb in this location. The increase in the temperature of the bulb is due only to the closer proximity of the hot coke to it after the grate is once covered.

In Fig. 9 the relation plotted between total air and ash-pit loss-recorder temperature shows widely scattered points. This is largely because the fuel-bed conditions vary rapidly, and there is considerable time lag between the condition of the fuel bed on the grate proper and the amount of coke being discharged at the same time. The log, Fig. 12, plotted over a short period, shows a typical case of the variations as the fire burns thin and is again thickened. The ash-pit loss-recorder temperature drops with the short fire, but the lowest temperature is not reached until twenty minutes after the greatest air excess and the lowest steam flow.

The conditions of the fuel bed on this stoker are sometimes very good and sometimes very poor, just as it may happen, due either to the stoker characteristics, the human factor, or the coal factor, or to a combination of all three. In any case there are certain average conditions which tend to repeat and show the relationship between the various factors. It is very evident from Fig. 9 that very high excess-air and high ash-pit losses do not occur at the same time, although either may be low when the other is high, but they should both be low for the best efficiency.

In Fig. 10 it will be noted that the natural-draft chain-grate

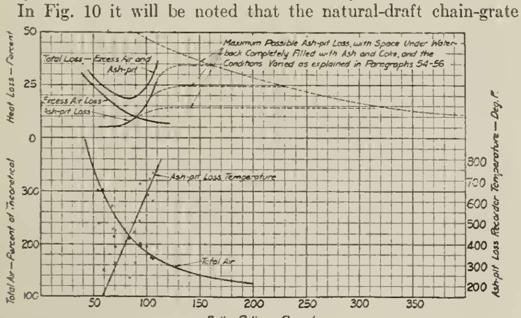

Fig. 11 Characteristic Loss Curves, on Basis of Boiler Rating, of Natural-Draft Chain-Grate Stoker as Operated in Station B

stoker in question, as it was being operated at this time, gives the best efficiency at about 210 per cent total air, with a loss of 18 per cent due to excess air and unburned coal. We all know that better results than this can be obtained under suitable load conditions with good operation and the right kind of coal, yet these curves indicate that there is a tendency for the losses to increase very rapidly as the fire changes to a shorter or longer condition from the most economical point.

The air having free and equal access to all parts of the grate takes the path of least resistance through the fuel bed and develops holes very rapidly when once started. In many plants the boilers are operated with the damper wide open. If the maximum amount of steam is not needed the fire burns short. If more steam is needed the stoker is speeded up and a little greater proportion of the grate area is covered with active fuel bed. In other words, the steam pressure is regulated by means of excess air. Fig. 12 shows this very nicely, as the air flow remains practically constant and more or less steam is produced as the coal is fed into the path of the air.

Fig. 11 shows the excess-air and ash-pit losses plotted on a basis of boiler rating. The total of these two losses has its lowest value of 18 per cent at about 90 per cent rating. At lower ratings the excess-air loss increases rapidly and at higher ratings the unburned-coal loss increases even more rapidly.

One naturally wonders whether the ash-pit loss would continue increasing at the rate indicated by the slope of this curve if the boiler were operated at still higher rating. The limit in this direction is reached when the space under the water back is completely filled with ash and coke. The percentage of combustible lost when operating with the space under the water back completely filled with ash and coke combined, will depend upon the percentage of ash in the coal, the coal-gate opening, and the height of the water back above the grate, and will be practically independent of the speed of the grate.

If the increased rate of combustion is obtained by increasing the gate opening and the intensity of draft, leaving the grate speed and the space under the water back constant for a given percentage of ash in the coal, a decrease in the ash-pit loss will result as shown by the upper dotted curve at the right of Fig. 11, because there will then be more ash per square foot of grate and therefore less space left for coke under the water back.

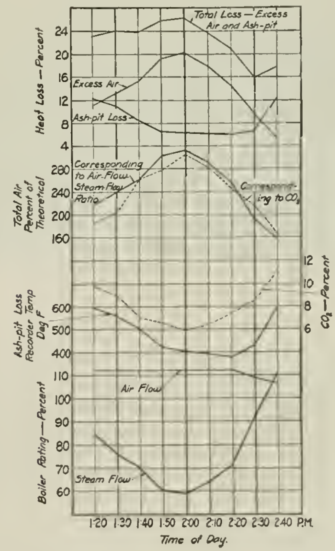

Fig. 12 Log Showing Change of Fuel Bed on Natural-Draft Chain-Grate Stoker as Operated in Station B

For any given relation between gate openings and space under water back the percentage of combustible lost would decrease with increased percentages of ash in the coal, and should of course remain constant for different ratings. A change in the height of the water back would also have a similar effect, the percentage of ash-pit loss remaining the same for all ratings in both cases so long as the space under the water back was kept completely filled and increased ratings obtained by increasing grate speed.

If the fire burns thinner, the ash-pit loss will be decreased for any of the foregoing conditions and the excess-air loss increased.

It is believed that characteristic curves like those shown in Figs. 10 and 11 will be very helpful in obtaining the best results from natural-draft chain-grate stokers. By means of such curves we should be able to accomplish better results in the arrangement of water backs, regulation of coal gate, grate speed, draft, etc., and also assist the fireman in obtaining the required amount of steam with the minimum loss.

Road Building and the Mechanical Engineer

Their Problems in Relation to Road-Building Machinery Presented Under the Auspices of the Materials Handling Division at the A.S.M.E. Spring Meeting

THE avenues of transportation of most importance to the greatest body of the public are the highways of the country. During the last five years highway construction has passed through a period of stress, which has focused attention on the proper application of machinery to the building of highways. The Materials Handling Division of the A.S.M.E. in devoting its Spring Meeting session to this subject afforded an opportunity for the contractor to meet with the engineer to discuss all phases of the problem.

While the extensive use of mechanical equipment may be of help to the road contractor, there is the added problem of increased overhead with the necessity for continuity in the operation of expensive equipment, calling for a complete understanding of the contractor's needs by the mechanical engineer.

The papers presented at the Chicago meeting emphasize to the contractor the importance of a careful planning of road-construction operations to better utilize mechanical equipment. There are no statements of principles by which the road contractor may be guided in the choice of equipment for a particular job and the presentations were made in the hope that their discussion would lead to the enunciation of such principles.

The meeting was also arranged with the idea of making clear to the mechanical engineer his field in the improvement of design of mechanical equipment for road-building purposes. The standardization of various types of apparatus is stressed in the papers and the importance of the publication of engineering data in regard to these various types is strongly recommended.

Road-Construction Plants

By B. H. PIEPMEIER,[1] SPRINGFIELD, ILL.

SUCCESSFUL road work offers more possibilities for different types of plants than perhaps any other single line of building construction, and every section of road to be built is a field for intensive study and investigation by the engineer and contractor. A thorough examination of the road plants in operation for the past few years shows clearly the need of more careful study of plant problems than is ordinarily given by engineer or contractor.

A successful road contractor in Illinois states: "No equipment should be purchased by a contractor unless he has sufficient work in view to enable him to practically pay for the equipment with a reasonable profit." If this rule were followed by more contractors, on many jobs, there would undoubtedly be less equipment and more profit. Such a statement should in no way discourage the road contractor in equipping himself thoroughly to do economical road work, but should force him to make a more complete analysis of his job before he invests in a road-building plant.

Small Construction Unit Advantageous—Duplicate Units Desirable

In general, the building of a system of roads requires the installation of a number of small plants in preference to a few large plants. This has been particularly true in the past on account of (1) the contractor's inability to secure experienced and capable superintendents for handling large-plant operations; (2) railroad transportation falling short in the delivery of sufficient materials to keep large plants working efficiently; and (3) frequent breaking of the machinery required in large road-construction plants—the breakdown of one machine very often delaying the entire plant operations and causing undue expense.

The small construction unit necessitates doing many operations by hand at somewhat greater expense than if done with machinery; however, when the final analysis is made, the small unit will show considerable efficiency on account of the possibility of its operating many times independently of any one particular machine out of service through breakdown.

Conditions existing during the past few years have made it impossible for the contractor with a large plant layout to show a fair profit. As soon as labor and transportation conditions become more stabilized, the large plant will show a much greater efficiency.

Contractors must give considerably more thought to the design of road plant so that its successful operation may not be wholly dependent upon one piece of machinery. Many successful road contractors realize already that to insure a constant and uniform output, it is economy in many instances to duplicate machines. Some contractors have installed a duplicate pumping system for the water supply, which is vital to the successful and economical operation of the road plant, and the additional cost of the duplicate unit is small compared to the advantage of being able to operate the plant without a delay.

In many instances duplicating concrete mixers has prevented a complete shutdown of operations. The average road job may not always justify a duplication of the mechanical units, but where a large season's work is required, a serious investigation of the advantage of the duplicate units should be made.

Transportation of Materials

The transportation problem in road building is one of the most important factors in the economical construction of roads. Consequently this part of the plant operation should be given a great deal of study. The transportation cost, should not only be estimated on the basis of the ton-mile cost but the effect it may have on the cost of operation of the remainder of the construction plant should be taken into consideration. Hauling cost varies from 20 to 40 cents per ton-mile. In a season's work a saving, therefore, of but a few cents per ton-mile may amount to several thousand dollars. The actual hauling costs may be exceedingly low, yet if the delivery affects the maximum output of the remainder of the plant, the inefficiency should naturally be charged against transportation cost.

Inasmuch as most specifications now prohibit storing road materials upon the subgrade, the road contractor is compelled to provide for transportation in one of two ways. He must deliver materials from his material yard to the road by industrial-railroad equipment or by truck. The industrial equipment, while expensive in first cost, will enable the contractor to complete his work with a minimum amount of trouble under normal conditions and regardless of weather, the average industrial equipment will insure a more uniform delivery of materials than any other unit that may be used. The chief objection to the industrial unit is that it is limited to road construction with grades ordinarily less than 4 per cent and a minimum number of railroad crossings. Further objection would be that the high initial cost demands a large mileage of roads be built each year in order to absorb the interest on the investment and the depreciation.

The other method of delivery is by truck or team. In recent years truck delivery has superseded team delivery, being more rapid and delivering material to a paving mixer or from a mixer direct to the road with less disturbance to the roadbed. Truck transportation of road materials is very flexible and therefore suited to more different sections of work than perhaps any other method of transportation. It is especially suited to the delivery of mixed concrete from a central plant to the road being improved, and to the delivery of proportioned batches direct to the paving mixer or to a

[1] Engineer of Construction, State of Illinois, Division of Highways.

A group of papers presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

dustrial line which in turn delivers them to the paving mixer.

Delivery of Concrete from Central Mixing Plant

During the past few years the delivery of mixed concrete from a central mixing plant direct to the job has been attracting considerable attention. This method is worthy of study as it enables the contractor to centralize operations and in many instances to economize in plant and operating expenses. The central mixing plant should be reasonably uniform in design and simple in operation. A study of the central mixing plants in use during the past two years shows no two very similar in design. It would seem possible that unloading aggregate and cement from railroad cars, mixing the materials to the desired proportions and consistency and turning out a mixed concrete, could be standardized to such an extent that central plants could be simplified and made more economical in operation. It is hoped that the mechanical engineer and the equipment designer will assist in the design of a practical and economical central-mixing-plant unit.

Although central mixing plants may be fairly uniform in design, the delivery of the concrete from the plant to the road will vary considerably to suit the existing local conditions. Mixed concrete may be delivered by industrial equipment, provided the hauls are

Fig. 1 Material Yard, Showing Arrangment of Loading Bins and Storage Pile

Fig. 2 Material Yard, Showing Arrangement of Loading Bins and Storage Piles when Stiff-leg Derricks are Used

reasonably short and the equipment is designed for small loads with considerable speed in transportation. The small pneumatic-tired truck will usually prove the most efficient machine for delivery of mixed concrete, taking the individual batch of mixed concrete direct from the mixer to the road being improved in the least possible time.

Use of the Pneumatic-Tired Truck

The pneumatic-tired truck is essential when speed is an important factor in delivery and where it is necessary to do considerable hauling over the subgrade. This truck will usually reduce the load on the subgrade to less than 125 lb. per sq. in. of surface, and this pressure, even though frequently applied, does not seriously injure or displace a prepared subgrade having average conditions.

over earth roads with trucks when the roads are muddy or during rainy periods. However, the road may be materially improved and the truck used practically the entire construction season if the road is constantly maintained by the use of the road drag and given an application of half a gallon of oil per square yard of surface early in the construction season.

The light pneumatic-tired truck may also be used for the de-

Fig. 3 Four-bag Batch of Materials Delivered and Dumped Directly into Skip of Mixer

Fig. 4 Three-ton Trucks Used for Delivery of Mixed Concrete from Central Mixing Plant

livery of proportioned batches of aggregates direct to the paving mixer on the road being improved. There are now on the market many types of batch boxes and dump bodies which permit the batches to be dumped directly into the skip of the paving mixer. This method has proved to be very satisfactory. It differs from the delivery of mixed concrete in that a paving mixer is used instead of a stationery building mixer, and most of the operations of the contractor are out where the road is actually being laid.

Improvements in Design of Equipment Desirable

The plant investment of the road contractor of today is entirely too expensive compared with the work accomplished during a single construction season or from one particular installation of a construction plant. From $60,000 to $100,000 worth of plant equipment is frequently set up to build less than ten miles of highway. This is equivalent to charging off $2500 to $3000 for equipment against every mile of road built. It is doubtful whether there is any other building construction in which so much depreciation and interest on plant investment must be charged off on so small an amount of work. The mechanical engineer, equipment designer and contractor should apparently spend more time in the design of road-construction plants in order to insure a greater output with less initial investment.

Many of our road-building machines are being made larger, more cumbersome, and more expensive each year. The fact that road-building machinery is subjected to more severe use than perhaps any other machinery used in building construction has induced the manufacturer to add to his equipment each year to insure

more rigid construction. Many machines, such as the concrete paving mixer, can undoubtedly be completely redesigned and a machine produced much smaller in size, to mix more concrete and be less cumbersome on the job.

Mixer manufacturers have continued to improve the design of their paving mixers by following the same principles of mixing that have been in use for many years. It seems absurd that we must have a concrete paver costing from $8,000 to $12,000 and weighing from 10 to 15 tons that will lay less than two miles of 18-ft. concrete road in thirty days. It seems absurd also that we should still be using mixers that require 60 seconds of time for the mixing of aggregate and cement when it should be possible to do the same amount of mixing by some mechanical means in less than 15 seconds. If such a machine could be produced, a one-bag paver would turn out as much concrete as our present four-bag pavers. The present paver is also designed so that the mixing is concealed from the view of the mixer operator. This prevents absolutely the uniform consistency essential in securing a good concrete.

Fig. 5 Central Mixing Plant, Showing Material Storage

If the mixer designer can produce a smaller machine having a greater output per hour of operation and so designed that the consistency of the concrete produced can be controlled by the operator instead of by some unsatisfactory mechanical means, the results will be a wonderful aid to the road-building industry.

Also Room for Improvement in Railroad Equipment

It also seems possible that a very material improvement can be made in the present railroad transportation equipment. Practically all road contractors now unload aggregates from open-top cars by means of clam shells. This method is not always the most economical, but the contractor is forced to use it as he cannot secure all hopper-bottom cars he might desire. On account of the large volume of road materials to be delivered by railroad cars, some type of car should be designed that would permit of more rapid unloading by more economical methods. If this is not done, it is hoped at least that open-top-car manufacturers will improve the design of their cars and make them so that they can be more easily unloaded with clam-shell equipment. Not only would such improvement aid the individual unloading the car, but the railroad company would add to the life of its equipment.

Many open-top cars are now designed with projecting angles, rivets, bolts, braces, timbers, etc., which interfere with the efficient operation of the clam shell. It is difficult to understand why railroad cars could not be designed so that the interior of the car would be perfectly smooth. In fact, it would be practicable and economical for all open-top cars to be built with a fillet having a radius of about 18 in. in the bottom angle at the ends of the car. The curved bottom angles would permit the cars to be emptied more rapidly and economically either with hand shovels or clam shells.

Further investigation should also be made of the use of open-top removable batch boxes for railroad transportation of materials. While the substitution of standardized batch boxes for open-top cars would be a very radical departure from present equipment, the average construction plant could be designed to handle the boxes much more economically than the loose materials.

Mechanical Needs in Highway-Construction Machinery

By R. C. Marshall, Jr.,[1] Washington, D. C.

The interest of the mechanical engineer in highway construction centers in the equipment used. This equipment has made great strides in recent years and will undoubtedly continue to do so, yet the equipment needs for road building might be called comparatively simple. Consider a concrete road. All the average road builder needs is a light, portable plant capable of handling, mixing and finishing 400 cu. yd. of concrete every day, with no delay for repairs.

The charge has been made that modern road-building methods have so increased overhead expense that they have accomplished little saving. This may be an exaggeration, but the elaborate equipment now used has undoubtedly increased the overhead to such a degree that steady output of the plant is essential to financial success.

In order that this overhead expense may be kept within reason and highway costs estimated with profitable accuracy, it is essential that contractors have equipment capable of maintaining a steady flow of materials; first, from unloading point to mixer, and second, from there to the finished road. This is the problem confronting the field force and one which must find solution if road building is to become financially safe. Until further development of equipment can assure more continuous performance, construction companies must insure themselves against the loss caused by frequent delays.

The slogan of the designer should be, "Make the machine foolproof." Increased strength may demand heavier parts and increased first cost, but this is inconsiderable compared with the loss due to one breakdown.

Last year's work, on account of spasmodic and continued delay, was not conducive to a careful study of equipment needs. Transportation troubles so disrupted operations that contractors were obliged to grasp at any expedient to push their work. This, combined with labor and material scarcity, left them little time for a constructive study of their specific equipment needs. Of one thing, however, nearly every road builder is keenly aware. His work suffered heavily from frequent interruptions which disorganized his force and increased the unit overhead cost. Delays from transportation difficulties and equipment trouble caused the overhead expense to absorb a large portion of his profit and in some cases much of his capital. Delays caused by equipment trouble are traceable to three main causes: First, lack of skilful mechanics; second, lack of standardization in design, and third, lack of accurate information concerning the adaptability, capacity and operation of machines.

The lack of skilful mechanics concerns both manufacturers and contractors. An equipment company may expend much time and money in perfecting designs or improving the quality of the workmanship, but if its machines are placed in the hands of incompetent operators, the money spent for them is wasted. Incompetent operators can readily offset the advantages of efficient equipment and well-planned work. Under careless handling the heavy delays for repairs mean a loss of money to the road builder and to the manufacturer a loss of that valuable asset, good will.

An economical solution of the shortage of good operators might be effected by establishing for them a short course of instruction during winter months when construction is slack. Savings effected in the field by competent operators would amount to many times the cost of their instruction. One of the worst obstacles to continuous output would thus be removed.

Plenty of Opportunity for Standardization

The second significant source of delay is a lack of standardization in equipment where standardization is possible. Road-building

[1] General Manager, The Associated General Contractors of America.

manufacturers, and to be prepared even for the usual run of minor field repairs on all machines requires a more or less elaborate machine shop. The financial burden of carrying duplicate units or a sufficient number of spare parts is too great for an already heavy overhead, and in order that this expense may be held within reason, greater interchangeability of parts should be made possible.

The amount of saving that might be effected through standardization of road equipment is not generally appreciated. To build a medium-sized high-type section requires a daily field payroll of three or four hundred dollars and an overhead of probably another hundred. So that five hundred dollars per day is not an unusual cost. An employee cannot be laid off every time a breakdown occurs, and since the overhead goes steadily on, fifty dollars an hour may be considered an estimate of the cost of equipment delays.

probably results more frequently in disaster, is a lack of unbiased and authoritative information concerning the adaptability, capacity and operation of machines. Lack of such information has already brought disaster to numerous individual companies, both old and young; and as new concerns are constantly taking up road work, it is essential that they secure authoritative mechanical advice.

What contractors need is accurate data showing under what conditions a certain type of machine is suitable, how long it may reasonably be expected to last, and what output it can deliver under normal working conditions. If this information can be made available, construction companies may be relied upon to intelligently select machines. They will then be able to coördinate their plant and estimate their costs.

Planning and Organizing a Road Job for Mechanical Handling of Material

By C. D. Curtis,[1] Washington, D. C.

The last few years of the decade just closed ushered in a new era in road building. Legislative action stimulated in a large measure by the Federal Aid Road Act has been taken in practically every state, making possible the inauguration of an unprecedented country-wide program of highway improvement. The rapid expansion of the use of the motor vehicle has created an insistent and growing demand for more and better highways. It so happens that this movement has had its greatest growth during a period of rising costs, the crest of which has only recently been passed; so that, along with the urge for more and better highways, there has been always in the mind of the highway engineer the necessity for rigid economy of labor and effort. Fortunately, the inventive genius of the country has not been idle during this period and many new and improved types of road machinery and equipment have been put on the market. The introduction of this new equipment has made it possible to perform mechanically many of the operations connected with road building not only cheaper but better than they can be done by the older hand methods.

While every one will concede that all construction jobs should be carefully planned and well organized for the handling of materials, it must be admitted that this is not always done. In the past too little thought and study have been given to this preliminary phase of the work. Until recently, however, road work has been handled on a comparatively small scale, and the cheaper types of construction prevailed. An extensive plant was not required and the evolution brought about by the general adoption of higher types of construction and the growth of construction programs is still under way. It is unfortunate, but nevertheless a fact, that most jobs are equipped without giving to their planning and organization a proper amount of careful study. As a result expected profits shrink and may even become actual losses. Improperly equipped jobs can be classified under three heads:

1 Too much plant,
2 Lack of plant, and
3 Unbalanced plant.

With too much plant on a job the efficiency of operation is lowered, and although fairly satisfactory progress may be made, the cost will be too high. Rental or interest on investment and depreciation charges continue regardless of output. On an under-equipped job it is necessary to resort to labor which may be less efficient and more expensive. The progress of the work is likely to be delayed and total costs increased.

Of all the improperly equipped jobs the ones that have an unbalanced plant are probably most common. They are the inevitable result of equipping without planning. The several units making up the plant may be efficient mechanically when considered alone, but totally incapable of being worked smoothly and continuously together. On such jobs efficient operation cannot be secured. The plant investment might, and probably would, be higher than for a balanced plant. The season's profits, however are certain to be lower than anticipated.

Classification of Road-Building Work Based on Desirable and Practicable Rate of Progress

In the author's opinion a classification of road-construction jobs based on the desirable and practicable rate of progress is feasible and would aid the contractor or engineer in selecting the proper plant. In determining on such a classification several factors would enter into the consideration, chief of which would be the size or length of the project. Another factor would be the problem of satisfactory detours and the probable economic loss to traffic. The cost, of course, would be affected by the classification. Ordinarily a higher rate of progress would be required on a large job than on a small one. The extra cost, then, of assembling and operating a large plant capable of rapid progress would be spread over a large yardage. It might easily happen, however, that the economic conditions would warrant requiring very rapid progress on a comparatively small job. This would change the classification and increase the cost of the work, but the bidder would know just what to expect.

In connection with concrete-road jobs there might be three classes, such as:

A—Jobs on which equipment with a daily capacity of 1000 ft. of 18-ft. roadway would be required;

B—Jobs on which equipment with a daily capacity of 500 ft. of 18-ft. roadway would be required, and

C—Jobs on which equipment with a daily capacity of 250 ft. of 18-ft. roadway would be required.

In the case of Class A jobs it would ordinarily be desirable to equip with at least two complete operating units. This would insure continued, even though retarded, progress in the event of a breakdown of one unit.

Such operations would, of course, be contingent on the weather and other conditions beyond the contractor's control, but the classification would give a more definite idea of the requirements and enable the engineer and all bidders to estimate on exactly the same basis. The classification conditions should be covered in the specifications.

Necessary Limitations Imposed by Specifications

Unnecessary refinements in the specifications which are met with at times usually lead to difficulties in operation and should, in the author's opinion, be avoided, especially where enforcement increases the cost of operation for minor or questionable benefits. There are, however, certain limitations which make necessary an intimate knowledge of the specifications under which work is to be performed. Examples of these limitations are:

1 Time limit on depositing of concrete after mixing. This limit would have a direct bearing on the location of central mixing

[1] Assistant to Chief, Bureau of Highways, Department of Agriculture.

plants and the equipment required for handling both the aggregate and the concrete.

2 Definite requirements relative to concrete mixers such as water-measuring devices, boom and bottom-dumping bucket, etc. Such requirements are small details, but must be met and so must be considered in selecting equipment.

3 Materials for concrete not allowed on subgrade. This feature is very important and makes necessary a careful study of the project in the field. Several alternative methods of handling the materials may be possible, and the most economical and efficient one can only be determined after a consideration of all the conditions. One location might be well adapted to the use of industrial-railway equipment, while in another location this method might be entirely impracticable and hauling of proportioned batches of aggregate and cement in trucks the most feasible. The central-mixing-plant method might be the proper selection in some other location. In the case of a large job conditions may vary considerably on different sections of the same job.

Precautions to be Taken in Selecting Equipment

In selecting equipment for a project, everything bearing on the situation should be considered. The source of materials to be used, whether local or imported, condition of roads to hauled over, width of available right of way, trackage and storage facilities available at receiving points for materials requiring rail transportation, maximum grades, water supply, availability of common labor and teams, and length of working season are some of the factors which should be looked into and studied before deciding on the type of plant to be used. In this connection the engineer may and should render all possible aid to the contractors. The preliminary investigations and detailed surveys made by the engineer give him much more information than the contractor can secure readily in his preliminary field inspection of the project. If the engineer knows that the conditions, even though not apparent, make the use of certain types of material impracticable, this information should be given to the contractor.

A feature which perhaps is not germane to this discussion but which is very important and deserves a few words, is the desirability of considering the source of the materials to be used with respect to the possibility of continuous rail-transportation service. Without a reasonable assurance of a continuous supply of materials throughout the working season, an elaborate plant layout may become much more of a liability than an asset. By arranging to ship and store materials during the season of light demand for open-top cars, for use during periods of car shortage, a continuous supply of materials can be secured. Such an arrangement may considerably alter the selection of equipment for handling the material. Strong arguments may be made against the plan of advance storage of materials in states where estimates for materials delivered are not allowed, but the extra cost of storing materials may be more than offset by the gain due to continuous operation during the construction season.

It is desirable, of course, when possible, to avoid all unnecessary rehandling of materials. Where the materials can be unloaded from cars or loaded from the quarry or pit directly into containers for transportation to the job and in addition can be deposited in the mixer, in the case of concrete, without touching the ground, a great advantage is gained. In addition to being kept clean and free from mixture with foreign matter, the item of waste is very greatly reduced.

Exclusive Development of Large Individual Units Undesirable

In some states, by adopting the practice of letting large contracts for long stretches of construction work, large contracting companies have been induced to enter the highway field. They have brought trained operating organizations to the work and have put extensive road-building plants on their jobs. There is wisdom in such procedure whenever possible, for, of necessity, a great many road jobs are and will continue, for a variety of reasons, to be of comparatively short length. Letting contracts in both large and small sections gives both the small contractor and the large a field of operation and greatly expedites the carrying forward of a large program. The small contractor, acting as his own superintendent and operating with but little mechanical equipment, has but little overhead and can compete on a small job with the large contractor operating a large plant and carrying heavy overhead expenses.

Road building differs from most other construction activities in that the operations are conducted along an extended narrow path. The failure of one link may interrupt the work of a whole operating chain. This fact, in the author's opinion, makes the present tendency toward the development of large individual units somewhat questionable. When a large unit is used every precaution should be taken to insure its continuous operation.

Importance of Maintaining Organization the Year Around

One of the greatest handicaps which the road builder encounters in the northern states is the short construction season. Continuous operation is impossible and each season it is necessary to organize new construction forces. It takes some little time to organize a new outfit so that the work will proceed satisfactorily. In the case of the skilled mechanics and foremen, an attempt should be made to retain their service the year around. They can be utilized during the winter in repairing equipment and putting it in first-class condition for the next season's work. It may even be necessary to furlough them for a time with pay, but the investment will bring big returns in added loyalty to the company and increased devotion to duty. The average man appreciates a square deal and will show it in increased efficiency. The use of an extensive plant requires skilled operators, and, once trained, their services should be retained. Efficiency of operation in road work depends on the proper functioning of all the separate units. The mechanical units function properly only when properly handled.

On large jobs where more than one plant or complete operating unit is used, the spirit of the organization can be kept up by introducing friendly competition. The rivalry between two outfits to reduce costs and increase yardage has a very healthful effect on progress and incidentally on profits. The author recalls a bituminous-concrete construction project on which four separate mixing plants were used. One of the plants was an old, makeshift affair, but was handled by an energetic suprintendent who had old and loyal employees of the company as foremen and mechanics. The output and costs compared more than favorably with the new plants, due entirely to the better morale of the men. It pays to retain loyal and efficient employees.

A New Alloy Steel

An alloy imparting to steel toughness, great density, a high elastic limit and ultimate tensile strength, and machinability even when showing qualities of extreme hardness, was developed during the war by Dr. L. P. Burrows. Tests conducted by the Ordnance Department of the United States Navy proved so satisfactory that the alloy was adopted for use in the manufacture of naval artillery material, and is now being made in a half-dozen plants by the open-hearth and crucible methods. The *Iron Trade Review* describes, in its issue for April 7, the process of manufacturing this alloy. Nickeliferous ore obtained in the Sudbury district of Ontario is first crushed and then treated in a revolving cylinder from which oxygen is excluded and into which a gas is introduced containing 89 per cent hydrogen and 10.8 per cent nitrogen. It is then smelted in a crucible or other suitable furnace and then thrown out on the floor. In about 24 hours the product disintegrates into a purple-colored powder. This is refined further and cast in pigs, the yield being estimated at from 1400 to 1600 lb. of metal per ton of ore. The chemical analysis of the alloy is as follows: Silicon, 2.51; iron, 52.89; nickel, 3.98; manganese, 0.046; sulphur, 1.90; cobalt, 0.15; arsenic, 0.11; copper, 0.59; phosphorus, 0.12; tungsten, 0.24; chromium, 2.61 per cent, and varying traces of rare earths and members of the platinum group.

Numerous independent tests of steel containing 1, 1.5 and 2 per cent of the alloy have been made at the Philadelphia and Brooklyn navy yards, several testing laboratories and a number of metallurgical plants. It has been found that specimens with a Brinell hardness of more than 364 are easily machined, a behavior which is contrary to the general assumption that the machinability range lies below 340. Mystery also attaches to the alloy due to the fact that when it is used in electroplating, it seems to impregnate the material instead of merely plating it. There are indications that the material resists corrosion.

Requirements of the Engineering Industries and the Education of Engineers

By MAGNUS W. ALEXANDER,[1] NEW YORK, N. Y., and DUGALD C. JACKSON,[2] CAMBRIDGE, MASS.

A combination of empiricism and training in rational science is needed in engineering education because it is needed in the engineering industries, and this consideration has led to various plans for placing engineering students within the influence of industrial operation, the most common being for engineering college graduates to enter industrial establishments as "cadets," "engineering apprentices" or "student engineers."

The first comprehensive, organized plan for bridging the gap between academic and practical training of the young engineer was made operative in the United States in 1906 when Herman Schneider, Dean of the Engineering Department at the University of Cincinnati, organized a cooperative engineering course in connection with the metal-manufacturing plants of that city. Schneider's ideas lie at the base of the cooperative plan which the authors succeeded in organizing a few years ago in connection with the Massachusetts Institute of Technology and the Lynn Works of the General Electric Company, and which is described at length in the present paper.

This cooperative engineering course covers a total of five years, the first two being identical with the freshman and sophomore years at the Institute and the last three being divided between instruction in theory at the Institute and instruction in practice at the Lynn Works. In these last three years the total time occupied in studies at the Institute and practice at the Works is eleven months per year. The first term of the cooperative period, extending through thirteen weeks, is spent at the Works by all of the students during the summer period immediately following the sophomore year at the Institute. The succeeding terms of similar duration are spent alternately by each half of the student group at the Institute and at the Works, while the final term is spent by all the students at the Institute for additional advanced instruction and the preparation of a master's thesis prior to the college commencement.

During their assignments at the Lynn Works, students are subject to the usual rules and regulations applying to employees of the General Electric Company, and on a full week's work schedule receive compensation at the rate of $21 per week at the beginning of the course and $24 at the end.

The joint supervisory committee of the two institutions believe that this experiment in cooperative engineering training will exert a most beneficial influence upon the relationship of the engineering college to industry and upon the activities of each. They are clear in their own minds, however, that the cooperative training in engineering must not and cannot replace the regular engineering courses at colleges which in the nature of things must cater to the majority of young men seeking a thorough training in the engineering sciences, and many of whom do not enter the manufacturing industries. The cooperative training, however, is destined to become a vital integral part of a comprehensive system of engineering education, to the detriment of none of the other parts, but to the mutual benefit of all, and is particularly important to the manufacturing industries of the nation.

> Upon the subject of education, not presuming to dictate any plan or system respecting it, I can only say that I view it as the most important subject that we as a people can be engaged in.—Abraham Lincoln

NO EDUCATION which is sound at base is without vital interest to the engineering industries. Herbert Spencer a generation ago defined the objects of education in five divisions:

1 Those activities which directly minister to self-preservation

2 Those activities which, by securing the necessaries of life, indirectly minister to self-preservation

3 Those activities which have for their end the rearing and disciplining of offspring

4 Those activities which are involved in the maintenance of proper social and political relations

5 Those miscellaneous activities which make up the leisure part of life devoted to the gratification of the tastes and feelings

It is clear that the first three aspects of education are very specific and relate to the individual or to himself and his immediate environment, while the last two are more general and relate as much to the associations of the individual as to the individual and his immediate environment. An education comprising all five aspects qualifies its possessor for "complete living," which, according to Spencer, is the real object of education. That industry is vitally concerned with the first three aspects is quite obvious and easily demonstrated. Thus, propaganda for "safety first" in industrial establishments is an impressive extension to mature workmen, of education for self-preservation which experience impresses on a child almost from birth; and the expense and effort for carrying forward this branch of education would not be sh ul-dered by industry were it not recognized that the safety of workmen is fundamental both as a matter of humanity and of conservation.

On the other hand, need for securing the necessaries of life is at the root of all industrial production and activity and is the motivating force for elementary work education, while the essence of education for artisanship seeks to broaden and refine this primitive activity. And finally, interest in educational effort for the development of family life, while primarily social in character, is equally important to industry both from the standpoint of self-preservation and the stabilization of man's character arising from family associations and responsibilities.

Industry is therefore vitally concerned with these three primary functions of education, and to the extent to which these aspects are allowed to languish, industry will suffer.

Although primarily of social importance, the two last-named aspects of education according to Spencer, namely, education for good citizenship and for proper enjoyment of leisure, have their bearing and effect upon the conduct of industry. Reason and experience show that successful industrial practice, useful alike to producers and users of industry's products, cannot be long sustained except in communities with a stable citizenship, rooted in a sense of right as between man and man. Wide interest in industrial circles in "Americanization" demonstrates the tacit recognition of the importance of education for thoughtful, steady citizenship. Similarly, not only as part of citizenship development but in its reaction upon the work period of life, the rational enjoyment of leisure as the result of adequate education comes within the domain of industry's interest in education.

In this connection it is significant to reflect that the settlers of New England founded schools and colleges simultaneously with the clearing of the land for their dwellings. These early impulses and policies exerted their influence throughout the later upbuilding of the country, and consequently the establishment of schools has played a notable part in our national development. The hardy frontiersman seldom blazed a trail which schools did not promptly follow.

This record for school education is not peculiar to the American people, but it has been peculiarly universal with them, and a comprehensive educational system has resulted which reaches even to the remote byways of the country. Yet an educational system to meet the needs of our country must be something more than merely a widespread school system in touch with all of the people. The universality of education must be supplemented by those special forms of education which are necessary for the fullest development of each branch of human endeavor and service. In

[1]National Industrial Conference Board. Mem. Am.Soc.M.E.

[2]Professor of Electrical Engineering, Massachusetts Institute of Technology. Mem. Am.Soc.M.E.

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satisfaction of this condition a great variety of specialized schools have been established: on the one hand divinity schools, law schools, medical schools, engineering and other professional schools, and on the other, trade schools and vocational schools of various kinds.

Types of Engineers Needed by the Engineering Industries

To conform to the scope of this discussion let us now consider more fully the aim, development, and result of engineering education. In the consideration of any plan of education as preparation for a specific field of activity it is necessary that it be tested with regard to the needs of that field.

What do the engineering industries require in the young men who as engineers are seeking to make this the field of their life work?

Industry is concerned with the transformation of the raw materials of nature into forms more readily adopted to the needs and desires of mankind, through the application of the forces of nature and of man's knowledge and power. This is kinetic in character, a process constantly changing and developing as new materials become available or as new knowledge points the way to improvement.

It is clear, therefore, that first there is need for the pioneers of science, the men to whom we may look to extend the frontiers of knowledge, to delve deeper into the mysteries of nature that new processes may be developed for the utilization and conservation of our natural resources. These men, while having little to do directly with commercial production, must nevertheless have an appreciation of the scope and organization of industry in order that their efforts may be directed along the lines of economic needs. Their chief requirement, however, is a thorough and intimate knowledge of the various branches of science and of the past as well as of more recent developments of practice and theory. As used by engineers, theory means a working hypothesis founded on known facts and experiences which may be utilized to guide progress beyond the margin of past experience. Theory is not antagonistic to practice, but is founded on experience and is a guide to progress.

The second need of industry for engineers arises out of the fact that the advance of industry in the last century has produced an organization of vast complexity and delicacy of adjustment, an organization calling for increasing numbers of efficient executives and administrators. They must be men with industrial training of a high order, competent to conceive, organize and direct extended industrial enterprises of broadly varied character. These men must be keen, straightforward thinkers who see things as they are and who are not misled by fancies; who are capable of quickly grasping the essentials of the many problems that arise, and who are trained in the orderly marshaling and correlating of facts and forces necessary to meet the daily problems that are incident to the functioning of the industrial organism.

But aside from a thorough knowledge of the physical and mathematical sciences, an adequate understanding of human character and of the trend of human progress is essential in order that these engineers may make the most of their abilities. To emphasize this fact it should be realized that over ten million people in this country are spending the major portion of their waking hours in the various processes of industry. This, then, makes it at once apparent how important it is that the engineering schools from which industrial leaders are to be recruited must teach the necessary knowledge of human nature, sound business methods, best means of effectively directing the human forces engaged in industry. Concerned more with the organization, correlation, and administration of mechanisms and productive activities than with the extension of scientific knowledge, they must address themselves in an increasing degree to the problems of the adaptation of the average human abilities to the requirements of those mechanisms and processes; but intimate knowledge of those physical mechanisms and processes must be a part of their intellectual equipment.

Methods of Preparing Prospective Engineers for their Professional Work

Generally the engineering industries need, therefore, three types of engineers: the scientist for discovery and for the instruction in fundamental laws; the practical specialist for application of science to the processes of industry; and the executive for administration and direction of the human forces. With this in mind we may now consider more definitely the problem of engineering education: namely, how most effectively to prepare the prospective engineer for the work he is later to perform.

The average student entering the engineering school at the age of nineteen to twenty-two years, has only a vague and uncertain understanding of the meaning and purposes of industry, and practically no understanding of the problems that will confront him when he enters the industrial field. His usual conception of what the college means is the acquisition of a body of facts handed to him by the teaching staff which in some way he will later on use to advance his own interests. He enters with an alert and inquiring mind and frequently full of enthusiasm for self-expression, but seldom with much unbiased effort at self-analysis or valuation.

Experience has shown that the usual method of taking this human raw material through four or five years of scholastic work without more than casual contact with the practical problems later to be met, frequently results in the neglect of, or superficial attention to, many of the studies essential to subsequent progress. Not infrequently it also results in a long and discouraging period of readjustment after graduation, during which the new engineer-recruit often endeavors to adjust industry to some of his false conceptions rather than to adjust himself to the new life he is entering.

There are two methods by which the engineer can acquire the knowledge needed for his professional work: the *rational*, wherein the solution of problems is obtained by means of direct reasoning from definite premises; and the *empirical*, which is based on experience and observation, and reasoning by balance of evidence. In certain fields of engineering the subjects dealt with are so complex and the knowledge regarding them so fragmentary that empirical or experimental methods must be resorted to almost wholly. In other fields the subjects are so open to analytical processes of reasoning, and knowledge regarding them is so well organized, that purely rational methods suffice for adequate solutions. In most instances, however, the conditions are such that a combination of the rational and empirical procedures should be used.

Broadly speaking, our engineering schools and colleges emphasize the former, while engineering practice depends largely on the latter. Rational methods are typified and developed by the study of the sciences, such as mathematics, physics and chemistry; and empirical methods are exemplified in the education derived from direct association with, and participation in, the activities and processes of industry. A combination of empiricism and training in rational science is needed in engineering education because it is needed in the engineering industries. A better balance must be established between the teaching of the sciences in the colleges, which should emphasize this part of education and resist any attempt to diminish its effectiveness, and practical education in industrial establishments, where it is rooted in production with consequent better appreciation of the value of time and money as elements of industrial activity.

This consideration has led to various plans for placing engineering students within the influence of industrial operation. The most common way is for engineering college graduates to enter industrial establishments as "cadets," "engineering apprentices" or "student engineers;" and sometimes engineering education during the undergraduate course is supplemented by practical industrial employment during the summer months. The value of the latter method of interweaving engineering practice with engineering education was emphasized by the late Frederick W. Taylor, man of genius and Past-President of The American Society of Mechanical Engineers, who advocated that each engineering student be required to spend a year or more in commercial shop employment before the end of his course of study in the college. Taylor recognized the weakness of the tandem relation of the college course and the subsequent student apprentice employment, and by his proposal approached the condition of intimately interlacing the time of these two. It is evident that European experience and practices served to stimulate his thought along these lines.

The West of Scotland Technical School for a long time has required its students to spend a period in the factories before completing their studies at the college. A like plan has long been in effect at the Royal Polytechnic School of Denmark and at similar engineering schools in other parts of Europe. Faraday House, a British school of electrical engineering, alternates its students in yearly intervals between the formal school and commercial engineering plants.

In the year 1906 the late Sir William White added all the weight of his great name and influence in British industrial circles to a report urging the importance to engineering students of interchanging time between the engineering school and engineering establishments.

The Schneider Plan for a Coöperative Engineering Course

In the same year the first comprehensive, organized plan for bridging the gap between academic and practical training of the young engineer was made operative in the United States when Herman Schneider, Dean of the Engineering Department of the University of Cincinnati, organized a coöperative engineering course in connection with the metal-manufacturing plants of that city. Prior to this, most of the engineering schools in the United States had urged their students to secure engineering employment during their summer vacations, and some had gone so far as to establish a system for crediting required work in the practice shops of the school by machine-shop employment during vacations, provided it was secured in approved shops and the factory superintendent certified to the extent, character, and satisfactory grade of work done by the individual student.

Schneider's plan is comprehensively dealt with by C. R. Mann in his important and suggestive report on Engineering Education issued in 1918 by the Carnegie Foundation for the Advancement of Teaching, in which The American Society of Mechanical Engineers took a part by participation in the Joint Committee advising the work. The report in part says:

> The Cincinnati plan was first formulated by Herman Schneider in 1899 while he was an instructor in civil engineering at Lehigh University. In 1902 Schneider presented a full statement of his scheme to the directors of several large industrial firms which were considering the establishment at Pittsburgh of a new technical school to give engineering training that would be better suited to industrial needs than that then given in the engineering colleges. This plan was abandoned when Mr. Carnegie founded the Carnegie Institute of Technology in the city of Pittsburgh. Finally in 1906 Dean Schneider found an opportunity to make his experiment at the University of Cincinnati.
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> The mechanism of the scheme is very simple. The students are divided into two groups, one of which is assigned to work in industrial plants while the other goes to school. At the end of each bi-weekly period the two groups change places so that the shops and the school are always full-manned. In the shops the students work as regular workmen for pay, but the nature of their work and the length of time each stays on any particular job are subject to approval by the university. The emphasis of the school work is on theory and principles, but these are well interrelated with the shop work by "coördinators" who visit each student during each shop period and then meet the several groups during the university periods in special "coördination" classes for this purpose.
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> The curriculum is completed in five years of eleven months each, so that each student receives twenty-seven months of university instruction. Since the regular four-year curriculum in other schools requires about thirty-six months of actual instruction, it would seem at first glance that the Cincinnati curriculum could not give as full a training in fundamentals as is given elsewhere. This inference, however, is wholly unwarranted because in the twenty-seven months of industrial work the student gets a vast amount of practical knowledge which is given in other schools in information courses, and because of the close coördination with practice which makes the theory more intelligible and significant to the students. The graduates of Cincinnati have unquestionably as extensive a training in theory as have those of other first-class schools. In addition, the Cincinnati graduates are able to command engineering positions at graduation without one- or two-year "apprentice" courses such as are required of men from other schools by the large corporations. . . .
>
> Schneider's experiment is clearly much more than a novel and inexpensive method of handling the shop work. It is an effort to create a type of school that meets the demands of an industrial age. It frankly recognizes that the present need is for masters of materials who can humanize industry. It tries to emphasize rather than to discourage the appraisement of values and costs, and endeavors to express idealism in the economics of life rather than build ideals that are unrelated to human experience.

Schneider's ideas have since been followed in the establishment of coöperative engineering courses at several educational institutions, and they lie at the base of the coöperative plan which the authors of this paper succeeded in organizing a few years ago in connection with the Massachusetts Institute of Technology and the Lynn Works of the General Electric Company.

Whatever weaknesses in major features or in detailed application Schneider's plan may possess, unstinted praise must be given him for his conception of the idea as far back as 1899, and for his persistence in pressing the proposal to a practical consummation in 1906.

Growing out of a close study of industrial and engineering educational methods as they seemed to be demanded by American industry, and stimulated by the development of the coöperative engineering course at the University of Cincinnati the paper was presented in 1908 at the Atlantic City convention of the American Institute of Electrical Engineers entitled The New Method of Training Engineers.[1] In this paper the merits and value of coöperative engineering education are analyzed and a strong plea is made for joint effort of college and industry for the comprehensive education of engineers. The paper deals somewhat at length with the method of interlacing theory and practice and the most advantageous time allowances for each. Arguments are advanced against the short periods of alternation between college work and industrial employment established under Schneider's plan—alternations at first of one week's duration, and later of two weeks' duration—and an improvement is suggested based on alternating periods of at least four or five weeks at the beginning, and of college semesters toward the end, of the coöperative course, with a full year of college training as a finishing work. Because the arguments then advanced in favor of longer periods of academic and practical instruction and in support of other major features of coöperative engineering education are pertinent to the discussion of the plan now submitted, the views expressed in that paper are briefly summarized here, as follows:

A serious study of this situation has led to the belief that the best engineering education can be obtained under a plan which provides that the teaching of the theory and practice should go hand in hand, and, so far as practicable, successive steps in the one should be based on similar advances made in the other, at such intervals as to permit of the most advantageous interplay of the two; and further, that the colleges should devote their whole time to the teaching of the theory for which they are so eminently adapted, leaving it to real workshops to initiate the student into practical work, for which they in turn are best equipped. From an educational standpoint this plan should prove efficacious, for mental conception of any activity is facilitated by the physical perception of a given process, as illustrated in the whole development of the human being; and on the other hand, mental visions are more firmly clinched by concrete application. Moreover, under such a plan the freedom enjoyed by students during the college career is happily interrupted by the stern discipline that must prevail in a business organization. This plan also trains and develops the young man in the very life to which he will devote his future efforts and gives him the love for it, which, after all, is necessary for his success. An arrangement of this kind, carrying with it financial remuneration during a part of the time, will attract to the engineering industries young men who are mentally and physically adapted, but who at the present time do not enter college for financial reasons or for lack of appreciation of the value of higher education. The poor boy, if otherwise fitted for it, will be given a chance to acquire a college education by "working his way" through college in activities that have a direct beneficial bearing on his future career. The influence of the college will therefore be extended and in no way restricted by the coöperative plan as contemplated.

The length of the alternating period is a very important element in this plan, for too long or too short a time may defeat the very objects which the coöperative course seeks to accomplish. In the light of the aims of the course previously advanced, short periods seem to recommend themselves. A year or even six months spent alternatingly at college and at the factory would, it is believed, fail to give that close coördination of theory and practice that is an essential feature of the plan; nor would it establish that balance between the college freedom and the factory discipline which has already been referred to as very desirable. Short

[1] Magnus W. Alexander, Trans. Am.Inst.E.E., vol. 27, p. 1459.

periods, on the other hand, will develop that facility in the young man's physical and mental make-up that will enable him to adjust himself quickly to the interacting influence of the college and the factory. The engineering apprentice should enter upon his factory work as a college boy with all the mental alertness and the inquiring mind fostered by the college; and he should return to the college as an industrial worker with the physical energy and the determined spirit of achievement that will be developed in a hustling factory organization. The attainment of these characteristics will to a large degree determine the success of the plan. Alternating periods of a day or even a week, to take the other extreme, might keep the young man's mind in a rather chaotic state, might not give the seed sown in the classroom and factory, respectively, a fair chance to take root. Such time arrangement, moreover, would seriously interfere with the best economy at the factory, and largely forfeit that sympathetic interest of the shop foremen and workmen which is not only desirable but decidedly necessary.

Attention is also called to the efficacy of an arrangement under which the periods increase in duration from the first toward the last year of the course, beginning perhaps with alternations of four or five weeks and ending with time elements of college semesters. In that way all the advantages of the coöperative course would be emphasized strongly at the beginning when they are of determining influence, and the economic consideration of the college and the factory would receive growing attention in later years as justified by the increasing importance of the work.

Coöperative Engineering Course Between the Massachusetts Institute of Technology and the General Electric Company's Lynn Works

This proposal of 1908 as above outlined in summary was seriously considered by a committee of representatives of the Massachusetts Institute of Technology and of the General Electric Company and was finally accepted by both institutions after the sympathetic coöperation of the president and the faculty of the Institute on the one hand, and of the officers of the company on the other, had been secured. Freshmen acceptable to both institutions were to be started on a six-year coöperative course with half of the total number of students in this course spending alternating periods of from six to nine weeks at the Institute and at the workshops of the General Electric Company, respectively. Meanwhile, however, the business depression of 1913 had set in and made postponement of the educational experiment advisable, affording at the same time opportunity for further reflection and study. This led to important modifications of the original plan, the principal one being that of accepting juniors rather than freshmen for the course, lengthening the alternating periods between college and factory to approximately three months' duration, and making the coöperative course last three years, predicated on a two years' college preparation but leading directly to the Master's Degree in Science. While the coöperative engineering students were to be recruited from the Electrical Engineering Department of the Massachusetts Institute of Technology, it was then clearly understood that the same privileges and the same conditions should later be extended to the students of the Mechanical Engineering Department and that in the future no difference should be made as between the two; it was also agreed that students from other colleges should be eligible for the coöperative engineering course if they could qualify for junior work at the Institute.

The advantages of these modifications appealed strongly to both institutions and a coöperative engineering course between the Massachusetts Institute of Technology and the Lynn Works of the General Electric Company was actually started in the summer of 1917 with a class of thirty students. Right from the beginning the experiment showed the earmarks of success and during the first year of its operation gained the support of the interested parties in both institutions. The exigencies of the war, however, in which the United States had meanwhile become involved, and especially the rules of the Students' Army Training Corps, the S.A.T.C., requiring all engineering students of draft age to be under military command and subject to drill, again interfered with the progress of the coöperative engineering course and necessitated its temporary relinquishment in the summer of 1918.

Undaunted by these unfortunate but unavoidable interruptions and more than ever believing in the efficacy of the proposed plan and in its value as an experiment in engineering education, the officers of the Massachusetts Institute of Technology and of the General Electric Company seized upon the opportunity offered by the cessation of war activities and the return to more or less normal conditions, and in the summer of 1919 reinstated the coöperative engineering course which has since continued in operation on an enlarged scale. Experience with this plan for now practically two years indicates quite clearly that, barring slight changes which may become advisable in the course of time, the plan itself is built on a sound basis of good pedagogy and good business principles. It would seem appropriate, therefore, to discuss here the principal features of the plan and the results so far achieved.

By agreement of the two institutions involved, a joint committee was appointed to supervise the coöperative engineering course and to make such changes within the limits of the accepted plan as may from time to time become advisable. The committee is headed by Dr. Frederick P. Fish, equally known as the country's most eminent attorney at the patent bar and as a keen student of educational methods and participant in their development, and moreover a directing factor in the councils of both institutions. Associated with him are, representing the Massachusetts Institute of Technology, Prof. Dugald C. Jackson and Prof. Frank A. Laws, the latter having taken the place of Prof. Comfort A. Adams; and representing the General Electric Company, Dr. Elihu Thompson and Mr. Magnus W. Alexander. In addition, Prof. W. H. Timbie of the Institute was selected to work in close and almost daily contact with Mr. Charles K. Tripp, the official in charge of the educational courses at the Lynn Works, in supervising the progress of the students and looking after all necessary administrative details, including the proper housing of the students and the conduct of certain lecture courses each week for the students on assignment at the Lynn Works.

As stated before, the coöperative engineering course covers a total of five years, the first two being identical with the freshman and sophomore years at the Institute and the last three being divided between instruction in theory at the Institute and instruction in practice at the Lynn Works. In these last three years the total time occupied in studies at the Institute and practice at the Works is eleven months per year, so that the students are provided with one month of vacation each year. In a general way, in the first four years of the coöperative course, the Institute covers instruction similar in method and content to the usual four-year engineering course, with certain omissions and abridgments for which equivalents are provided at the Lynn Works. During the final or fifth year of the coöperative course, however, the Institute gives advanced or post-graduate instruction in research and creative design. On the other hand, the training at the Lynn Works is laid out and conducted with a primary view to its educational value and is closely correlated with the instruction at the Institute; with it all, however, the instruction is eminently practical in character and is on the surface as little as possible differentiated from the regular work of the General Electric Company. In this way the coöperative students not only perform work as it is performed by and demanded of a commercial industrial establishment of recognized standing, but they perform it under the same conditions and in connection with the same types of co-workers, high and low in rank, as those with whom they will be associated in their daily work when they will have finally taken their places as engineers and managers in industry.

Juniors from the Massachusetts Institute of Technology, or students from any other engineering school who are eligible as juniors at the Institute, may enter upon the coöperative engineering course if they are also acceptable to the supervising official at the Lynn Works, and they may continue in the course as long as their work and deportment are satisfactory to both institutions. If a student should at any time during the course so fail to satisfy either institution as to make his separation from either advisable, he is automatically dropped by both from the coöperative engineering course—without any prejudice, however, as to his continuance in other employment at the Institute or at the Works.

thirteen weeks, is spent at the Works by all of the students during the summer period immediately following the sophomore year at the Institute. The succeeding terms of similar duration are spent alternately by each half of the student group at the Institute and at the Works, while the final term is spent by all the students at the Institute for additional advanced instruction and the preparation of a master's thesis prior to the college commencement. An opportunity for an additional optional summer term of engineering and research assignments at the Works will be open to those graduates of the coöperative engineering course who desire to elect it.

This arrangement offers several advantages. It gives to the Works an opportunity during the initial shop assignment to test all students as to their adaptability to practical work and for their general character; and allows rejected students or those who may then voluntarily withdraw from the coöperative course to enter the regular junior class at the Institute at the proper time. At the other end of the course it brings both groups of students together for nine weeks of intense application to original research and to thesis work, and permits of the formation of closer college associations and the development of a broader college spirit. Thus, each coöperative student class commences and finishes the course at the same time for all members.

On the other hand, the division of the intervening time of substantially two and one-half years of coöperative training into periods of thirteen-weeks' duration enables the students to complete one or two assignments at the Works within each period and to fit into the standard classes at the Institute. The advantages from a pedagogical, practical, and economical point of view are obvious. Each thirteen-weeks' period assigned to the Institute comprises eleven weeks of classroom attendance and two weeks of vacation, thus giving each student a vacation of two weeks twice each year. These vacations are not so much for recreational purposes—for the complete change in character of work after each period provides in itself recreation—but more for the sake of gradual change of emphasis from taxing mental work without physical strain to that of essentially physical effort for the achievement of an intellectual purpose. The robust health of the coöperative students and their marked mental agility while at the Institute furnish corroborating evidence of the wisdom of the plan.

In order, however, to keep the mind active during the assignment at the Works so as to avoid, as far as possible, the necessity of taking up a slack at the beginning of the Institute periods, all coöperative students are required to attend lecture courses and to do a certain amount of scholastic work while at the Works. To this end members of the Institute faculty are devoting certain evenings each week at Lynn to the teaching of electrical engineering subjects, English, and accounting, thus making the study of electrical engineering theory continuous throughout the three years of coöperative training, so arranged that theory and practice are linked with each other step by step as far as this is practicable. Similarly the continued study of English has for its main purpose the training of the potential engineers in effective speaking and writing, and the enlarging of their interest in human activities generally, while the addition of instruction in accounting is for the purpose of emphasizing the importance of considering time and cost, and for giving familiarity with the statistical methods of keeping record of the same. The coöperative students, while at the Works, are also expected to devote part of their evenings and Saturday afternoons to selected reading collateral to their scholastic training.

In addition, the managers and superintendents in charge of various departments at the Lynn Works give weekly lectures on different phases of manufacturing methods and business practices. The students are therefore obtaining first-hand engineering and business information of an eminently practical character and are brought into personal contact with the leading officials at the Works. It is obvious that this system of study and lecture service, combined with the weekly practical work schedule, contributes not only to the students' technical knowledge and literary appreciation, but also keeps them in a mentally alert condition. This, in turn, reflects itself, as experience has shown, in the wide-awake attitude of these students when they return to the Institute for their college an observed effect.

Briefly outlined, the curriculum of the coöperative engineering course comprises substantially thirteen weeks of machine-shop training, assembling and inspecting; five weeks of practical work in winding and insulating electrical elements of machinery and apparatus; thirteen weeks of drafting and designing experience; twenty-one weeks of testing of meters, motors, generators, transformers and steam turbines, and twenty-six weeks of practical engineering and research assignments in the various engineering departments of the Works.

On the side of the Institute work the curriculum provides for the usual program of regular junior and senior classes in the Institute's engineering departments, minus certain parts of the standard curriculum which can more effectively be taken care of at the Works, such as drafting and designing, testing and calibrating, and some of the engineering laboratory work. On the other hand, during the last Institute assignment of nine weeks coöperative students are given training in business law and organization and, as already stated, are afforded the necessary time and facilities for their master's-degree thesis.

The study and lecture system, linked up with the practical work while the students are at the Lynn Works, is facilitated greatly by the arrangement under which coöperative students are given opportunity, even though they are not obliged, to live at a well-situated club house at Lynn. This club house is now given over entirely to the use of coöperative students. It provides adequate facilities for lecture and study purposes. A similar residence is provided for the students while at the Institute, thereby facilitating the interchange of residence between the two locations.

During their assignments at the Lynn Works students are subject to the usual rules and regulations applying to employees of the General Electric Company, including a reasonable physical examination by the company's Works physician. The periods of rather strict discipline at the Works are a happy offset to the alternating periods of greater freedom at the Institute, save for the observance of regular college discipline during lecture courses and laboratory assignments. In addition, because now living under the discipline that a commercial establishment must exact of its working force, the coöperative students will, when they have been graduated into managers and leaders of men, be in a better position to prescribe and enforce discipline of others with wisdom and discretion.

Compensation is paid to coöperative students during their assignments at the Works. On a full week's regular work schedule this compensation amounts now to $21 per week at the beginning and $24 per week at the end of the course, these rates having been increased by $6 and $4, respectively, from the rates originally established.

The coöperative class which started in the summer of 1919 numbered 28, of whom 27 are still in the course preparing to enter the third and last year of the coöperative training within a few weeks. The class which entered in the summer of 1920 numbered 54, of whom all are still pursuing the coöperative training. It is the intention to start a third class this coming July, and there seems to be no doubt in the minds of the supervising committee and the officials of the two interested institutions that an entering class of from 40 to 60 students will be selected and provided for each coming year, so as to continue the flow of students through the course.

As stated before, the Institute faculty is heartily approving the coöperative engineering course. The officials of the General Electric Company are equally convinced of the efficacy of the plan. What is more significant, however, is that the superintendents and foremen, and even section leaders and individual workmen, are cheerfully doing their part to help the coöperative students in their work. The supervisory committee believe that this experiment in coöperative engineering training will exert a most beneficial influence upon the relationship of the engineering college to industry, and upon the activities of each. All parties, however, are clear in their own minds that the coöperative training in engineering must not and cannot replace the regular engineering courses at colleges which in the nature of things must cater to the majority of young

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The Rise of the Industrial Worker in an Organized Society[1]

By IRA N. HOLLIS,[2] WORCESTER, MASS.

MANY volumes wouldbe required to deal adequately with the great industrial upheaval that has taken place since James Watt applied the steam engine to a rotating shaft in 1781. The information at the present time is meager and statistics are almost valueless. It will be reserved for some future historian to write about the rise of the industrial worker after he had either emerged from this period of doubt and conflict or pushed upward into the control of society. We can see evidences of change and we can understand well what is meant by industrial warfare, a warfare that would have involved much bloodshed a few centuries ago, but happily now, through our conception of democracy, is taking place without bloodshed and in most cases without evil memories and evil deeds. We can only hope here to indicate the size of the problem ahead of society in this twentieth century.

A short paragraph in Daniel Webster's speech against Hayne expresses fairly accurately our position today:

> . . . When the mariner has been tossed for many days in thick weather and on an unknown sea, he naturally avails himself of the first pause in the storm, the earliest glance of the sun, to take his latitude and ascertain how far the elements have driven him from his true course. Let us imitate this prudence and before we float farther, refer to the point from which we departed that we may at least be able to conjecture where we now are.

He might also have added,"to determine the course that we had been following since the last observation of the sun was taken." Our country is in the troubled sea and the clouds have completely cut off the sun, so that we truly are in the position of the puzzled mariner who knows neither his course nor his place on the ocean.

Who are the industrial workers of America? As a matter of fact we all are, except a few who by inheritance are freed from the anxiety of the shifting industries. The man who receives a large salary usually works harder than the man who receives a small salary, and in addition has to stand the constant wear of responsibility. Why should a distinction be drawn between wages and salaries? It does not make much difference whether a man is paid by the hour, the day, the week, the month, or the year; he must always have some employer to please. The common laborer is more fortunate than the professional man in that he usually has only one employer, while the professional man has many, and he draws his pay only in proportion to his service. The piece worker and the professional worker are on exactly the same level and obtain their wages by practically the same method, the only difference being the character of the work.

Too much has been said about capitalistic government. Capital usually represents the hard-earned wealth of those who were frugal and careful. It is true that there are some who have taken advantage of the development of recently discovered raw materials or resources or inventions, but in the main, all the people in the United States are capitalists. In many cases the workmen themselves who have been foresighted have accumulated some capital, and in most cases an industry in the United States represents the effort of some one who began at the bottom.

We know also the enormous expansion of invention made possible through the application of mechanical energy. This has been largely material and there is no evidence whatever that man has advanced either morally or ethically since the Constitution of the United States was written.

We are trying out a social evolution on a great scale which can be tested only through the lapse of many years and the complete readjustment of society to the new forces in our hands. In this change one class cannot be considered as separated entirely from another, and when we speak of the rise of the industrial worker we must at the same time consider his relation to others.

[1]Abstract of address delivered March 25, 1921, at a joint meeting of the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of The American Society of Mechanical Engineers.

[2]President, Worcester Polytechnic Institute. Past-President Am.Soc. M.E.

We may study this subject under five general heads:

1 The increase in numbers of the industrial workers
2 Their gain in power through combination
3 Their wealth
4 The opportunities for advancement
5 The satisfactions in life derived from their occupations.

It is upon the latter that I really prefer to dwell; as after all the success of any great change is measured by its permanent influence over the happiness and the mental attitude of society toward life.

Increase in Numbers of Workers

There has without doubt been an increase in the number of industrial workers since our Civil War, but the relative increase is largely a matter of definition. The term "industrial worker" has come to mean something quite different from the domestic workers of the eighteenth century, and consequently it is hard to make a comparison even between years so short a distance apart. The increase of labor-saving machinery would, if the only influence, reduce the number of workers and turn them to agriculture or other avenues, but with invention there has come more than a corresponding increase in the standard of living and the demands for manufactured articles, increasing the number of workers. In the automobile industry alone we have now nine million workers as against none in 1861.

Gain in Power Through Combination

It is evident that the power through organization of a minority has increased enormously. In some respects this has benefited all labor. In other respects it is a threat, because it is the strength of minority in a government which has as its ideals the predominance of the majority.

The power of the unorganized industrial worker has been found in the vote of quiet citizens who do not follow radical leaders and who have not felt the need of pressure by a central organization to better their conditions.

The power of organization stands out plainly, as we have at present the ruling of this country, at least in part, by minorities. That is what invention has done for us. By the use of labor-saving machinery and the change from the old type of mechanic to the specialist, we have built up enormous aggregations of capital and of labor. Wherever these exist, monopoly is possible, and control by the minority is also likely.

One of the directions in which the power of labor organization has been felt is in the reduction of hours. That has followed naturally upon the use of mechanical energy, and every individual in the United States is entitled to his share of the gain that has followed from putting our work into the hands of machine slaves. While it is not necessary to go into details of calculation, the potential power of America is between three and four thousand million men. That is based upon mechanical energy and all other forms outside of the human body. It follows at once that every inhabitant inherits the benefit of between thirty and forty manpower, or, as I have called it, thirty and forty "machine slaves." We, as citizens of the republic, are determined that this benefit shall not be obtained by a few, hence the difficult period through which we are passing. The hours of labor ought to have been reduced, and it is possible that with increasing invention they can be reduced still more.

In summing up this matter of power and the rise in power, it may be said that there are two methods by which this power may be exerted:

1 The quiet vote of the great majority of workmen who are following the constitutional system of representative government without pledging themselves first to fealty toward a union or an organization;

2 The organization of a minority for united action, either by holding the balance of power or by controlling through actual force certain agencies of our Government.

Wealth of the Workers

The gain in wealth of any community or state is measured by the conditions of life, and usually it is quite impossible to separate one class from another. Has labor made any substantial gain? It is doubtful if the average individual in labor is better off today than he was sixty years ago in the sense of being contented, but it is probable that a vastly larger number of laboring people are comparatively well off. The fact is that America has never had any of the great poverty that existed in Europe because we came to a country which God had endowed with boundless resources not yet used by man.

A fair measure of gain may be perhaps afforded by the savings banks. Are the deposits greater than they were sixty years ago in proportion to the population? Without question they are. Many places where there is large manufacture have shown enormous gains. We may conclude, though, that labor has risen in wealth during the past century simply because the standard of living is vastly in advance of anything our ancestors could have imagined.

Opportunity for Advancement

After all, we get down to real values as we leave the numbers, the power, and the wealth of the industrial workers. The most important thing in this life is opportunity.

The machinery of mechanical energy has opened the way to undreamed-of achievement, and every individual should find it possible by his work to do better for himself than ever before in the history of the world. In our experience it is true that a man may rise out of the ranks more readily than ever before. Opportunity is better than ever before. That is a true measure of the rise and the kind of advance which carries civilization along with it. I know of no more interesting history than that of the industrial communities in the United States. In one of them where I live, almost every factory is founded on the energy, enterprise, and character of workmen who sprang up among us. When we talk of the closed shop as a means of shutting out non-union labor, we are simply taking a step backward and absolutely laying a barrage through which individual enterprise cannot pass. One of the things that labor should not forget is that many of the men against whom they are endeavoring to legislate, as the managers or the capitalists, have been like themselves ordinary workmen who have taken advantage of the opportunities afforded through this democracy.

The curse of our modern controversy on the subject of capitalism or capitalistic government springs out of a total misunderstanding of what opportunity means. When the present governing classes in Russia speak of the bourgeois with a certain amount of contempt, they refer to the people whose families made Russia. Are we drifting backward here toward that form of government or are we going ahead in developing opportunities and openings for men to rise out of the ranks? No statistics can tell that. It is impossible to answer the question satisfactorily, but we do know that when the time comes that a man's right to make a living shall be judged solely by his membership in an association, in a church, in a political party or otherwise, then our Government is in danger.

The gathering power of labor may be summed up through the disappearance of monopoly. In the decision as to conditions under which labor has to be carried out, the disappearance of political democracy as the prime essential of government and the appearance of an industrial consciousness will do more than make this world safe for democracy. It will adapt democracy to work a new form of government which the twentieth century must work out, and in which the engineer must have a voice in order that the test of opportunity may become a reality instead of a shadow upon the first page of our own national Constitution.

Satisfaction from Occupation

We are certain of one thing, and that is that no citizens can take any satisfaction or feel happy with the present condition of warfare in the United States. The "get together" spirit is passing even from the churches, although there is some indication that certain sects are prepared to coöperate. There has never been a time of greater restlessness or discontent in the whole world. The United States is feeling the effect of it, but on the other hand there has never been a time of greater responsibility for the human race. It is perfectly proper, then, to inquire in this connection what are the satisfactions of life and what effect are they going to have on the happiness or the continuance of the race? What are they going to do for the industrial worker? Through them is he going to have a true rise and influence over the future of our Government, or is he simply going to sink to the level of the poor, struggling mortals of an outworn century? I have put the whole thing down in a formula that no one can be satisfied unless he has served, and he can serve only through work.

I ran across some sentences in Spencer's Ethics a few days ago, and one of these I put down here as written when Spencer was a young man. I omit a large part of the paragraph and take only the words that apply to the subject under discussion: "The growth of voluntary coöperation has been necessarily accompanied by decrease of aggression and by an increase of sympathy leading to services beyond agreement." Could anything define better what should be the true rise of the industrial worker? "Services beyond agreement;" where do we find them today, through the labor organizations or through the employers? In this advancing power of the industrial organization more attention has been paid to control than to service. Little has been done to better the lot of working men and women in the nature of the higher satisfaction that follows through better preparation for service. The tendency has been quite the other way.

The rise of any human effort or agency is measured by its tendency to minister to the satisfactions of life. No gain in numbers, power, or wealth that does not accomplish this is a permanent gain. It must pass away.

REQUIREMENTS OF THE ENGINEERING INDUSTRIES AND THE EDUCATION OF THE ENGINEER

(Continued from page 395)

men seeking a thorough training in the engineering sciences, and many of whom do not enter the manufacturing industries. The coöperative engineering training, however, is destined to become a vital integral part of a comprehensive system of engineering education, to the detriment of none of the other parts, but to the mutual benefit of all, and is particularly important to the manufacturing industries of the nation.

The pragmatic test, of course, will come for this plan, when the first group of coöperative engineering students will have been graduated and will have taken their rightful place in industry. It will then be seen to what extent these graduates will more quickly fit themselves into and become effective leaders of that branch of industry which calls for practical engineers accustomed to applying the technical sciences to the needs and wants of the human race, equipped by their understanding of human nature to coördinate human forces and to inspire them with their leadership, and endowed with that vision which will permit American engineering industries to develop to the greatest benefit of all engaged therein and to the glory of our country.

The project is planned to afford a definite professional education of a high order leading toward the technical and executive responsibilities in industry. In order that this ideal shall be accomplished, several factors must contribute to the desired end. The engineering college should have a notable capacity for teaching the exact sciences, and also sympathize with coöperation by means of which its students may obtain coördinated experience and instruction in practical employment. The officers and department heads of the industries participating in the coöperative arrangement must also correctly appraise the advantage to leadership in industrial engineering of a rational scientific as well as a practical training. Given these relations and a readiness to enter into mutual supervision of the enterprise, a foundation for success is laid.

The Failure of Metals Under Internal and Prolonged Stress

AT A JOINT MEETING of the Faraday Society, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institute of Metals, the North-East Coast Institution of Engineers and Shipbuilders, the West of Scotland Iron and Steel Institute, and the Institution of Engineers and Shipbuilders in Scotland, held in London on April 6, the subject of failure of metals under internal and prolonged stress was discussed.

In an introductory address, Dr. W. Rosenhain surveyed the nature of the problems before the meeting and their actual position. He related some experiments he had performed to investigate the time element in tension testing, and ascribed season cracking to viscous flow in the amorphous intercrystalline layer found in metals. An aluminum alloy having a tensile strength of 24 tons per sq. in. ruptured under that load in 2 min., but supported loads of 16 tons, 14 tons and 13 tons per sq. in. for 9 min., 31 min., and 56 min., respectively. This time effect, however, was only associated with intercrystalline fracture. Dr. Rosenhain projected on the screen photomicrographs which, he believed, confirmed the hypothesis explaining season cracking by viscous flow. His slides showed that crystals with smooth regular boundaries were easily cracked, and that when the same material was treated so as to make the boundaries irregular it would not undergo intercrystalline cracking under any circumstances. In confirmation of his argument, Dr. Rosenhain pointed out that ordinary wires would, if twisted, not quite reacquire their original position when released; but if the wire consisted of a single crystal the return was immediate and complete, because then there was no seat for viscous phenomena in any intercrystalline boundary. In his final remarks the speaker referred to the opinion of metallurgists who explain intercrystalline cracking as a result of chemical action. He experimented with metal strips which were annealed in different media, some in air, moist or dry, some in hydrogen, and some in vacuo. Season cracking occurred in all although much sooner in those treated in air than in those treated in vacuo or in hydrogen. This, he said, proved that season cracking took place in the absence of chemical action.

Fourteen technical papers were presented, of which excerpts from seven are given below. (Others will be abstracted later in this section if space proves to be available.)

CHEMICAL INFLUENCES IN THE FAILURE OF METALS UNDER STRESS

By Cecil H. Desch

There are two directions in which the failure of metals under stress may be influenced by chemical conditions, the first being through the composition of the metal or alloy, and the second through contact with a substance which is capable of reacting chemically with the metal. The first of these has not been systematically investigated. The form of failure known as "season cracking" appears to be confined to a limited class of alloys, principally brasses and alloys of copper with zinc and nickel. In the brasses the liability to crack under continued stress appears to increase with increasing zinc content and to be favored by the introduction of iron or tin. On the other hand, intercrystalline failure under the application of stress may take place in many other metals, including steel, in such circumstances as to indicate a relation to season cracking. Brasses composed of the better constituent occasionally crack in the cast condition, without the application of external stress, and this form of failure is always associated with the presence of aluminum in the brass. The influence of corroding agents has been rather more fully studied. The most striking feature of this action is its specific character. In the case of severely cold-worked metals in a state of internal stress, cracking may be produced by contact with solutions of mercury salts or with ammonia, but only rarely by any other reagent, although acids may attack the metal much more rapidly than either of these. The difference between reagents in this respect does not appear to be merely one of degree, but the strictly selective action of certain compounds is very remarkable. Chemical action in metals frequently advances along the surfaces which separate the crystal grains more rapidly than through the mass of the metal, and such a course is more likely to occur when the portion of the metal which is exposed to the reagent is in a state of tension than when it is in compression or in an unstressed condition. At the same time, this process is not observed with all reagents. The action of strong acids is so powerful that the minor differences between the crystal boundaries are obliterated, but their mode of action may be intercrystalline when the metal attacked is in a highly cold-worked condition. The action of weak electrolytes is usually intercrystalline. Mercury is the most powerful reagent for separating the crystal grains at the ordinary temperature. Tin and other fusible metals behave like mercury at higher temperatures. None of these reagents, however, can produce an intercrystalline weakness which does not previously exist, but only reveals, either a state of stress, as in the cold-worked metals which are subject to season cracking, or a state of weakness of unknown origin, as in some large castings of propeller alloys. (*Engineering*, vol. 111, no. 2884, April 8, 1921, p. 418, *g*)

INTERCRYSTALLINE FRACTURE IN STEEL

By D. Hanson

A description of four cases in which steel developed intercrystalline cracking, and a consideration of the general causes of season cracking. The first case was that of a steel wrapper plate from the combustion chamber of a marine boiler, which was severely cracked around the edges between the rivet holes. The chemical composition of the plate was not unusual, although the phosphorus content was 0.7 per cent. Tensile tests gave normal results for the center portions of the plate, but the edges showed a low elastic limit and elongation, while notched-bar impact tests gave variable and low results. Microscopic examination revealed the fact that the cementite occurred mainly in the form of intercrystalline films. The second case was drawn from the drum of a water-tube boiler, and the cracks as before started mainly from the edges of the rivet holes, though some were found to start at the calked edge of the plate. Microscopic examination showed the existence of intercrystalline films of cementite. The third case was found in a number of plates from a high-pressure marine boiler. In this case intercrystalline cracks were found in the steel at a point where the thickness of metal was 4 in., including the wrapper plate of the boiler, two butt straps and a cover plate. Failure is attributed in these three cases to the probable existence of internal stresses in the material. Another case of intercrystalline failure, in which internal stresses appeared to have been present in the metal, was that of a piece of cold-drawn steel tubing which cracked after six months intermittent service without working stresses in a niter bath operating at a temperature of 300 deg. cent. The cracking in this instance was probably accelerated by the corrosive acting of the fused nitrate at the working temperature. It was observed, however, that as similar steel tube which had been annealed below the critic range, and another which had been normalized, did not crack when exposed to the action of the fused salt. The evidence afforded by the instances mentioned is adduced in support of the theory that internal stresses are the main factor in bringing about failures in season cracking. It is believed that the most favorable conditions for the development of the phenomenon in the case of steel arise within a temperature range a little below 300 deg. cent. corrosion is considered as an after effect and not the primary cause of cracking. Failure can occur solely as the result of stresses either internal or external, to which the metal is subjected. (*Engineering*, vol. 111, no. 2885, April 15, 1921, pp. 467–469, 7 figs., *d*)

THE MECHANISM OF FAILURE OF METALS FROM INTERNAL STRESS

By W. H. Hatfield

A study of the influence of cold work and of chemical action on the failure of metals without the operation of deforming stresses. The possibility of the existence of the non-crystalline phase of metal either between the crystals or as a result of cold work, at temperatures ranging from the freezing point to the normal, has been postulated as a general working theory to explain such phenomena as season cracking in brass, smashing of castings from internal stress, the rupture of ingots, of hardened steel parts, etc. This theory is examined in the light of experimentally established facts. No direct evidence is found of the existence of an amorphous condition in metals. Arguing, however, from the results obtained in experiments on cold-worked and annealed brass, it is established that the amorphous phase, as compared with the crystalline, is considerably harder, and has a higher elastic range and a reduced capacity for plastic deformation. It is also experimentally determined that the amorphous phase cannot have sufficient mobility to allow viscous flow. The general conclusion is that except in certain cases where selective chemical or physico-chemical action causes a separation of the remains of crystals from each other, fractures such as those under discussion are due to internal stresses introduced during processes of manufacture. Such stresses may not be high enough, initially, to produce rupture, but rupture occurs when weaknesses introduced by chemical or other influences lead to increased local concentration of stress, or in some cases where changes in temperature in themselves lead to accentuation of the breaking stress. (*Engineering*, vol. 111, no. 2884, April 8, 1921, p. 435, *e*)

INTERNAL STRESSES IN RELATION TO MICROSTRUCTURE

By J. C. W. Humfrey

Study of the microstructure of metals and of the mechanism of their behavior under plastic deformation indicates that internal stresses between one crystal and another, due to a previous overstrain or thermal treatment, must play a large part in determining the subsequent mechanical properties. It is found that if a metal is overstrained in tension and allowed to "recover" its elasticity, then, in addition to the elastic limit in tension being raised, the corresponding elastic limit in compression is lowered; vice versa, if the elastic limit in compression is raised by overstrain in compression, then, at the same time, the elastic limit in tension is lowered. The two elastic limits appear in fact always to move in the same absolute direction together, metals possessing a certain elastic range, which, while it may vary in extent, yet reaches certain limiting values. In a bar built up of two materials possessing different mechanical properties, uniform straining will set up internal stresses which have the effect of producing a symmetry in the position of the elastic limits, similar to that which has been found in the actual experiments upon metals. It would appear reasonable, therefore, to deduce that the heterogeneous structure of metals was responsible for this particular phenomenon. In pure metals it is considered that the intercrystalline boundaries are the chief cause of heterogeneity of structure. Microscopic study of the effects of strain shows that the boundaries offer a definite barrier to the propagation of continuous slip between two crystals, and that each crystal in a mass of metal behaves as if it were enclosed in a thin but hard skin which can only deform by elastic bending. In alloys, and especially in the carbon steels, the heterogeneity is more evident, and it is obvious that no general deformation can take place without comparatively large stresses being left between the different crystals. A photomicrograph of severely strained pearlite shows that the cementite laminæ lying in the direction of the strain have been doubled up into wave forms. Internal stresses can also be set up in metals by virtue of the possession by the constituent parts of different coefficients of the thermal expansion. In steel, the coefficient of the ferrite is 10 per cent less than that of the pearlite, which might result in the ferrite being put into compression. (*Engineering*, vol. 111, no. 2884, April 8, 1921, pp. 419–420, 3 figs., *t*)

INTERNAL FRACTURES IN STEEL RAILS

By Henry S. Rawdon

A discussion of the type of defect known as "transverse fissure," which is sometimes found in the heads of American steel rails. Its prevalence in American rails is attributed to the difference in the service the rails have to withstand and the harder rail which is used as compared with European practice. The defect is internal and consists of a bright silvery mass enclosed within the normal metal and itself enclosing a nucleus of coarsely granular appearance. The microscope reveals a number of deep gashes or discontinuities, usually, though not always, approximately perpendicular to the axis of the head of the rail. These internal cracks have been found in rails before use, but are much more frequent in rails which have been in service. The general opinion is that transverse fissures represent the growth of internal defects which arise in the rail as a result of the severe cold-working of the tread and become larger and larger with the repetitions of stress developed in the rail in service. The fact that the appearance of the nucleus is identical with that of the face of internal fractures also strongly supports the view that the two are one and the same thing. This is in line with the well-known fact that fatigue breaks of all kinds originate most readily in the neighborhood of those defects which considerably modify the stress distribution. (*Engineering*, vol. 111, no. 2885, April 15, 1921, pp. 470–471, 2 figs., *g*)

INTERNAL STRESSES IN BRASS TUBES

By R. H. N. Vaudrey and W. E. Ballard

An investigation of a peculiar type of failure in some brass tubes of circular section containing 70 per cent of copper. The defect took the form of an apparent stratification of the wall of the tube, which was shown by the ordinary commercial test of expanding on a conical plug. The fracture usually showed at least two layers, the outer one being dark and tarnished, the inner one crystalline. "Hollow-sunk" tubes were first studied, that is, tubes drawn through a die without any form of internal support. A tube $1^3/_4$ in. in external diameter and $1^1/_2$ in. in internal diameter was annealed and hollow-sunk to an outside diameter of $1^{29}/_{64}$ in. A piece of the tube about 3 ft. 6 in. long was left on a table for four days and at the end of this period it had deformed 1/4 in. from the straight. Lengths of 2 in. of the tube, with multiples of 1/64 in. turned off the inside and outside, were immersed in an acid solution of mercurous nitrate and the times taken for the specimens to crack noted. Similar experiments were conducted on a tube drawn from the same original size, through a die of $1^{23}/_{64}$ in. bore, the inside being supported by a $1^1/_8$-in. diameter mandrel bar. It was concluded that in the "hollow-sunk" tube a thin layer on the outside of the wall was under high tension rapidly falling to zero, while a thin layer on the inside was under a high compression. In tubes manufactured without sink the internal stress passed uniformly from a maximum tension on the outside through zero to a maximum compression on the inside. The stratification of the specimens which occasioned the investigation was attributed to the tubes having been formed with too large a sink and too small a reduction in thickness, combined with the cracking action of the pickle bath. (*Engineering*, vol. 111, no. 2884, April 8, 1921, p. 421, 5 figs., *e*)

NOTES ON FRACTURES IN LOCOMOTIVE BOILER TUBES

By Sir Henry Fowler

A study of a peculiar brittleness that was found to have developed in the superheater tubes of a locomotive after it had run about 60,000 miles. Investigation showed that of the 21 large tubes, 8 had brittle ends, while 13 were fairly malleable. The tubes were lap-welded, and it was obvious that the steel-tube strip from which they were made was in both cases of poor quality. Microscopic examination showed that the impurities were largely concentrated in the boundaries between the crystals, and that the fractures were generally intercrystalline. The actual increase in the diameter of the tubes due to expansion was found to be only about 3.5 per cent of their original size. Tensile tests taken from the ends and middle

of the tubes disclosed the fact that in both the brittle and the malleable specimens the maximum stress was much greater and the elongation much less at the ends than at the middle. In bending tests the expanded portion of a brittle tube fractured at 10 deg., while pieces beyond the zone on which work had been put passed through an angle of 180 deg. without fracture. In some few cases the fractures showed laminated materials and signs of rust. In order to ascertain if the brittleness of the tubes was due to the original stresses set up in expanding, portions of two separate brittle tubes were taken from unaffected parts of the tube, made into rings and expanded in the usual way. The Brinell hardness was in one case increased from 111 to 156, and in the other from 131 to 143, but in neither case did the metal become brittle. No definite suggestion as to the causes of the brittleness and fractures is offered, but it is intimated that they might be due to the repeated stresses set up during the work of the locomotive acting on the material already in a state of stress, regard being had for the fact that the phosphorus content of the metal was 0.009 per cent. (*Engineering*, vol. 111, no. 2885, April 15, 1921, pp. 466–467, 11 figs., *e*)

Short Abstracts of the Month

AERONAUTICS

Aircraft Statistics. The following preliminary statement of the general results of the 1920 census of manufactures with reference to aircraft has been issued by the Bureau of Census, Department of Commerce, and furnishes a detailed statement of the quantities and values of the different types of aircraft manufactured during the year 1919. It was prepared under the direction of Mr. Eugene F. Hartley, Chief Statistician for Manufactures.

Reports were received from 31 establishments engaged in the industry during 1919 showing products for the year valued at $14,372,643, as compared with 16 establishments in 1914 with products valued at $789,872. Of the 31 establishments reporting for the year 1919, ten were in New York; four in Ohio; two each in California, Massachusetts, and Missouri; and one each in Connecticut, Indiana, Illinois, Louisiana, Maryland, Nebraska, New Jersey, Pennsylvania, Rhode Island, Washington, and West Virginia.

The following is a summary of statistics of the industry for 1919, the "All other products" reports consisting chiefly of airplane parts, engines, and repair work:

Number of establishments	31
Total value of products	$14,3⁻2,643
Airplanes:	
Number	432
Value	$3,466,452
Seaplanes:	
Number	230
Value	$4,580,016
Value of work done during year on airplanes and seaplanes not completed	$1,658,670
All other products, including parts and repair work	$4,667,505

(*Department of Commerce, Bureau of Census, Preliminary Notice.*)

Strutless-Type Aeroplanes, E. Meyer. Discussion of the elementary theory involved and description of some European types of strutless planes.

The main reason for the existence of the strutless plane lies in the desire to reduce the so-called parasite resistances, i.e., resistances to the motion of the plane which do not in any way contribute to its lift. Such resistances increase very rapidly with increase of speed, and call for correspondingly greater expenditures of power.

Of the planes described the Junkers is well known in this country. Of the other planes may be mentioned the Siemens-Schuckert monoplane, the Fokker monoplane, the Sablatnig machine, and a very interesting monoplane hydroaeroplane of all-metal construction, built by the Zeppelin Works in Lindau and known as the Dornier. No detailed data are given as to any of these machines except the general dimensions and rated power of the engines, and in the case of the Zeppelin plane not even these are given. (*Schweizerische Bauzeitung*, vol. 77, no. 15, Apr. 9, 1921, pp. 166–168, 7 figs., *d*)

BUREAU OF STANDARDS (See Engineering Materials)

ENGINEERING MATERIALS

The Sprenger Process of Making Concrete, E. Weiss. In this process a machine is used which its inventor calls the Aero-Malaxeur. In this machine wet sand and gravel are projected through an atmosphere saturated with the binding material, which may be blown in a state of complete pulverization by some kind of a blower.

The machine essentially consists of a slightly inclined mixing drum rotatable in its bearings. In the top part of the drum there is a hopper for storing the sand and gravel, into which there is discharged at a predetermined rate water to give the materials the desired degree of moisture. At the other end of the cylinder there is a double proportioning hopper containing the binding elements, such as lime, cement, or a mixture of the two. The graduated orifices admit these materials into the cylinder in a strictly predetermined proportion and a strong blast of air coming from a blower

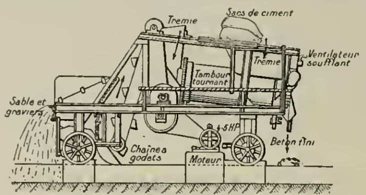


Fig. 1 Diagrammatic View of the Sprenger Aero-Malaxeur Concrete-Making Machine

Sable et graviers = Sand and gravel; *Tremie* = Hopper; *Sacs de ciment* = Cement sacks; *Tambour Tournant* = Rotating Drum; *Ventilateur soufflant* = Blower; *Beton fini* = Finished concrete, *Moteur* = Motor: *Chaine à godets* = Roller chain

carries them to meet the materials coming from the other end of the drum. As each grain of sand or gravel is projected from the upper hopper into the cylinder where it moves in an atmosphere filled with the binder, it becomes therefore completely and intimately blended with the latter.

The machine is of the continuous-operation type and is entirely automatic, the concrete arriving at the bottom of the cylinder being discharged into cars or bins. It is claimed that with this machine the lack of uniformity of sand or gravel is less important than in the production of concrete by other means. (*La Nature*, no. 2444, Feb. 5, 1921, pp. 95–96, 4 figs., *d*)

Some Properties of White-Metal Bearing Alloys at Elevated Temperatures, John R. Freeman, Jr. and R. W. Woodward. The Bureau of Standards as part of a general investigation of the properties and methods of testing the white-metal bearing alloys has developed apparatus for determining their properties at elevated temperatures. This paper describes apparatus for determining the yield point and ultimate strength of these alloys in compression at temperatures up to 150 deg. cent. A similar apparatus is also described for determining the Brinell hardness at these elevated temperatures.

The results of compression tests and Brinell hardness tests obtained with this apparatus at 25 deg. cent., 50 deg. cent., 75 deg. cent., and 100 deg. cent. are given for the five following alloys:

Alloy No	1	2	3	4	5
	Per Cent				
Copper	4.56	3.51	5.65	2.90	.....
Antimony	4.52	7.57	6.90	10.50	10.03
Tin	90.02	88.92	87.36	61.55	5.02
Lead	absent	absent	0.09	25.05	84.95
Iron	0.05	0.05	0.05	0.05	0.05

Alloys Nos. 1, 3, 4, and 5 are the four alloys being recommended by the S.A.E. as standard alloys.

The results of these tests show that the three tin-base alloys maintain their properties better at the elevated temperatures than either the lead-base or the intermediate alloys.

(*Abstract of Technologic Paper of the Bureau of Standards*, no. 188, *g*)

Influence of Nickel on Cast Iron. Buner and Piwowarsk have carried out a series of tests to determine the influence of nickel on cast iron, using Swedish charcoal iron with a total carbon content of 3.90 per cent, of which 2.80 per cent was graphitic carbon, a silicon content of 0.69 per cent, and a manganese content of 0.18 per cent. It was found that this metal readily formed an alloy with 1.2 to 3 per cent of nickel at a temperature only 50 deg. cent. higher than the melting temperature of cast iron.

Mechanical tests have shown that the best results are obtained with an alloy containing 1 per cent of nickel, the transverse strength being increased 30 per cent, the compressive strength 30 per cent, and the tensile strength 25 per cent, while the hardness is increased only 18 per cent. The addition of $1^1/_2$ per cent of nickel conferred no advantage whatever, the influence of the nickel on the separation of graphite more than counterbalancing the favorable effect on ferrite. (It is not quite clear whether by this is meant that an addition of $1^1/_2$ per cent of nickel gave no advantage as compared with an addition of 1 per cent, or that the comparison is made with nickel-free cast iron.)

For the manufacture of high-tensile cast iron for machine parts, gear blanks, etc., cast iron containing 1.2 per cent of nickel is recommended.

It is of interest to note that cobalt, which usually has an effect very similar to that of nickel, in this case acted in quite the reverse manner, reducing the resistance to bending, tensile and compression strengths, while increasing the hardness. This is due to the fact that cobalt retards the separation of the graphite and favors the formation of carbides. (*Stahl und Eisen.* Abstracted through *Automotive Industries*, vol. 44, no. 13, Mar. 31, 1921, p. 705, *e*)

Materials for Turbine Blades, P. Bardenheuer. In rolled and drawn materials for steam-turbine blades there are often stresses set up during the process of manufacture which are equalized only after the apparatus has been in use for some time. The equalization of these stresses results in permanent changes of shape and contraction of turbine parts which may more or less endanger the safety of operation of the machine.

In order to obtain reliable data as to the the magnitude of elongations in turbine blades due to the above-described causes, Gustav Wallenborn, in a thesis presented in 1916 in Darmstadt (probably at the local polytechnic institute) investigated several materials such as nickel steels, carbon steels, and the more common copper alloys, including monel metal. In the course of these tests he determined the coefficient of heat expansion and permanent elongation after tenfold heating to 350 deg. cent. (662 deg. fahr.) and also the specific weight, hardness, and tensile strength of the samples of their original state and after such heat treatment.

The test pieces were used in the form of rolled or drawn bars as well as in the final machine form of blades, the bars having either round or rectangular shapes. The cross-sections of the test pieces differed very materially. The chemical composition was not determined and exact information as to the manufacture of the test pieces before they reached the investigator was not available, which deprives the investigation of much of its scientific value.

Of the data collected the most important are presented in Table 1. Of particular interest is the expansion due to heating and the permanent elongation of the test pieces.

As regards the elongation, the author of the thesis states that it appears to depend exclusively on the molecular stresses in the material. If the material has merely been rolled, permanent elongations appear; but if it is then subjected to cold drawing, the permanent elongations gradually disappear, until after a certain number of passes a permanent contraction sets in. The correctness of this statement, however, may be questioned. (*Stahl und Eisen.*, vol. 41, no. 6, Feb. 10, 1921, p. 204, *e*)

30 per cent nickel teel.....	1.28	1.26–1.30	0.00	—0.02 –+0.02
36 per cent nickel steel.....	0.063	....	+0.018	....
40 per cent nickel steel.....	1.10	....	+0.22	....
Cast steel..........	1.07	0.98–1.13	+0.11	—0 04 –+0.22
Monel metal..........	1.37	1.31–1.47	—0.04	....
Aluminum bronze.......	1.55	1.54–1.56	—0.08	0.18 –+0.13
Delta bronze..........	1.82	....	+0.25	....
Phosphor bronze........	1.65	1.64–1.65	0.21	....
Bronze..........	1.72	1.65–1.83	+0.017	—0.07 –+0 16
Brass..........	1.72	1.59–1.76	+0.015	—0.45 –+0 145

FOUNDRY

Centrifugal Castings. Description of the methods used at the works of Stokes Castings, Ltd., Mansfield, England, where a regular output of centrifugally made castings is now being obtained, the average output for the last few months being in the neighborhood of 2000 castings per week.

The castings produced are, in the main, for internal-combustion engine work—piston-ring drums and engine liners—and it is said that perfectly satisfactory machining qualities are being obtained without any annealing or heat treatment. This result has been obtained as an outcome of an excessive series of experiments on mixtures, pouring temperatures, die temperatures, speeds, etc., each of these variants being a determining factor in the quality of the resulting material.

The quality of the product obtained is said to be markedly superior to material cast in sand molds or stationary chills. Graphite plates are practically eliminated.

The casting plant consists of a number of machines. In the latest type the machine is driven direct by means of a variable-speed motor through a flexible coupling and friction clutch. The time taken to produce a 6-in. diameter drum is something under a minute, counting from the time of pouring into the receiver on the machine to time of taking out the completed castings.

Up to the present most of the research has been devoted to the question of gray cast iron, but interesting experiments have been made with some of the non-ferrous metals. The comparison of microsections of lead-bronze castings made in ingots and centrifugally, shows that in the latter casting the grain is very much smaller, indeed about 1/150 the size of the ingot crystal. The chemical analysis of the material shows that the lead and tin have tended to fly to the outside of the casting, which is reflected in the fact that the Brinell hardness near the bore is 101 and near the outside 90.0. (*Engineering*, vol. 111, no. 2881, Mar. 18, 1921, pp. 311–312, 6 figs., *d*)

FUELS AND FIRING

Novel Type of Oscillating Grate

Two-Stage Combustion in the "Evaporator" Stepped Oscillating Grate. The stepped oscillating grate has come into prominence on the market in the last few years because of its advantages for the combustion of friable, dirty and powdery fuels. These advantages consist in the comparatively large free grate area which can be easily obtained with a stepped grate and the ease with which the dropping of fuel through the grate can be prevented. This makes the stepped grate particularly suitable for such fuels as lignite, breeze, etc.

The conditions of combustion in the case of a stepped grate are also said to favor the employment of the poor grades of fuel.

In order, however, to utilize all fuels at a higher efficiency a two-stage combustion may have to be considered, as has already been done in the new stepped grate developed by the German Evaporator Company.

Fig. 2 shows the general arrangement of the new grate. The amount of fuel supplied from a hopper on to the main stepped grate *d* is regulated by the usual gate *a*. In addition to this, there is in the hopper a throttling device *b*, the position of which can be shifted by a gear drive. The hopper *c* under the throttle *b* is equipped with airtight gates, which are used for starting the fire on

the grate and to permit seeing what is going on on the grate by withdrawing the throttle *b*.

The stepped grate itself extends into the body of the coal-supply hopper so that the mechanical introduction of fresh coal on the grate begins directly under the fuel-regulating gate *a*. This gives the coal in the hopper a slight motion and makes a constant and regular supply of coal to the grate more certain. The main grate consists of a series of perforated overlapping plates located stepwise and held by the grate-bar shoes. These latter have their bearing in the grate frame which permits a certain freedom of oscillation to the grate plates and this, in its turn, enables the spaces between the grate plates to be made smaller or greater; furthermore it permits the grate plates to be swung into a position inclined at such an angle as to sweep away the residues of the foundation fire, which is of practical importance in connection with the burning of sandy fuels, such as certain kinds of lignites. The grate-plate shoes with their lever-shaped ends, usually in groups of five, are connected to a lever with link action *e*, by means of which and the rod *f* they can be shifted into the desired position. The rod *f*, in its turn, is connected with the speed-change gear *l* driven by a motor *m*, the lever rods *g*, *h*, *i*, and *k* serving to transmit the motion from *l* to *f*. By shifting the rod *f*, the grate plates can be adjusted so as to make the interstices between them either large or small. The movement of the grate plates themselves is regulated from the speed-gear shift on the motor and must be suitably adjusted for the fuel burned, so as not to distribute the foundation fire and make certain the ignition of fresh fuel.

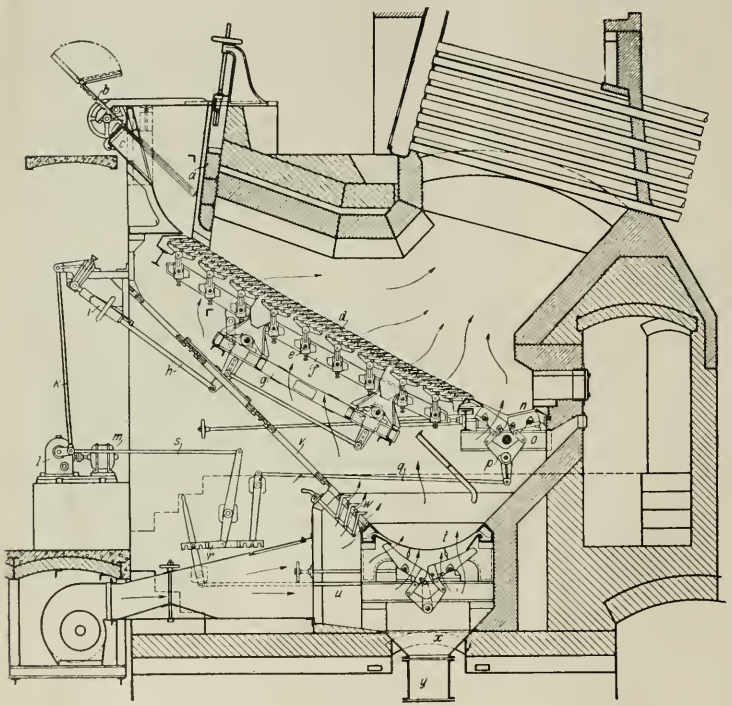


Fig. 2 Stepped Oscillating Grate with Two-Stage Combustion Built by the German Evaporator Company

The residues of combustion from the main grate *d* are taken up by the intermediary grate *n*, which acts also as a clinkering grate and as a kind of sluice for transferring the residues on to the end grate *t*. The intermediary grate consists of oscillating grate members *o* swinging in opposite directions and thereby breaking up the residues of combustion from the main grate.

From the grate *n* the residues of combustion travel down an incline to the end grate *t* which is built in the same way as the intermediary grate *n*, located in an air chamber *u* and supplied by air from a blower. This air chamber is located tight against the wall *v* of the main grate and is provided with a number of outlets *w* closed by shutters, the openings in which can be regulated. It is from this chamber that the undergrate blast is supplied to the main grate, so that the blast is partly under the main grate and partly under the end grate *t*, where it helps to burn up all the fuel residues.

It is claimed that the resulting gases of combustion together with the excess of blast highly superheated on its way, ascend upward to the main grate and materially assist in the combustion. The ashes and clinkers from the end grate go into the ash pit *x* and are discharged into the ash cars through *y*. (*Zeitschrift für Dampfkessel und Maschinenbetrieb*, vol. 43, no. 53, Dec. 31, 1920, pp. 405–407, 3 figs., *d*)

Properties and Characteristics of Colloidal Fuel, Linden W. Bates and Haylett O'Neill. It is stated that a colloidal fuel is composed of from 0 to 40 per cent of carboniferous material (coal, coke, charcoal, lignite, peat, hard pitch, or any similar grindable material) mixed with fuel oil and held in suspension with about 1 per cent of fixateur (no information given as to this latter). Data are given for determining the specific gravity and heating value of various colloidal fuels. (Paper read before the Royal Society of Arts, London. Abstracted through *Power Plant Engineering*, vol. 25, no. 7, April 1921, pp. 368–369, 2 figs., *g*)

INTERNAL-COMBUSTION ENGINES (See also Thermodynamics)

Fuel and Air Regulation in Heavy-Oil Engines

Device for Automatically Regulating the Supply of Fuel and Injection Air in Heavy-Oil Engines, Max Lindemann. With the usual Diesel-engine injection valves the conditions are such that if the air pressure and valve design are adjusted properly to take care of full-load conditions too much air is used at half load, which makes the mixture excessively lean, and if the load is reduced still further the engine may cease to fire.

This could be obviated by reducing the amount of injection air at part load, but it isdifficult to accomplish it in actual practice, because if the load varies suddenly the variation in the amount of injection air cannot follow it fast enough.

One way to obviate this is to govern the engine by varying the lift of the valve needle. By this method a practically constant composition of mixture may be maintained at all loads and the combustion conditions made more uniform and certain. This method of governing is, however, complicated and cannot be applied to all kinds of engines.

Fig. 3 illustrates a device said to have been developed by the Leobersdorf Machine Company. Here a valve disk *N* sliding on the valve stem of the fuel valve *M* is held by a spring against the lower surface of the cylindrical piece *P* fixed in the valve housing. In *P* a passage *A* reaches to the top of the piece, into which the fuel flows through another passage *T* in amounts proportional to the load. An air passage *B* is also located in *P*. The passages *A* and *B* both open into the lower face of the piece *P* and are closed off by the same automatic valve *N*.

The device operates in the following manner: The fuel introduced into the passage *A* in accordance with the load on the engine

is held therein by the valve disk N. When valve M is opened, however, N is forced away from P by the injection-air pressure, and fuel and injection air flow respectively from passages A and B. As the same constant injection pressure obtains in both passages, there is discharged from each of them an amount of fuel or air proportional to the time during which the passages are held open. Hence, once the cross-sections of the two passages have been placed in a constant relation to each other, the ratio of fuel to injection air will also have to be constant. If all of the fuel from passage A has been discharged, the remaining injection air will flow into it.

As a result of this arrangement, from the very beginning of the opening of the fuel valve a constant mixture of fuel and injection air is admitted, and this admission lasts until a sufficient amount is discharged to correspond with a given load on the engine. From then on and up to the time that the fuel valve is closed, only injection air flows into the working cylinder. Fig. 4 gives diagrammatically the proportioning of the fuel from one-quarter up to full load. In this figure the base line indicates the path of the opening of the fuel valve. The sectioned areas correspond to the injected mixture of fuel and air, while the white areas show the amount of air flowing after the flow of the fuel mixture has been cut off.

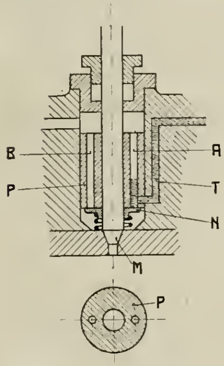


Fig. 3 Diesel-Engine Fuel-Injection Valve of the Leobersdorf Machine Co. (Germany)

In all such constructions the following two conditions must be observed:

(1) The passages for the reserve of fuel and for the injection of air must be arranged in such a manner that their cross-sectional areas which are in constant relation to each other give a constant mixture ratio of fuel and air all at loads until the entire fuel (in the reserve passage) has been used up.

(2) The passages which are closed by a common automatic valve or similar device must be so arranged that from the beginning of the flow of injection air both fuel and air are discharged; that is, from the beginning of the air-injection period a constant mixture ratio is available.

In the test carried out by the author a two-cylinder Dissel engine developing 110 hp. at 190 r.p.m. was equipped with the device shown in Fig. 5. Here a helical passage A has been provided for the fuel and from it small holes lead to the seat of the valve B. Further, six passages C are provided for the injection air in order to make it possible to vary the mixture ratio by opening and closing some of these passages.

The test engine has purposely been equipped with a very light flywheel, so that the coefficient of fluctuation has been computed to be 1/38. This was done in order to make it possible to observe the regularity and reliability of ignition from the tachogram.

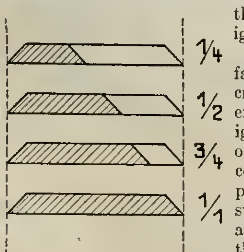


Fig. 4 Relative Fuel and Air Proportions for Various Loads with the Valve of Fig. 3

The first effort to start the motor failed. Heavy white clouds of crude-oil vapor came out of the exhaust, but the mixture did not ignite. The passages C were closed one after another by the insertion of conical rods. When two of these passages were closed the engine started to run, but it soon became apparent that the cross-sections of the air passages as compared with the cross-sections of the fuel passages were still excessive. A third air passage was then closed and the cross-section of the fuel passage enlarged by boring it out. It was only then that the correct ratio of cross-section was obtained, and the motor, even when cold and at a lower speed, began to work reliably and regularly at all injection-air pressures. The original paper shows the card covering the operation of the motor from 25 per cent overload down to no load with the injection air at 60 atmos. pressure.

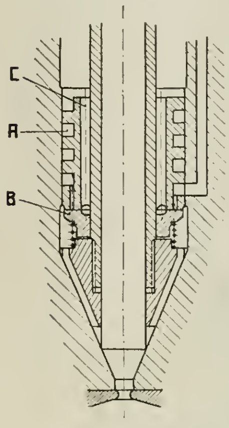


Fig. 5 Valve Used on an Experimental Two-Cylinder Diesel Engine (Same Principle as Fig. 3)

After a number of tests the motor was connected to an electric generator acting as a brake. In these tests it was found that with the full injection-air pressure the load may be varied within wide limits without bringing about failure of injection and prolonged variations in speed. It was found that the difference in pressure in the injection air between prolonged operation at normal load and prolonged operation at no load amounted to only 2 atmos. (65 down to 63 atmos.). It would appear, therefore, that the load may be varied within wide limits without any regulation on the compressor. It would further appear that the valves remain in good condition after fairly prolonged operation of the motor, (*Oel-und Gasmaschine*, vol. 18, no. 1. Jan. 1921, pp. 1–5, 13 figs., *de*)

Palm-Oil Engine Fuel. At a recent meeting of the Association for the Improvement of Colonial Materials, Major Trentals of the Belgian Colonial Army described developments in the use of palm oil and other vegetable oils grown in the Belgian Congo in internal-combustion engines.

The tests were carried out on a stationary two-cycle semi-Diesel engine developing 8 to 10 hp. at 500 r.p.m. The palm oil employed was of medium or low quality, containing considerable amounts of free fatty acids and impurities. The only really special feature on the engine was an arrangement made for keeping the palm oil in a sufficiently liquid condition. For this purpose the cylinder-cooling water was used and together with the hot exhaust gases maintained the oil in the feed tank at a temperature high enough to insure liquidity, and at the same time evaporate any water which might be present. In addition to this a gasoline vapor lamp was placed under the tank.

The feed tank consists of a series of compartments divided from each other by fine-mesh metal screens to filter the oil before admitting it to the injection pump.

The engine starts on gasoline and finishes on gasoline in order to remove any residual palm oil from the feed pipes, which might get clogged by the congelation of the oil when the engine is at rest. [The average melting point of oil is about 37 deg. cent. (99 deg. fahr.) which varies with purity and origin.]

A certain amount of water is injected into the cylinder. The palm oil referred to in this paper is obtained from the fleshy pericarp of the palm fruit and is not the palm-kernel oil contained in the palm nut. Palm-kernel oil does not differ much in heat value from peanut oil. (Paper before the Association pour le Perfectionnement du Matériel Colonial. Abstracted through *Gas and Oil Power*, vol. 16, no. 186, Mar. 3, 1921, pp. 85–86, *e*)

MACHINE PARTS (See Machine Shop)

MACHINE SHOP

Maag System of Gearing and Gear Cutting

The Maag System of Gearing. The Maag system of gearing has been developed by Max Maag, of the Maag Gear Wheel Company, Zurich, Switzerland.

The gear-cutting machine employed is a modification of the Sunderland gear planer made in England. The wheel blank in the Maag machine, however, is mounted on a vertical axis so that the cutting movement of the rack is vertical, which is said to in-

crease rigidity and enable the tool to take heavy cuts. Also, in order to eliminate the effect of the backlash in the screw communicating the rectilinear component of the rolling motion to the work, an arrangement has been introduced consisting of a second and more quickly threaded screw and nut and a friction drive, whereby the cross-slide during the generating movement is maintained in uniform contact with the flanks of the main pitch screw. The actual movement of the slide is therefore effected by the subsidiary screw, while the main screw is relieved of all duties except the regulation of the movements. It is claimed that this makes the motion truly uniform and results in a complete absence of play.

There is also an interesting arrangement for balancing the cutter ram.

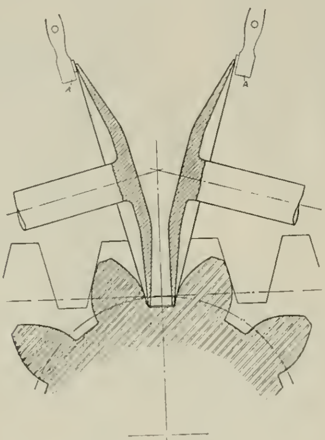


Fig. 6. Diagram Showing the Maag Method of Grinding Gear Wheels

One of the features of the Maag system is that the wheels can be formed of a mild or nickel steel and case-hardened and ground after being cut. The object of grinding the wheels is not only to produce a good surface on the hardened teeth, but to remove the distortion almost inevitably caused by the hardening process.

In the Maag generating grinding machine the grinding is performed (Fig. 6) by means of two saucer wheels set apart and inclined in such a way that the planes of the saucer lips would coincide if superimposed with the flanks of one tooth of the rack cutter used in the preceding process. The gear wheel to be ground is mounted on a longitudinal axis and is fed longitudinally beneath the rotating grinding wheels. As it passes beneath the grinding wheels the gear wheel is reciprocated transversely through a small distance and at the same time is rocked through a corresponding angle, the two movements being correlated so as exactly to reproduce the movement of the gear wheel if it were rolled, without slipping, on its pitch circle. True rack-and-pinion action is thus secured as in the preceding cutting machine, but in this case the work has to be indexed relatively to the grinding wheels once for every tooth gap, as the "rack" has but one "tooth."

The most interesting feature of the machine is the means adopted for compensating the wear of the grinding wheel which would reduce the width of tooth of the imaginary rack cutter, and therefore progressively to increase the width of the teeth being ground. The wear can, however, be compensated by moving the grinding wheels apart, each parallel with itself.

The compensating mechanism consists of an electrically controlled mechanical device. Associated with each grinding wheel is a camshaft driven continuously at about ten revolutions per minute by belt and gearing from the motor driving the grinding-wheel spindle. At each revolution the camshaft causes the lever A, Fig. 6, to oscillate on its pin and to advance, toward the grinding wheel edge, a diamond carried at its lower end. If the movement of the lever is checked by the grinding-wheel edge at the correct point nothing happens. If, however, the wear of the grinding wheel exceeds a certain amount the lever, before its movement is checked, will swing sufficiently far to establish an electrical contact. The current which then flows is relayed to operate a clutch on a continuously driven shaft from which, when the clutch is active motion is transmitted through a pawl and ratchet wheel to a differential thread and thence to an adjusting screw on the grinding spindle bracket. The bracket is thus moved until the plane of the grinding-wheel lip is restored to the correct position. The arrangement it is stated, is sufficiently sensitive to keep the wheels in the correct position to within one-thousandth of a millimeter. In addition, the compensating movement is said to be so trustworthy in action that it can be relied upon to correct the wear of the softest grinding wheel. It thus permits wheels to be used which, although they wear rapidly, are recommended from the point of view of cutting efficiency in preference to wheels of much greater hardness.

Arrangements are also made to secure the correctness of the rolling motion of the work.

An interesting gear-testing machine used by the same company is described. (*The Engineer*, vol. 131, no. 3403, Mar. 18, 1921, pp. 283–285, 5 figs., *d*. Compare *Machinery* (London), vol. 17, no. 437, Feb. 10, 1921, p. 575 *d*)

MARINE ENGINEERING (See Shipbuilding)

MOTOR-CAR ENGINEERING

Steam Car with Engine on Rear Axle

Coats Steam Car. Description of a new steam car being built at Indianapolis, Ind., and involving several apparently novel details.

In particular, the engine is located in the rear axle and the engine axle and differential function all in one, the engine itself in its housing being just about the size of the ordinary rear-axle gear case.

The housing of each half of the axle carries three fixed cylinders set at 120 deg. apart. These cylinders are exactly like those of the internal-combustion automobile engine with poppet valves, pistons and connecting rods. The bore is $2\,^3/_4$ in. and the stroke 3 in. The three connecting rods in each half of the axle are pivoted to a

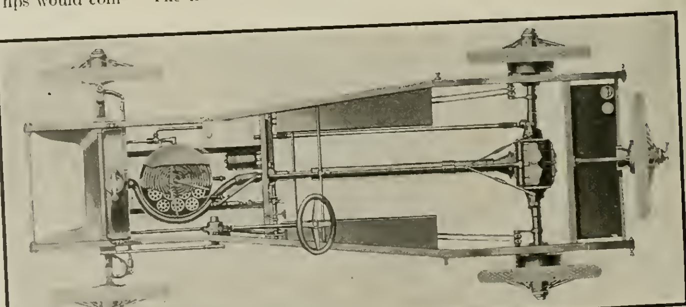


Fig. 7 General Arrangement of Coats Steam Car

crankpin integral with the drive shaft of each wheel. At a speed of 40 m.p.h. the engine is running at about 500 r.p.m.

The exhaust steam is taken by return pipe to the condense located in front of the boiler in the position of the ordinary radiator

The whole engine has therefore six cylinders and the genera arrangement is shown in Fig. 7. The car for five passengers com pletely equipped weighs less than 1800 lb. and has less than 4

moving parts. It has no carburetor or ignition accessories, no clutch, gear shift, flywheel, propeller shaft, universal joints or differential; and uses kerosene as fuel, on which it is claimed to operate very economically.

It is stated that the design was worked out primarily by a Norwegian engineer, but developed to its present state of refinement in America. (*The Accessory and Garage Journal*, vol. 10, no. 11, Mar. 1921, pp. 88–89, 2 figs., *dA*)

MUNITIONS

A New Firearm: The Submachine Gun

Submachine Guns, A. B. Richeson. The submachine gun is a new-comer in the world of firearms. It is really a machine gun reduced to the form and dimensions of a large pistol and is capable of delivering a stream of several hundred shots per minute, firing the 0.45 caliber Army automatic-pistol cartridge.

Three new mechanical principles have been necessary to produce the extreme lightness and simplicity of the new weapon combined with its sturdiness and reliability of functioning. They are the wedge lock, the oiling device, and the new disk magazine feed.

In the breech lock a small wedge weighing a few ounces takes the place of the usual recoil mechanisms. In working with a simple wedge type of breech closure it has been found that the smaller the inclination of the surfaces of the wedge, the smaller the pressure at which adhesion ceases, and, of course, as long as the surfaces adhere they resist any sliding upon each other.

The experiments have further shown that the breech opened when the wedge angle was considerably below the angle of repose, when friction might have been expected to hold the block after the adhesion ceased; and further, with the larger wedge angles considerable pressure in the bore still compressed the wedge between the cartridge case and the wedge housing with considerable force. The explanation of these two phenomena apparently lies in vibrations set up in the mechanism by the rapidly varying bore pressure.

In the rifle mechanism as developed, sufficient pressure remained in the bore when the wedge opened, for the empty cartridge case to be blown to the rear, carrying the bolt (containing the firing pin and firing spring) before it, with sufficient velocity to cock the firing pin when the bolt brought up against the rear buffer, and causing the empty cartridge case to rebound and to be ejected to the front. This movement of the bolt to the rear was against the force of compression of a spring designed to reload the piece.

In investigating the operation of a machine gun viewed essentially as a gas engine, it was found that the friction between the cartridge case and the walls of the firing chamber varied during extraction and at times was excessive due to residual pressure of powder gas within the cartridge case. This variable friction is attributed to different degrees of annealing the cartridge cases during manufacture and to tolerances in diametrical or longitudinal dimensions required in the commercial manufacture of cartridges. The important result, however, is that the ejection of the various empty cases takes place at different pressures and therefore does not occur at regular intervals or with equal ease and rapidity.

To obviate this an oiling device was built in, consisting of felt pads in the breech. Enclosed and protected against dirt, the pads are impregnated with lubricant by an ordinary squirt oil can, and each rearward movement of the bolt lubricates the mechanism afresh. Experiments have shown that it is not necessary to coat a cartridge case with oil to eliminate the friction difficulty in extraction, a very slight smear of lubricant answering the purpose satisfactorily.

The magazine feed is of the disk type, interesting because friction, which has been the great stumbling block in this type of feed, has been largely eliminated by a method of moving cartridges by means of a spiral spring that can be wound with the magazine either loaded or empty. In Fig. 8 the magazine device is, however, not fully illustrated.

The submachine gun is made without shoulder stock or sights, for ordinary rapid fire from the hip, but can be provided with stocks and sights if desired. It fires full-automatically as long as the trigger is held back, but single shots can be fired by quick release of the trigger after each shot. The gun seems to have good ballistic properties. (*Army Ordnance*, vol. 1, no. 3, Nov.-Dec. 1920, pp. 134–136, 2 figs., *dA*)

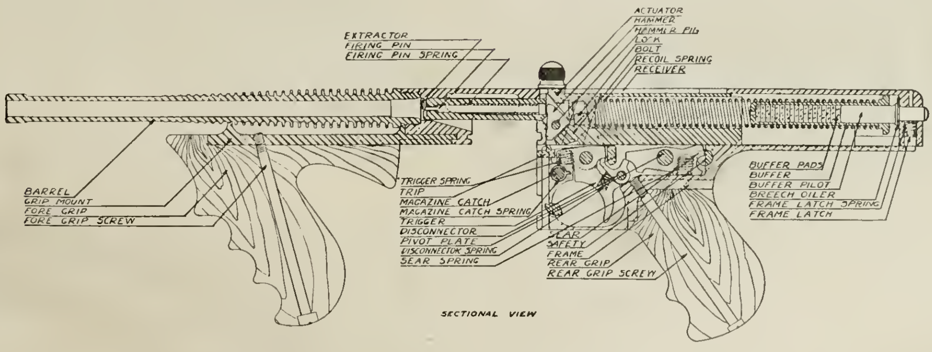


Fig. 8 Sectional View of the Submachine Gun

POWER PLANTS (See also Refrigeration)

Design and Testing of Water-Cooling Towers

Water-Cooling Towers, I. V. Robinson. Description of the types of coolers and methods of testing. The article is the first of two on this subject.

Water-cooling towers are extensively used in Great Britain in connection with the largest central stations where the plant has outgrown the natural supply of circulating water and has to supplement it by artificial means.

Water-cooling apparatus differs considerably in type, but the principle and method of cooling is the same in all types, i.e., bringing into intimate contact with the hot water a large quantity of air at a lower temperature.

The coolers are classified as follows:

1 Chimney type:
  a Natural draft
  b Forced draft
2 Open type
3 Spray type.

In a cooling tower heat is absorbed from the water by the air through two distinct actions: (*a*) Direct heating of the air, and (*b*) evaporation of a portion of the water.

Under the usual working conditions in Great Britain the heat absorbed by evaporation is about 75 per cent of the total heat absorbed, as shown by a brief calculation in the original article.

Natural-draft chimney-type cooling towers are most generally used. The water is admitted at a height varying from 16 ft. to

25 ft. above the sill level and is distributed over the whole area of the tower by main distribution troughs. From these troughs it falls into smaller troughs pitched closer than the larger distribution troughs and is allowed to fall on to the cooling stack by various special methods differing with various makers. Air is admitted usually around the whole perimeter of the tower at the base of the stack, openings about 5 ft. to 6 ft. high being left for this purpose. The various designs differ mainly in the methods used for initially distributing the water over the cooling stack and bringing the water and air into intimate contact.

Some concerns employ cast-iron or porcelain pipes and allow the water to fall into porcelain disks. If the height of fall of the water and the shape of disk are correctly chosen, the water will be broken into a fine spray.

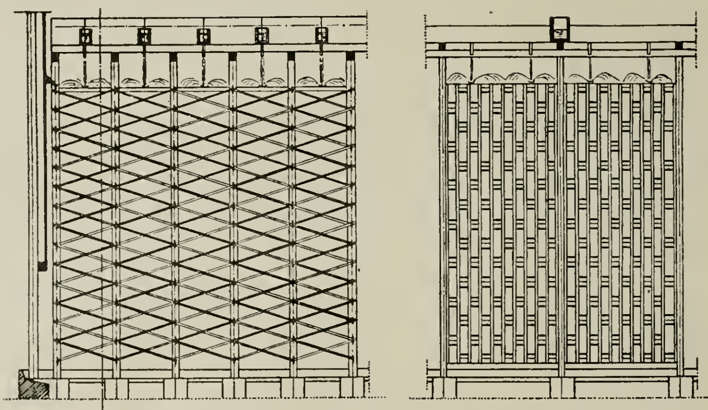
Another method is to use dipper bars let into the side of the main distribution troughs. These bars have concave surface along which the water flows, overflowing then on to the cooling stack. The object in all cases is to divide the water so that it presents a large surface to the air and yet at the same time to allow the air to ascend the tower freely.

It is because of this second condition that the splash system has not found much favor with designers lately.

Fig. 9 shows a section though a cooling stack which depends upon film and not splash. After rebounding from the splasher disks under the small troughs, the water falls on to a number of inclined laths and flows down them. At the lower end of each lath there is a V-notch through which the water passes and then falls on to the upper end of the next inclined lath, and so repeats the process till the bottom is reached. In the stack illustrated the water flows over fourteen inclined laths, seven sloping in one direction and seven in the reverse direction. Each vertical set of laths is comparatively narrow and the sets are so arranged that adjacent laths at any level are inclined in the opposite direction. This alternate arrangement allows a free passage for the air up the stack, the air having to move horizontally only the width of one lath when passing each lath.

Towers are usually built over a tank varying in depth up to 6 ft., and the concrete forming the tank has an important bearing upon the stability of the tower. Many local authorities in England stipulate that a structure such as a natural-draft cooling tower shall be able to withstand a wind pressure of 30 lb. per sq. ft., and do not consider that this condition is met unless the resultant of the horizontal wind pressure and the weight of the tower and the concrete tank to which it is securely attached passes through the middle third of the base. The original article shows how these magnitudes are computed.

The author presents some facts, however, which would indicate that this regulation is excessively stringent, and believes that there would probably be an ample margin of safety if the resultant of the wind pressure and weight of tower and tank passed through the middle half of the base with the tank empty, as the effect of the water which is usually in the tank would be to bring the resultant into the middle third. As regards the testing of cooling towers, it is necessary first to determine clearly the object of the test. Manufacturers usually guarantee that when the tower is dealing with a stated quantity of water per hour at a given temperature, it will reduce the temperature by a definite amount under specified atmospheric conditions; and if the object of the test is merely to ascertain whether or not this guarantee of performance has been maintained, the test is quite simple and very few tests on cooling towers pretend to do more than this. But if it is desired to test the tower completely so as to learn whether any improvement can be made, a much more detailed test becomes necessary, a matter which is briefly discussed in the original article. [*Beama* (A monthly journal devoted to the interests of British electrical and allied engineering), vol. 8, no. 3, Mar. 1921, pp. 227–234, 5 figs., *dp*]



Longitudinal Section. Transverse Section.

Fig. 9 Diagrammatic Arrangement of Cooling Stack of Film-Cooling Type

Design of Spray Ponds

Spray Ponds, Terrell Croft Engineering Co. Discussion of the design and description of several arrangements of spray ponds and nozzles used for recooling condensing water.

Two types of spray nozzles are shown in Figs. 10 and 11. The purpose of these nozzles is to break up the water into a fine mist, and the nozzles are set either vertically or at an angle—usually 60 deg.—with the horizontal.

It has been demonstrated experimentally (Fig. 12) that, first, recooling is more affected by the air temperature and humidity than by the temperature of the water coming from the condensers; second, that with 80 to 90 per cent relative humidity the water temperature can be lowered to within 12 or 13 deg. fahr. of the dry-bulb air temperature; third, that with 20 to 30 per cent relative humidity the water temperature can be lowered about 8 deg. fahr. below the dry-bulb air temperature; and, fourth, that the loss of water is usually about 6 per cent.

TABLE 2– SPRAY-NOZZLE CAPACITIES, GAL. PER MIN.

Pipe size of nozzle, inches	Pressures on nozzles, lb. per sq. in. 6	6	7	9	10	10
2	54	60	65.5	70.5	75	78
2½	77	85	92	98	103	106
3	115	125	133	140	146	151

To compute the temperature reduction which can be effected by a spray-nozzle installation, the following formula can be used:

$$T_2 = T_1 - \frac{(T_1 + T_x + 920)^4 - 16(T^x + 460)}{16\,(K \times 10^8)}$$

wherein all temperatures are in degrees fahrenheit and T_2 = temperature of cooled water after spraying, T_1 = temperature of water before spraying, $T_x = (4T_w + T_d) \div 5$, T_d = dry bulb-thermometer or air temperature, and Tw = wet-bulb-thermometer temperature. K = a constant = 5.1 for average installations operating at 6½ lb. water pressure, but it may vary from 4.4 to 5.7; it varies with the wind velocity and the pressure with which the water is forced through the spray nozzles.

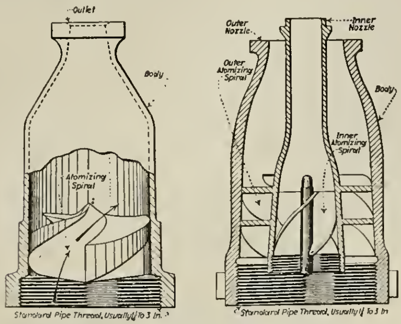
To determine the probable temperature reduction in any locality the average data for this locality have to be consulted. They may be found for a number of places in a table in *Power Plant Engineering*, Apr. 1, 1921, p. 361.

Recooling by spray nozzles may be done in one stage where a cooling of 20 to 30 deg. fahr. is sufficient, or in two stages where a greater range is desired.

The spacing of the nozzles depends mainly upon their design and size. Centrifugal nozzles of 2-in. size are usually spaced about

8 to 10 ft. from center to center, and larger nozzles may be set proportionately further apart.

A typical installation, spraying 4800 gal. per min., consists of nine rows of nozzles with eight nozzles in each row. Thus each nozzle sprays $4800 \div (9 \times 8) = 66^2/_3$ gal. per min. The rows are 20 ft. apart and the nozzles are spread 13 ft. between centers. A 2-in. nozzle (Table 2) at a little over 7 lb. per sq. in. water pressure would meet these requirements.



Figs. 10 and 11 Types of Spray Nozzles

Spray fountains should be surrounded by wind breaks in order to avoid excessive water loss during heavy winds. They may be located on power-house roofs. The power required to operate a spray fountain in connection with the steam-condenser equipment seldom exceeds 1.5 to 2 per cent of the main engine power, and the circulating pump may often be used to deliver the water directly

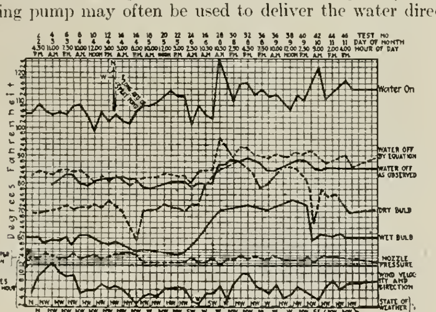


Fig. 12 Data of Spray Nozzle Test (Circulation 5000 Gal. per Min.)

to the nozzles, which cannot, however, be done where barometric condensers are used. (*Power Plant Engineering*, vol. 25, no. 8, Apr. 15, 1921, pp. 408–410, 9 figs., *pd*)

RAILROAD ENGINEERING

Handling 9000 Tons Down a 1.6 Per Cent Grade. Description of methods by which a 70-car train with automatic straight air brakes can be successfully controlled on the Norfolk & Western Railway over comparatively heavy grades.

On the Elkhorn section, one of the worst sections of the Norfolk & Western Railway, as far as grades are concerned, the handling of coal trains has been simplified by electric traction which permits the control of train movements down a 2 per cent grade by regenerative braking. For the rest of the line steam operation still obtains and the problem of train control is an important one, particularly so as the Norfolk & Western uses high-capacity cars, and, in fact, ranks as a pioneer in their introduction. At the present time, for example, the railroad is completing the construction of 500 gondola cars of 100 tons capacity, which is a considerable advance in the development of the high-capacity car. (These cars, are equipped with an entirely new type of six-wheel truck.)

As regards braking, they are equipped with automatic straight air brakes and the test train weighing approximately 9000 tons on a run from Bluefield to Roanoke is described in the present article.

This train was made up to include the Norfolk & Western all-steel dynamometer car equipped to record graphically the brake-cylinder pressure, the train-line pressure and the auxiliary reservoir pressure on the dynamometer car, and also to record the exact amount at which brake-cylinder pressure built up to and dropped below 15 lb. on the first, twenty-seventh, fifty-third and seventieth car back of the dynamometer car.

During the test run the chronograph also recorded various facts such as the drawbar pull of the locomotive, and it may be noted that on the test run the maximum pull of the single Mallet locomotive attached to the head of the train exceeded 120,000 lb. and on several occasions the locomotive developed more than 2500 hp. at speeds between 15 and 20 m.p.h.

The tests are of great interest and cannot be described in detail because of lack of space.

The most interesting of the standing emergency tests was conducted as follows: A 2-lb. reduction was made, then the valve was lapped for 20 sec., after which the brake valve was thrown in emergency position for one minute. In this test the brake cylinder on the first car developed 15 lb. pressure 19.5 sec. after the service application, while the seventieth car developed the same pressure 20.3 sec. later. The maximum brake-cylinder pressure recorded on the dynamometer car with a 20-lb. service reduction was 29.7 lb., whereas with subsequent emergency action a pressure of 56.5 lb. was developed in the brake cylinder. Upon completion of this test the first car released in 9.5 sec. after the brake valve was placed in full release, and the seventieth car released in 122 sec. after the first car released.

The action of the graduated release, which is one of the important characteristics of the operation of the automatic straight air brake, has been carefully tested and successfully demonstrated, and it proved to be possible to handle the train down the steepest grades under perfect control.

On the whole, within eight hours the train effected a gross ton-mileage output somewhat in excess of 900,000 without a hitch, which may be taken as an interesting indication of the state of development of the modern locomotive as well as of the braking equipment. (*Railway Review*, vol. 68, no. 14, Apr. 2, 1921, pp. 515–521, 9 figs., *dcA*)

REFRIGERATION

Columbian Flask Steam Condenser. Description of a condenser said to be extensively used in ice-manufacturing plants. The steam enters at the bottom of the head of the condenser into the first or reboiling compartment formed by baffle plates. It travels then through the entire length of the condenser, ascending into the next compartment, back through the full length of the condenser, again ascending into the next compartment, until it reaches the top compartment at the end of which is provided a small opening for the escape of foul or gassy steam, the two in the center being the main condensing compartments.

The distillate travels back over the baffle plates, descending to the bottom of the condenser in the same manner in which the steam traveled as it ascended over the baffle plates. This distillate reboils on its way back to the bottom of the condenser and is finally carried off through the distilled-water outlet in the bottom of the condenser down into the ice cans below, where it is finally frozen into ice cakes.

The steam entering at the bottom of the condenser is generally from 218 to 220 deg. fahr. with a pressure from 1/2 to 1 lb. The cooling water, which is evenly distributed over the outside of the condenser, is usually from 90 to 100 deg. fahr. The hot steam passing back and forth up through the condenser meets the distilled water and reboils it so thoroughly that by the time the distillate reaches the bottom of the condenser in the reboiling chamber, there is no further need of a separate reboiling, yet the temperature in this lower compartment is at about 212 deg. fahr.

Columbian flask condensers are made mostly by hand. The rivets are finished from the inside in order to leave a smooth surface

on the outside as a protection against the quick collection of alkalis and minerals that are found in the water. They are usually equipped with a 4-in. steam inlet and 2-in. distilled-water outlet, and an additional small outlet in the end of the condenser near the top for the escape of foul steam. (*Refrigeration*, 28, no. 2, Mar. 1921, p. 39, 1 fig., *d*)

SHIPBUILDING

An Entirely Electrically Welded Vessel. Last December at the works of the Electric Welding Company of Gothenburg, Sweden, the first electrically welded ship built in that country (the second on the European continent) was launched. The boat has a flat bottom which extends at both ends right up to the water line. The total length of the vessel is 52 ft. 6 in., breadth 13 ft. $1^1/_2$ in., molded depth 7 ft., and draft 3 ft. 6 in.

The propelling machinery consists of semi-Diesel oil engines intended to drive specially constructed generators for electric welding and air compressors. The boat is to be employed along the seashore for carrying repairs to ships.

Rivets are practically absent and the sides as well as the bottom are smooth and glossy as if cast in one piece. The boat was built under special survey of Lloyd's Register, Bureau Veritas and the Swedish Government Inspection. The engine-room skylight is the only part of the whole ship that is made removable, bolts having been used.

The first entirely welded ship on the Continent was built in 1919 at Caen, France, and is now stationed in the harbor of Le Havre. It was built by a French autogenous welding company and is to be used for the same purposes as the Swedish ship. (*Marine Engineering*, vol. 26, no. 4, Apr. 1921, p. 277, 1 fig., *d*)

SPECIAL PROCESSES (See Engineering Materials)

STEAM ENGINEERING (See also Engineering Materials)

Development of the Stirling Boiler. The original Stirling boiler consisted of a single upper or steam drum and a mud drum, water tubes being expanded into the steam drum and forming drop tubes closed at the lower ends. When the boiler was placed in service, trouble developed through the burning of tubes at the bottom ends.

The first modification was to increase the number of drums by installing two steam drums instead of one. Then a third steam drum and structural-steel supports were added and other improvements made. Some seven or eight years later the water columns were connected to the center drum, in which location a true water level was indicated.

During the last 15 years there have been numerous changes made in the Stirling boiler, either in the effort to meet special and unusual operating conditions, or as a result of improvement in detail of design and construction. The principal improvements in design have been:

1 All steel drums are now placed on the same level, the same being taken from the rear steam drum, this being done largely in an effort to overcome priming troubles arising under certain conditions of feedwater.

2 Protection at the rear steam drum is given by a baffle carried on the front tube of the rear bank which is expanded into the center drum.

3 An arrangement of tubes circumferentially on the mud drum has been provided such as to give a larger superheater chamber, which is important when higher superheats are desirable and which also gives a better access of the superheater headers and handhole caps. The sizes and types ("classes") have also been standardized in a manner to reduce the number manufactured.

A section through one of the new classes is shown in Fig. 13. (*Power*, vol. 53, no. 16, Apr. 19, 1921, pp. 632–634, 7 figs. *dp*)

THERMODYNAMICS

Thermodynamic Cycles of Internal-Combustion Engines

Thermodynamic Cycles in Relation to the Design and Future Development of Internal-Combustion Engines Prof. Wm. J. Walker. A discussion of the various thermodynamic cycles and factors affecting the design of internal-combustion engines. The author claims that the outstanding feature in the thermodynamics of the internal-combustion engine distinguishing it sharply from that associated with steam practice is the necessary inclusion of the variable specific-heat factor in all fundamental, analyses.

He classifies various engine types on the basis of the following three factors:

1 *The method of ignition* employed to initiate combustion. This more or less determines the *combustion efficiency* of the engine.

2 *The method of operation* employed to carry out the thermodynamic cycle of the engine. This more or less determines *the mechanical and volumetric efficiencies* of the engine

3 *The thermodynamic cycle* to which the working fluid is subjected. This more or less determines *the thermal efficiency* of the engine.

Of these three the third is the one discussed in particular detail. Figs. 14 to 16 illustrate the classes into which thermodynamic cycles

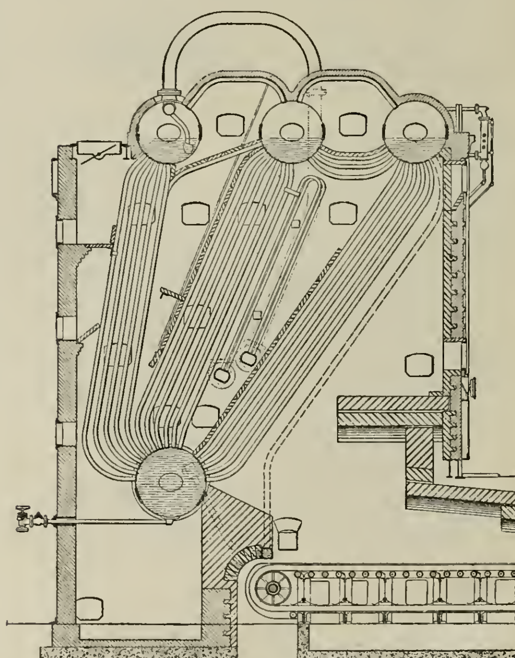


Fig. 13 Section through One of the New Classes of the Stirling Boiler.

may be divided. In Fig. 14 the full-line diagram to the left represents the constant-volume combustion cycle (C.V. Cycle) with compression-volume expansion. This is the standard cycle for most modern engines. With the dotted portion of the diagram included in the full-line left-hand portion, the figure represents the C.V. Cycle with extended expansion. So far as the author is aware, there are no engines in existence operating on this cycle at full load. The entire diagram represents the C.V. Cycle with complete expansion. This is the cycle of the well-known Atkinson engine and also of the Humphrey pump.

Similarly Fig. 15 represents the constant-pressure combustion cycle (C.P. Cycle) with the same three divisions according to expansion. The first division represents the Diesel-engine cycle, the second has no counterpart in past or existing practice, while the third is typified by the Brayton gas-engine cycle.

Fig. 16 represents the class of cycle on which engines, such as the Blackstone oil engine, are operated, and is here called the dual combustion cycle (D.C. Cycle), the heat being imparted some at con-

stant volume and the remainder at constant pressure. This cycle is also divisible as before into three sections according to degree of epansion.

As regards the combustion processes the author defines them in terms of the ratio of the pressure at the end to the pressure at the beginning of constant-volume combustion (α), and the ratio of the volume at the end to the volume at the beginning of constant pressure combustion (ρ). In this connection the author claims that it is incorrect to presume that the efficiency of the constant-pressure

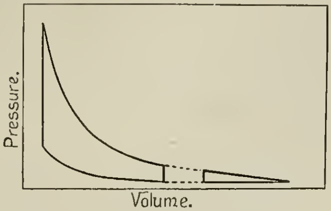


Fig. 14

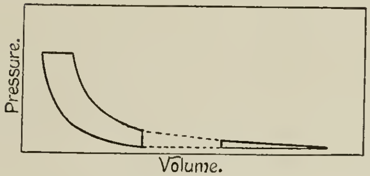


Fig. 15

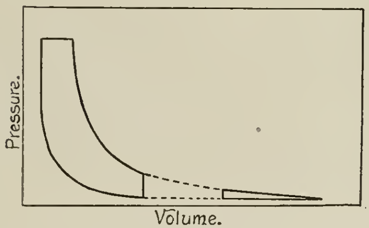


Fig. 16

Fig. 14–16 Diagrams Illustrating Classes into which Thermodynamic Cycles of Internal-Combustion Engines May Be Divided

combustion cycle is theoretically adversely affected by the addition of heat at constant volume, as for instance when a small quantity of oil burned at constant volume is used to facilitate the combustion of heavy tar oils. The discussion of this subject is very interesting, but cannot be abstracted here owing to lack of space.

Referring again to Fig. 16, the author believes such a method of additional fuel injection constitutes really an extension of the fuel combustion cycle and sees in this cycle the possible way of ultimately adopting the Diesel cycle to automobile and aero engines.

As regards the subject of variable specific heat, the author states that the question as to how much of the variability of specific heat is apparent and how much is real does not greatly matter for present purposes, and for all practical purposes it is sufficient to formulate the closely approximate law that the "apparent" specific heat varies directly with temperature. He further comes to the conclusion based on varions recent experiments on air-cooled and water-cooled engines that the brake thermal efficiency actually realized approaches, according to perfection in design, to a theoretical minimum which is identical for all types of engines operating on the same thermodynamic cycle and is independent of engine speed.

The conductivity of the cylinder walls affects brake thermal efficiency, the author admits, but he believes that this diminution in brake thermal efficiency is due wholly to a diminished volumetric efficiency.

The relations between the mean effective pressures, the maximum pressures and the efficiencies of the various cycles are discussed in considerable detail and illustrated by curves. This part is not suitable for abstracting.

As regards the subject of regeneration, a belief is expressed that the raising of steam by means of the waste heat of an engine and utilizing this steam in a high-efficiency steam engine or turbine is the best and most practicable method of increasing overall efficiencies.

Some recent work carried out at the Manchester College of Technology by a research student, R. Koivulehto, in conjunction with the author, on the effect of water injection on the heat distribution in a gas-engine cylinder, has resulted in the determination of actual quantitative values relating to the amount of heat diverted from the jackets to the exhaust per pound of water injected per brake horsepower.

In connection with this, the following regenerative scheme is suggested, experimental figures being adduced in evidence of its value: The proposal is that by running a multi-cylinder engine on a maximum-efficiency dual combustion cycle of compression ratio 8 or 9 : 1, an indicated thermal efficiency of over 40 per cent is possible. By water injection a large proportion of the jacket heat would be diverted to exhaust, resulting, say, in an exhaust discharge of comparatively low temperature and containing 40 per cent of the original heat contained in the fuel. Assuming 20 per cent of this waste heat to be utilized in a high-efficiency turbine of the Rateau type, the total overall efficiency would be raised to the neighborhood of 50 per cent, and this without the introduction of any complicated steam-raising plant. The water injection also would serve to keep down the flame temperatures of the D.C. cycle.

The following figures are typical of the results obtained in the above-mentioned water-injection experiments:

Lb. of water injected per b.hp-hr	0	1.3
Exhaust-gas temperature, deg. fahr.	722	646
Percentage of exhaust heat	27	44
Percentage of jacket heat	34	20
B.hp., per cent	33	30

The paper is followed by a highly interesting discussion which unfortunately cannot be abstracted owing to limited space. (*The Journal of the Institution of Mechanical Engineers*, no. 10, 1920, Feb. 1921, original paper pp. 1235–1258, 12 figs., and discussion pp. 1258–1311, illustrated, *eA*)

VARIA

Adoption of Compulsory Use of the Metric System of Weights and Measures in Japan, Ch.-Ed. Guillaume. A telegram has been received from Shirio Kikkawa, Director of the Bureau of Weights and Measures, in Tokyo, to the effect that the Japanese parliament has passed a law making the use of the metric system of weights and measures compulsory.

In this connection it is recalled that the use of the metric system in Japan has been legal since Jan. 1, 1893, at which time the national Japanese units, shaku and kwan, were respectively fixed as 10/33 of a meter and 15/4 of a kilogram.

In China the use of metric units has been permitted since 1908 and in 1913 a bill was introduced in parliament to make its uses compulsory but has not yet been passed. The same situation exists in Siam. (*Comptes Rendus des Séances de l'Académie des Sciences*, vol. 172, no. 13, Mar. 29, 1921, pp. 795–796, *g*)

WELDING (See Shipbuilding)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research at Michigan

Prof. A. E. White, Director of the Department of Engineering Research at the University of Michigan, has recently presented a paper before the Detroit Section of the S.A.E. on Research—The Bond between the University and Industry. This has been issued as a bulletin by the University.

Professor White explains the plan of work at the University in engineering research. The control of the Department is in the hands of two committees, one known as an Administrative Committee, consisting of the Dean of the Colleges of Engineering and Architecture, the Director of the Department of Engineering Research and the heads of the various departments in Engineering and Architecture; and the second as the Advisory Board and consisting of one hundred men selected from various industrial centers of the state. The Executive Committee of seventeen members of the Advisory Board transacts the largest portion of the work of the Board.

Research Resume of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Aircraft A1-21. Air Propellers. Prof. W. F. Durand and E. P. Lesley completed in January 1921 an investigation covering the technical characteristics of performance of 12 model propellers in "yaw," that is, with the wind stream oblique to the direction of the shaft and especially when such angles of obliquity are large as in the case of helicopter flight with the propeller serving for both sustentation and traction. Each model was tested at obliquities of 90, 85, 80, 70 and 60 deg. and at wind velocities of 30, 45 and 60 ft. per sec. and for 7 to 10 rotative speeds relative to each wind speed. The data were reduced to coefficients C_1 and C_2 defined by the equations—

$$gT = C_1 \Delta N^2 D^4$$

$$gQ = C_2 \Delta N^2 D^5$$

and these are plotted on an axis of V/ND, where T = thrust, Q = torque, Δ = density of air, N = r. p. s., D = diameter, C_1 = thrust coefficient, and C_2 = torque coefficient.

Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Aircraft A2-21. Air Propellers. Prof. W. F. Durand and E. P. Lesley completed in December 1920 an investigation covering the technical characteristics of ten forms of model propellers at a series of air speeds relative to r.p.m. and included in the determination of the thrust and torque coefficients and efficiency. The thrust coefficient C_1 is defined by the equation $gT = C_1 \Delta V^2 D^2$. The torque coefficient C_2 is defined by the equation $gQ = C_2 \Delta V^2 D^3$, where T = thrust, Q = torque, Δ = density of medium, V = speed, and D = diameter.

Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, California.

Apparatus and Instruments A5-21. Calorimeter. (see *Heat A8-21*)

Automotive Vehicles and Equipment A3-21. Combustion Products. Report No. 2225 of the Bureau of Mines on gasoline losses due to incomplete combustion in motor vehicles, by A. C. Fieldner, A. A. Straub and G. W. Jones, is an abstract of a paper read before the S. A. E. in January 1921. The investigation was made for the purpose of caring for the ventilation of the vehicular tunnel under the Hudson River. The report shows the results of tests extending over ten months and compares the results of these tests with previous tests, giving diagrams and charts. Curves giving various important data are also included. The tests on 101 passenger cars and trucks of various capacities give the following results:

1 Automobile exhaust gas consists of carbon dioxide, carbonm onoxide, hydrogen, hydrocarbons, oxygen, nitrogen and water vapor, the relative proportions of which vary greatly depending on carburetor adjustment, degree of atomization, compression and other elements.

2 The important constituent of exhaust gas regarding tunnel ventilation is carbon monoxide. Physiological tests show that the maximum allowable concentration for an exposure of one hour is four parts in 10,000.

3 The carbon monoxide varied from 0.5 to 14.0 per cent in passenger cars and speed trucks on level grades at from 15 to 20 miles per hour, averaging 7 per cent. With 1½ to 5-ton trucks at 10 miles per hour the average was 7.3 per cent. The average percentage of carbon monoxide corresponds to an air-gasoline ratio of 11.8 This is slightly richer than that required for maximum power. Maximum power mixture is 12.5; maximum-thermal-efficiency mixture, 16.0; complete-combustion mixture, 15.4.

4 The larger percentages of carbon monoxide are produced when the throttle is nearly closed or when the car is standing with the engine idling. The largest quantity of carbon monoxide is produced when the gas consumption is greatest, as when car is accelerated or running up grades.

5 Completeness of combustion varies directly as the percentage of carbon dioxide in the exhaust gas and inversely as the percentage of carbon monoxide. For constant carburetor adjustment combustion is more complete when the motor is operating under full load at normal speed. The primary factor in completeness of combustion appears to be carburetor adjustment. The efficiency of combustion varies from 50 to 95 per cent, the average being 70 per cent.

6 The combustible gas in the average automobile exhaust contains 30 per cent of the total heat of the original gasoline. This means a loss of $400,000,000 per year on the consumption of gas in 1919 with gas at 33 cents per gallon.

7 The majority of motor cars and trucks operate on a rich mixture suitable for maximum power but wasteful for gas economy.

8 The average motor-car carburetor is set for winter operation and not changed in summer. This is shown by the highest percentage of carbon monoxide and richer mixtures found in summer tests.

9 The public should realize the saving resulting from the use of lean mixtures. Taxicab and trucking companies could well afford to employ chemists to make regular control tests.

Address Director, Bureau of Mines, Washington, D. C.

Boilers A1-21. Evaporators. A study of measures to reduce the effects of priming in evaporators was the subject of a thesis completed by D. K. Dungan and H. Stewart. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Cement and Other Building Materials A8-21. Tolerance of Coarse Aggregate Under ¼ In. The Experiment Station of Purdue University has made experiments on the properties of Indiana sands and gravels sieved to different gradings of size. During the last two years the results show that 20 to 30 per cent of the coarse sand which passes over with the pebbles may be allowed to remain in the coarse aggregate without detriment. The report is published by the American Concrete Institute February, 1921. Address Dean A. A. Potter, Engineering Experiment Station, Lafayette, Ind.

Fuels, Gas, Tar and Coke A8-21. Continuous Calorimeter. See *Heat A8-21*.

Fuels, Gas, Tar and Coke A9-21. Third Semi-Annual Motor Gasoline Survey. Report No. 2220 of the Bureau of Mines gives the third semi-annual motor-gasoline survey made in January 1921. One hundred and fifteen samples were collected and analyzed from nine cities. The difference between the averages for the nine cities in this survey and the seven cities included in the 1920 survey is very slight. The analysis of the distillation curves shows that the curve is slightly below the Federal Specifications until the 85 per cent point is reached, when it rises slightly above. The average results from the nine cities are as follows:

Specific gravity	0.744
Baumé degrees	58.3
First drop	113 deg. fahr.
20 per cent	197 deg. fahr.
50 per cent	261 deg. fahr.
90 per cent	377 deg. fahr.
End point	431 deg. fahr.
Average boiling point	264 deg. fahr.
Percentage recovered	95.9

Address Bureau of Mines, Washington, D. C. F. G. Cottrell, Director.

Glass and Ceramics A2-21. Ceramic Industry. Report No. 2212 by D'Orsay A. Lyon to the Bureau of Mines outlines the investigation made by the Ceramic Station of the Bureau at Columbus, Ohio. The work of finding bond clays for graphite crucibles and the investigation of foreign and domestic graphites is almost complete. The Station is working on dolomite refractories for furnace linings. The work of the Station is to produce brick which will not disintegrate in storage or when placed in furnace. It is also working on white pottery clays and Ohio fire clays. Address Director, Bureau of Mines, Washington, D. C.

Glass and Ceramics A3-21. Dissolved Gases in Glass. Dissolved gases in glass is the subject of Bulletin No. 118 of the Engineering Experi-

ment Station of the University of Illinois. The investigation was made by Prof. Edward W. Washburn, Frank F. Footitt, and Elmer N. Bunting. The investigation shows that—

1 All varieties of glass in the finished state contain dissolved gases.

2 The amount of this dissolved gas is sufficient to cause the glass to effervesce violently if the pressure upon it be suddenly reduced while it is in a fluid condition.

3 The amount and composition of the dissolved gas vary greatly with the type of glass and the details of the melting and fining procedures.

4 In the three types of industrial glass examined the volume of the dissolved gases (measured under standard conditions) varied from 0.2 to 2 times the volume of the glass itself.

5 Carbon dioxide, oxygen, and nitrogen were found in varying amounts in the gas.

In addition, as a result of this experimental work a convenient apparatus for measuring and analyzing the dissolved gases was developed, and an improved type of vacuum furnace for the manufacture of gas-free glass was constructed.

The paper gives a number of figures showing the apparatus used and the method of procedure. Price 20 cents. Address Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Heat A8-21. Recording Calorimeter. Technical Paper No. 2 of the Fuel Research Board under the Department of Scientific and Industrial Research of Great Britain has been issued. It is a Report on the Simmance Total-Heat Recording Calorimeter by Thomas Gray and Alfred Blackie. It contains a record of the operation of this instrument on town gas during five months with occasional adjustments. During the second period the instrument was supplied with coal gas and water gas in order to check the accuracy of the gravity governor when subject to rapid and extreme changes of density and calorific values. Tables of results and curves illustrating the experiments are also included. Obtained at 10½d. from H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2.

Heat A9-21. Thermometers. The Bureau of Standards requires that partial-immersion thermometers be used for work in which the thermometer is not completely immersed. Few people are willing to make stem corrections for full-immersion thermometers when partially immersed. The advantages of total and partial immersion thermometers are given in the *Journal of Industrial and Engineering Chemistry* for March 1921. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Internal-Combustion Motors A1-21. Combustion Products. See *Automotive Vehicles and Equipment A4-21.*

Machine Design A1-21. Shrink Fits. The Bureau of Standards has investigated the feasibility of making shrink fits on so-called body-bound bolts by contracting the bolts by using liquid air or by expanding the bolt by the use of an explosive within a small hole in the center of the bolt, the bolt having a sliding fit in the hole. The results of the investigation showed that with 1/1000 in. over size for a cylindrical pin contracted by liquid air the withdrawing frictional resistance was equal to 2150 lb. per sq. in., while with an explosive charge the frictional resistance was equal to 2180 lb. per sq. in. Address, S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Machine Design A2-21. Screw Threads. The report of the National Screw Thread Commission has been issued as a Miscellaneous Publication No. 42 of the Bureau of Standards and is obtainable from the Superintendent of Documents at 15 cents per copy. It was abstracted in Mechanical Engineering during June and July 1920.

Petroleum, Asphalt and Wood Products A4-21. Assaying Oil Shales. A convenient and reliable retort for assaying oil shales is the subject of Report No. 2229 of the Bureau of Mines by L. C. Kerrick. Address Director, Bureau of Mines, Washington, D. C.

Properties of Engineering Materials A3-21. Physical Properties. The Bureau of Standards has issued Circular No. 101 which is obtainable from the Superintendent of Documents. It presents in readily accessible form the best available data on the strength and related properties of materials. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Refrigeration A2-21. Properties of Ammonia. The Bureau of Standards has recently completed a set of accurate measurements on the thermal properties of ammonia. The work completed is sufficient for the preparation of a table of properties, and such a table has been issued in mimeographed form. The results do not differ greatly from the tables now in general use. The properties, of superheated ammonia have not been investigated to a sufficient amount for the construction of a table. This will be done. Address S. W. Stratton, Director, Bureau of Standards, Washington, D. C.

Road Materials and Equipment A1-21. Slate Dust in Surface Mixtures. Report No. 2230 by Oliver Bowles describes tests that prove the feasibility of using slate dust as a portion of the mixture used for the surface of asphalt roads. The tests suggest the possibility of this application and indicate that the use of slate flour as a filler would result in improved highways and would utilize the waste from slate quarries. Address Director, Bureau of Mines, Washington, D. C.

Steam Power A1-21. Calorimeter Sampling Tubes. See *Apparatus and Instruments A4-21*, Mechanical Engineering, May, 1921.

Ventilation A2-21. Dust in Air. Report No. 2214 by S. H. Katz to the Bureau of Mines is on the subject of the dust in the air of granite-working plants. To determine the dustiness three methods were used, two of which involved catching the dust particles from a volume of air at high velocity on a sticky-coated glass plate. They were then counted under a microscope. Other samples of dust were obtained by filtering 15 cu. ft. of air through a layer of granulated sugar held in a glass tube. The sugar retains the dust. After this the sugar is dissolved in pure water and a small portion of the water is examined microscopically. The entire sugar solution is then filtered through a pure paper, and after burning off the paper the dust is weighed on a delicate balance. The dustiness of the air is finally expressed in millions of particles per cu. ft. and on a weight basis in milligrams per cu. ft. Address Director, Bureau of Mines, Washington, D. C.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work, and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Air B3-21. Air Flow. The nature of the static pressure changes near the outlet of tubes to check results which show a region of static pressure below the atmosphere, extending back into the tubes and depending on the average velocity of the air; and the static pressure drop along various-shaped tubes, particularly those having an oblong cross-section with circular edges, for various velocities of air, are the subjects of investigation in the Research Department of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. Address C. E. Skinner, Manager.

Electricity, General B1-21. Contact Resistance. Contact resistance of various metals under different pressures. Address Prof. Paul Cloke, University of Arizona, Tucson, Ariz.

Fuels, Gas, Tar and Coke B1-21. Automobile Fuels. A study by Prof. C. A. Norman, Engineering Experiment Station, Ohio State University, Columbus, Ohio.

Heat B14-21. Heat Transmission. The effect of air-cell asbestos as a pipe covering for hot-air pipes. Research Department, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. Address C. E. Skinner, Manager.

Hydraulics B3-21. Steam Flow in Elbows. A study of the frictional drop due to the flow of steam through elbows. Address A. M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Metallurgy and Metallography B7-21. Detection of Copper Sulphide Ores by the Use of Audio Frequency Current and Waves. Address Professor Paul Cloke, University of Arizona, Tucson, Ariz.

Steam Power B1-21. Flow of Steam in Elbows. A study of the frictional drop due to the flow of steam through elbows. Address, A. M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Transmission B1-21. Ropes and Tackle. The Engineering Experiment Station of the State College of Washington is preparing a short bulletin on the Care and Use of Ropes and Tackles. Address Dean H. V. Carpenter, State College of Washington, Pullman, Wash.

Water, Sewage and Sanitation B1-21. Pipe Thawing. A bulletin on electrical pipe-thawing outfits is being prepared by the Engineering Experiment Station of the State College of Washington. Address Dean H. V. Carpenter, Pullman, Wash.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

Chemistry, Inorganic C1-21. Fused Caustic Soda. The action of fused caustic soda on commercial alloys such as cast iron is a problem for which the Mathieson Alkali Works, Inc., at Niagara Falls desires coöperation. Address R. E. Gegenheimer, Chief Chemist.

Metallurgy and Metallography C3-21. Fused Caustic Soda. See *Chemistry, Inorganic, C1-21.*

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

University of Wisconsin D1-21. The Engineering School of the University of Wisconsin has special equipment for testing pipe coverings and complete equipment for air measurement, including a Thomas electric meter with a capacity of from 50 to 200,000 cu. ft. per hour, pitot tubes and thin-plate orifices. The laboratory is equipped for comparative tests of shaft bearings. A 50-hp. Sprague electric dynamometer is arranged for the testing of automobiles. A 15-ton ammonia compressor is available for research work on cold-pipe insulation. The laboratory is equipped with the following apparatus:

A 28-hp. Foos engine for producer gas, city gas, kerosene and gasoline.

A 50-hp. cross-compound poppet-valve, Nordberg engine.

A 25-hp. semi-Diesel oil engine with various small steam engines and internal-combustion engines, including those for automobiles.

Address Prof. A. E. Berggren, Asst. Professor of Steam and Gas Engineering, University of Wisconsin, Madison, Wis.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

American Leather Research Laboratory E1-21. The American Leather Research Laboratory, 180 South St., New York, has been discontinued and the work has been transferred to the College of Engineering and Commerce of the University of Cincinnati. The Tanners' Council of the United States is supporting research work of a fundamental nature and in the environment of a university where men are available who have specialized in colloids and physiological chemistry as well as bacteriology this work can be carried on advantageously. Address Prof. George D. McLaughlin, University of Cincinnati, Cincinnati, Ohio.

Kansas State Agricultural College, E1-21. The Engineering Experiment Station is planning to print three bulletins: namely,

1 Service Tests of Paints and Painting Materials
2 Water Heaters in the Home
3 Work of the Road Materials Laboratory.

The Experiment Station is at work on the following subjects:

1 Heat Transmission of Insulating Materials
2 Endurance Tests of Lubricating Oils
3 Automatic Tests of Ventilators
4 Atmospherical Resistance to Movement of Motor Vehicles
5 Tests of Belt Lacings
6 Temperature Stresses in Rigid Pavement Slabs
7 Wear Tests of Concrete
8 Road-Building Materials of Kansas
9 Concrete in Highway Construction.

In most of these investigations the work is well under way and many data have been obtained.

Address Dean R. A. Seaton, Kansas State Agricultural College, Manhattan, Kan.

North Carolina State College E1-21. The new Laboratory of Mechanical Engineering is about completed and equipment is now being installed. The work is under the supervision of Prof. Wm. J. Dana, West Raleigh, N. C.

Pennsylvania State College E1-21. Engineering Experiment Station. The Experiment Station of Penn. State College has issued thirty bulletins up until May 1920. Of these four deal with cement, concrete and building construction, three with electric substances, five with heating and ventilation, and five with internal-combustion engines and coals. Address Director, Engineering Experiment Station, Penn. State College, Pa.

University of Utah E1-21. Engineering Experiment Station. The Engineering Experiment Station of the University of Utah has published thirteen bulletins up to December 1920 as follows:

1 Test of Utah Brick (out of print)
2 Tests of Macadam Rock
3 The Construction and Maintenance of Earth Roads
4 The Economical Design of Reinforced-Concrete Beams
5 Measurement of Flowing Streams. A Simple, Accurate Method of Using the Weir
6 Leaching a Lime-Zinc Ore with Acids
7 Results of Experiments on Sewer Pipe and Drain Tile
8 Patents Relating to Oil Flotation Processes
9 Report of the Department of Metallurgical Research, State School of Mines, University of Utah, 1914, 1915, 1916
10 Mine Sampling and the Commercial Value of Ores
11 Descriptive Bulletin of the Department of Metallurgical Research, University of Utah
12 The Mineral Industry of Utah
13 Extraction of Potash from Low-Grade Alunite.

Address Director, Engineering Experiment Station, University of Utah, Salt Lake City, Utah.

University of Washington E1-21. Engineering Experiment Station. The Experiment Station at the University of Washington, Pullman, Wash., has issued the following bulletins:

How to Measure Water
Sewage Disposal for the Country Home
Water Supply for the Country Home
Construction and Maintenance of Earth Roads
Fuel Economy in Domestic Heating and Cooking
Cost of Pumping for Irrigation.

Address Dean H. V. Carpenter, Pullman, Wash.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Steam Power F2-21. Steam Flow. Measurement of Steam Flow in Pipes. A bibliography of 10 pages. Search 3297. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Petroleum, Asphalt and Wood Products F3-21. Fuels. History and Properties of Petroleum Fuels. A bibliography of 8 pages. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

CORRESPONDENCE

Contributions to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Engineer Cabinet Member

To the Editor:

It appears that engineering training should be an excellent thing in preparation for public life. An engineer is trained rigorously to avoid error, for a machine that is wrong cannot be made right by bluff, appeals to patriotism, censorship, or propaganda. He usually extends his training to his relations with his fellow-men, and I submit that the average engineer has less trouble with his subordinates than does any other class of men.

But I question Mr. Miller's comment in the April Mechanical Engineering that "Whether or not Mr. Hoover is to be followed by a long line of engineers in high and responsible positions, depends far more upon him and how he shall conduct himself during his term of office than upon anything or anybody else."

The more we examine it the more it appears that Mr. Hoover is an unusual engineer. He is more than a mining engineer or industrial engineer; he is a humanity engineer. He knows not only Americans but Englishmen, Frenchmen, Germans and others. Yet has engineering an old profession, been compelled to wait all these years for Mr. Hoover to blaze the way?

If it is true that we have something that the world needs and has failed to get, the fault is ours. We have not been good salesmen.

Recently an engineer presented an important report to a city council. His report showed careful preparation and he is a man of unquestioned ability. But his attitude was that "Facts, being established, leave no room for opinions, traditions or fallacies." *He* knew they were facts but the council did not. He took little pains to sell the facts to the council.

The human body is a machine, the ultimate achievement of the Great Engineer. It has a pump, with suction and discharge valves, that will run a hundred years without a stop.

The human mind is a wonderful thing, but during the thousands of years of evolution it has been ingrained with mere opinions, fallacies and instincts of various kinds which are harmful today; and due to the facilities afforded by science and particularly by the branch engineering—it does widespread damage when it runs amuck.

All engineers must take hold. No one man can do it all. We must demonstrate that as a group we can be trusted to show a way out of the present state of world affairs.

Joel R. Belknap.

Lansing, Mich.

Concerning Non-Scientific Management

To the Editor:

May I call your attention to the heading of an editorial article in the April number of the Journal? This heading is "A Place for Non-Scientific Management." Personally, it seems to me that the use of such a heading as this in a scientific journal is somewhat bad taste, to say the least. The general impression one would obtain by reading this article is at variance with modern development, and its use in a journal of the standing of Mechanical Engineering does not seem warranted. Doubtless certain of the plant methods suggested are worth while, but if they do fit a particular plant to the best possible advantage, they are scientific and not "non-scientific."

Sanford E. Thompson.

Boston, Mass.

Production Minus Consumption Equals Capital Not Value

To the Editor:

In the Secretary's letter in Section 2 of the March issue of Mechanical Engineering, reference was made to the formula $p - c = v$. I have been accustomed to read and believe that production minus consumption equals capital, not value, and that it is by increment of capital that society is advanced.

The political economy of John Stuart Mill is summed up in the formula: Production minus Consumption gives Capital, and selective limitation of population so that pro rata capital increases is the way of human progress. This seems a prerequisite and a more fundamental law than the "binding time" idea of Mr. Polakov, Mr. Korzybski and Mr. Wolf.

I am anxious to determine whether the practical "conservation of capital" idea as set forth in my paper on Appraisal and Valuation Methods[1] is not the fundamental law we seek to know, and consciously develop and strengthen for social advantage.

"Dogmas," "police forces" and "the man-made law of barristers" are human inventions to hold the gain and to consolidate the advance of the race in conserving capital, and as instrumentalities of progress they should not be disparaged or weakened, unless we wish to risk losing the gain, sliding back and beginning again.

Consider two current topics: (1) A dose of capital in the form of farm tractors, etc., seems to have changed the bandit Villa from something less human into a factor in industrial production; (2) Current reports quote the Bolsheviki leaders as saying that (foreign) capital is the solution of the Russian chaos—they will produce if capitalized.

If Bolsheviki means, as I am informed, those who haven't anything, J. S. Mill's principle of industrial philosophy seems more fundamental than anything enunciated by Mr. Polakov or Mr. Korzybski, for the Bolsheviki are successful at "binding time" but not at conserving capital.

With a full appreciation of the brutalities and hardships of the capitalistic system, I would emphasize "conservation of capital" as the practical instrumentality for industrial and human advancement. Conservation must always take precedence over service in anything that is to continue. This emphasizes, as the essence of the maligned capitalistic system, the idea of abstinence.

Production minus Consumption gives the Abstinence Factor (conservation of service or capital ratio), and where this is high in a nation, society or individual, power increases, and with it, happiness, which is the sensation of increase of power in any form or in any field.

Any "service" or "time binding" which is not geared to conservation of capital does not advance humanity—it may even weaken and destroy it. It is not sound industrial philosophy.

Los Angeles, Cal. David H. Ray.

[1] Mechanical Engineering, December 1919, page 93.

The Theory of Crowned Pulleys

[A letter received not long ago in the office of Mechanical Engineering raised the question as to the theory on which a crown-faced pulley is used instead of a straight-faced pulley with flanges, and why flanged pulleys are not more generally used. The matter was referred to various members of the Machine Shop Practice Division of the Society and the theory agreed upon by them has been submitted in a letter from F. O. Hoagland, chairman of that Division. A letter was also received from George A. Perry, Springfield, Vt., in which the same explanation was offered. Mr. Hoagland's letter follows.—Editor.]

To the Editor:

The pulley with the crowned face is used because of the well-known tendency of flat belts to climb to the largest diameter of a tapering pulley. The theory for this is illustrated in Fig. 1, in which A is a pulley of exaggerated taper, running in the direction of the arrow. The point at which the belt first comes in contact with the pulley is indicated at D. If the belt is to pass around the pulley without climbing, that is, in the direction of lines G and H, then the side E would have to stretch, as the circumference of the pulley at G is greater than at H.

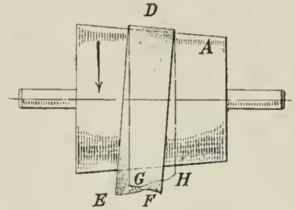


Fig. 1

The stiffness of the belt and its resistance to stretching or bending sideways compel it to follow the direction of lines E and F. If, then, we use a pulley tapering so that the largest diameter is in the center of the path of the belt, it will resist any tendency to deviate in either direction.

As Henry J. Eberhardt expresses it, the highest part of the crown practically acts as a barrier to keep the belt from running off.

It is true, of course, that considerable attention must be given to the amount of crown necessary, according to the various widths of belts and the conditions under which they operate.

Flanged pulleys are frequently used, yet to insure good action on the belt, generous allowances must be made so that the belt will not rub against the flange, and at the same time the flanges should be deep to prevent the belt from riding should it come in contact with the pulley. A low-flanged pulley is absolutely dangerous.

Furthermore, members of the Machine Shop Practice Division all concede that flanged pulleys are much more expensive to manufacture and should be used only where it is impossible to apply crowned pulleys. From experience covering a period of 45 to 50 years, it is recommended that crowned pulleys be used wherever possible.

F. O. Hoagland.

Worcester, Mass.

The Properties of Steam

To the Editor:

The review of Professor Callendar's Properties of Steam abstracted in the April issue of Mechanical Engineering from London *Engineering*, contains two surprising statements, which, if true, place our American steam tables in an unfavorable light. On page 259 occurs the assertion that "the elaborate tables compiled in America on the basis of German experiments and formulas are claimed to fail to satisfy the test which consists in that the work done in a given cycle should be the same whether it be measured on the temperature-entropy chart or on the indicator diagram." Again on page 260, the test—

$$c_p = \frac{dH}{dT}\bigg]_p = \frac{T}{J}\frac{dV}{dT}\bigg]_p \frac{d_p}{d_T}\bigg]\phi$$

is mentioned and the statement is made that all tables based on the German formulas fail to meet this test, the discrepancy being as much as 20 per cent, and that the only tables that do satisfy the test are those based on Callendar's work.

We may assume that the statements in question originated with the author of the review in *Engineering;* for it is inconceivable that Professor Callendar could have shown such ignorance of the recent researches on the properties of steam.

As pointed out in the preface to the Properties of Steam and Ammonia, a steam table should have two qualities, accuracy and thermodynamic consistency. While our older tables may be regarded as fairly accurate, they lack consistency. To such tables the preceding criticisms are quite applicable. If, however, a table is calculated from a thermodynamically consistent formulation, the tests mentioned are automatically satisfied. There are at least two formulations, based on the German experimental data and not all on Callendar's work, that are thoroughly consistent.

It is easily shown that the Goodenough formulation satisfies this test which is asserted to be the exclusive property of Professor Callendar's equations. Using Callendar's notation, the fundamental equation[1] from which the general expression for entropy is derived is—

$$ds = c_p\frac{dT}{T} \quad \frac{1}{J}\left(\frac{dv}{dT}\right)_p dp$$

To obtain the derivative $(dp/dT)\phi$, take ϕ = constant and $d\phi = 0$

Then the equation becomes—

$$c_p\frac{dT}{T} = \frac{1}{J}\left(\frac{dv}{dT}\right)_p dp, \; (\phi = \text{constant})$$

or —

$$c_p = \frac{T}{J}\left(\frac{dv}{dT}\right)_p\left(\frac{dp}{dT}\right)_\phi$$

which is the required expression for c_p in terms of p, v, and T.

The other criticism relates to the quality of areas on the temperature-entropy and pressure-volume planes. The point was forcibly brought out in a criticism of an American steam table in London *Engineering*, June 9, 1916. The heat turned into work in the ideal Rankine cycle is the difference $H_1 - H_2$ between the total heats at the beginning and end of the adiabatic expansion. The work of the cycle is, however, given by the integral $-\int_1^2 vdp$ consequently the first law requires the equality—

$$J\,(H_1 - H_2) = -\int_1^2 vdp$$

If a table is not consistent, the two members of the last equation, as calculated from the tabular values, may show a considerable discrepancy. A table that has this defect may be justly criticized. In the case of any consistent table the two members of the equation are necessarily identical. To show the identity for the Goodenough formulation, take again the adiabatic relation (with $d\phi = 0$)—

$$c_p\frac{dT}{T} = \frac{1}{J}\left(\frac{dv}{dT}\right)_p dp$$

or—

$$c_p dT = \frac{T}{J}\left(\frac{dv}{dT}\right)_p dp$$

The total heat H being a function of T and p, we have—

$$\begin{aligned} dH &= \left(\frac{dH}{dT}\right)_p dT + \left(\frac{dH}{dp}\right)_T dp \\ &= c_p dT + \left(\frac{dH}{dp}\right)_T dp \\ &= \left[\frac{T}{J}\left(\frac{dv}{dT}\right)_p + \left(\frac{dH}{dp}\right)_T\right] dp \end{aligned}$$

The equations[2] for v and H are—

$$v - c = \frac{BT}{p} - (1 + 3ap^{1/2})\frac{m}{T^n}$$

$$H = \alpha + \beta T + \frac{\gamma}{T^2} - \frac{mn\,(n+1)}{JT^n}\,p\,(1 + 2ap^{1/2}) + \frac{cp}{J} + H_0$$

Hence—

$$\left(\frac{dv}{dT}\right)_p = \frac{B}{p} + (1 + 3ap^{1/2}) \quad \frac{mn}{T^{n+1}}$$

$$\frac{T}{J}\left(\frac{dv}{dT}\right)_p = \frac{BT}{Jp} + (1 + 3ap^{1/2})\frac{mn}{JT^n}$$

$$\left(\frac{dH}{dp}\right)_T = -(1 + 3ap^{1/2})\frac{m(n+1)}{JT^n} + \frac{c}{J}$$

$$\frac{T}{J}\left(\frac{dv}{dT}\right)_p + \left(\frac{dH}{dp}\right)_T = \frac{1}{J}\left[\frac{BT}{p} - (1+3ap^{1/2})\frac{m}{T^n} + c\right] = \frac{v}{J}$$

Substituting v/J for the bracket in the preceding equation, the result is—

$$dH = \frac{1}{J}vdp$$

and integrating with J constant,

$$J\,(H^2 - H^1) = -\int_1^2 vdp$$

By a similar procedure it may be shown that Professor Heck's consistent formulation also satisfies these tests.

From the reviewer's statement one naturally receives the impression that the satisfaction of these tests is dependent on the experimental data used. That is, tables based on the German experiments do not meet the requirements, tables based on Callendar's experiments do meet them. Such an inference is entirely erroneous. The satisfaction of these tests is solely a matter of consistency. A table may, however, be consistent and yet grossly inaccurate; such, in fact, was Smith and Warren's table based on Callendar's earlier equations.

In his latest work Professor Callendar has apparently discarded completely the Munich experiments. Whether in so doing he has improved the accuracy of his results is an open question.

G. A. Goodenough.

University of Illinois, Urbana, Ill.

In the method of flying recently proposed by Prof. Raimund Nimfuhr of Vienna, it is intended to imitate the process of flying of an insect, that is, to set up powerful reacting vibrations in the air by a series of very rapid strokes or beats. The underneath section of the wing will take the form of a flexible membrane, which will be set beating or pulsating by the action of pneumatic pumps alternately filling and emptying the air bags in the wing. These pulsations can be made also, according to the theory, to propel a machine forward through the air by the wave-like motion of the atmospheric vibrations they set up. Another essential feature is a flexible extremity at either end of the wing, which, again by pneumatic action, can be made to extend or contract in imitation of the "reefing" of a bird's wing.

Rubber is a peculiar material, contracting when heated and expanding when cooled, and has been largely used for railway buffer and draw springs. An important property that comes into question in some classes of springs is not so much elasticity, as ordinarily understood, but proof resilience, i.e., the energy which a material can store when stretched up to the elastic limit. In that respect rubber far surpasses all other materials, a paper in the February 1921 issue of the *Journal of Industrial and Engineering Chemistry* giving the following values for proof resilience in ft-lb. per cu. in.: Gray cast iron, 0.373; soft steel, 3.07; rail steel, 14.1; tempered spring steel, 95.3; structural nickel steel, 14.7; rolled aluminum, 7.56; phosphor bronze, 4.06; hickory wood, 122.5; vulcanized rubber, 14,600. Thus the spring steel has less than a hundredth of the resilience of rubber.

[1] Properties of Steam and Ammonia, G. A. Goodenough, p. 18.
[2] Properties of Steam and Ammonia, pp. 8 and 10.

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 322 (reopened), 337, and 342 to 346 inclusive, as formulated at the meeting of April 19, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Boiler Code Interpretations

CASE NO. 322 (Reopened)

Inquiry: What material is it necessary to use under the requirements of the Boiler Code for the Y-fitting, also for the safety-valve body, for safety valves to be operated at a pressure of 225 lb.? May cast iron be used for this purpose?

Reply: It is the opinion of the Committee that the Y-fitting referred to may be made of cast iron provided the temperature does not exceed 450 deg. fahr. as stipulated in Par. 12. The safety-valve body need not be of steel unless it is to operate with superheated steam. (See Par. 289)

CASE NO. 337

Inquiry: In applying reinforcing plates within the drums of water-tube boilers to strengthen the shell where the tubes enter, as shown in Fig. 12 (of the Interpretations), what is the requirement of the Boiler Code for the thickness of the plate and the strength of the riveting to compensate for the material removed in forming the tube holes?

Reply: Reinforcing plates shall be riveted to the shell, and the tubes shall be expanded into the inner and outer plates so that the rivets and tubes will hold the plates together in accordance with the rules for stayed surfaces.

The spacing of the rivets with respect to the tubes shall conform to Par. 199 for stayed surfaces using a valve of 135 for *C.* and shall be based on a unit pressure equal to the pressure that can be carried by the inner plate with a factor of safety of 5. (NOTE: Where a reinforcing plate is inside the stem drum it is the inner plate; where it is outside and there is no inner reinforcing plate, the unreinforced shell of the drum is the inner plate.)

The tension in rivets and tubes shall conform to Pars. 220 and 232.

The combined drum shell and reinforcing plate or plates shall have a facter of safety of not less than 5 in ligaments, when calculated in accord with Pars. 192 and 193, also in rivet connections. When reinforcing plates or butt straps are exposed to flame or gas of the equivalent temperature, the joints shall be protected therefrom.

CASE NO. 342

Inquiry: Is it permissible in a heating boiler to be operated at a pressure not to exceed 15 lb. per sq. in., where cross-bracing is required in the side furnace sheet of a locomotive-type boiler between the center line of the cylindrical portion and the crown sheet, to locate a through cross-rod one-half of the staybolt pitch below the center line, as shown in Fig. 15?

Reply: It is the opinion of the Committee that the method of staying described does not conflict with the requirements of the Code when the working pressure does not exceed 15 lb. per sq. in.

CASE NO. 343

Inquiry: What constant will it be necessary to use in the formula in Par. 199 of the Boiler Code, for a surface braced with through stays having inside and outside nuts, but omitting washers?

Reply: It is the opinion of the Committee that where through stays are used with inside and outside nuts, but omitting washers, the constant of 135 should be used in the application of the formula in Par. 199.

CASE NO. 344

Inquiry: In complying with the requirements of Par. 289 for a safety valve used on superheater, is it necessary that the entire casing of the safety valve be made of steel?

Reply: It is the opinion of the Committee that the intent of Par. 289 is that the *body* of a safety valve includes all parts of the body and casing which come in contact with the boiler steam or the steam discharged, and therefore in the construction submitted the casing shall be made of cast steel for use with superheated steam.

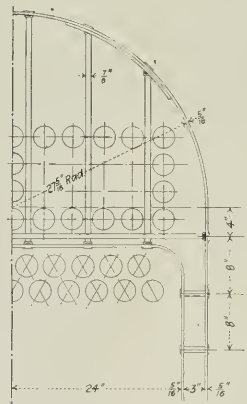


FIG. 15 DETAIL OF SIDE FURNACE SHEET OF LOCOMOTIVE-TYPE BOILER SHOWING STAYING

CASE NO. 345

Inquiry: Is it the intention of Par. 335*b* of the Boiler Code, that hot-water boilers must be built according to the rules for power boilers when either the grate area exceeds 10 sq. ft. or the maximum allowable working pressure exceeds 50 lb. per sq. in., or is it the intention that this requirement applies only when both of the above limits are exceeded?

Reply: It is the opinion of the Committee that the requirement of Par. 335*b* applies only when both of the limits therein specified, are exceeded in the hot-water boiler.

CASE NO. 346

Inquiry: Is it permissible, in the application of the requirements in the A.S.M.E. Boiler Code for safety valves for heating boilers, to take advantage of the proportional difference between bevel-seated and flat-seated valves provided for in the safety-valve rules for power boilers?

Reply: It was the intent of the Committee that Table 9 of the Boiler Code should cover the application of safety valves to all heating boilers, no matter what the character of the seat. Attention however, is called to the fact that where the conditions specified in Table 9 are exceeded, the formula in Paragraph 358 may be used.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

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Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

LESTER GRAY FRENCH

LESTER GRAY FRENCH, editor and manager of MECHANICAL ENGINEERING, and for thirteen years editor of the publications of the Society and latterly assistant secretary, died on April 18 at the French Hospital, New York City, from septic poisoning following an operation.

Mr. French was born in Keene, N. H., in April 1869. He received his technical education at the Massachusetts Institute of Technology, from which he was graduated in 1891 with the degree of S.B. He served the year 1891–92 with the Cranston Printing Press Company as draftsman, and then became connected with the International Correspondence Schools, Scranton, Pa., as instructor in mechanical engineering. Leaving this institution in 1895 he went to Providence, R. I., where he entered the employment of the Builders Iron Foundry as assistant to the superintendent. In 1897 he became editor in chief of *Machinery*, continuing in this position until 1906, when he resigned to take up the publication of technical books, among them being one of the earliest American treatises on the steam turbine, of which he was the author. In 1908 he was made editor of the publications of the Society, serving faithfully and ably to the last in that capacity.

Particulars regarding his activities at Scranton and on *Machinery* are given in the tributes printed below from his associates, Professor Goodenough and Messrs. O'Neill, Rogers and Flanders.

Mr. French was elected a junior of the Society in 1899 and became a member in 1912. He was also a member of the Engineers' Club of New York City, and of the University Club of White Plains, N. Y., where he resided.

Resolutions of appreciation of the work of Mr. French were adopted by the Council of the Society and by the Boiler Code Committee at their April meetings, as follows:

Resolved: That the Council of the American Society of Mechanical Engineers hereby expresses its deep regret and sorrow at the loss by death of Mr. Lester Gray French, esteemed Member of the Society since 1899 and for the past fourteen years Editor of its Journal and other publications, acting also as Assistant Secretary.

With rare ability, good judgment and devotion, Mr. French has contributed in an important way to the growth and development of the Society. Not only our own Members, but the Engineering Profession, owe to him a debt of gratitude.

The Boiler Code Committee learns with great regret that Lester G. French, the assistant secretary and editor of the Society's publications, has passed away after protracted illness.

The publications have been brought to a high standard under his direction, enhancing the work and prestige of the Society. Too much credit cannot be given Mr. French for this major activity of the Society, notwithstanding that it is understood that all work of the Society is directed by Committees. Mr. French, by a rare combination of enterprise, vision, tact and devotion has been personally responsible for much of the Society's progress. Mr. French has been a strong supporter of all standardization movements, particularly the Boiler Code movement, and his loyal coöperation in the work of the Committee has been thoroughly appreciated. Be it therefore

Resolved: That the Boiler Code Committee acknowledge and record their appreciation of the life work of Lester G. French, and be it further

Resolved: That a copy of these resolutions be sent to the family and also the Secretary of our Society.

The following letters of appreciation of the professional work of Mr. French and of his sterling personal qualities have been received from members and other friends well fitted by long acquaintance to bring them into review:

LETTERS OF APPRECIATION

When it was perceived by some of us that the Society ought to develop its Journal into something like its present state and the problem of a suitable man to conduct its editorial work arose, I happened to discuss with Mr. French some features of our problem, not thinking he would be available, for I knew that he had plans for the future that I supposed would be more attractive to him. To my surprise, he was interested, and to my gratification he declared that to give up his plans and undertake the work would be very agreeable to him.

Neither of us, as I remember, mentioned the subject of compensation—his interest in the matter was entirely from the standpoint of the service which he saw the prospect of rendering to the profession in helping to develop such a journal of engineering as we had in mind and which he agreed ought to be published and could be best published by a great engineering society.

Though the Society had not at the time achieved greatness, measured by our present standards, he saw that it could achieve it, and his greatest wish and ambition were to help in that work.

Bringing to the service the experience and knowledge based upon successful and high-class technical editorial work, he, with rare ability, tactfulness and complete absorption and devotion, has built for himself a monument that will endure so long as there are engineers having an appreciative understanding of what such work as he did really means.

By nature, retiring and unobtrusive—conservative, yet not afraid of new ideas, nor of departures from the beaten path when they seemed justified, he was peculiarly fitted for the task he undertook to perform; his one failing being that he could not be prevented from driving himself beyond his strength.

He had the faculty of attaching to himself and holding other capable and devoted workers and has left behind him an organization that can continue the work and develop it to the fullest degree; but a very large share of whatever success "The Journal" may hereafter attain will be due to the splendid foundation he did so much to construct.

As his personal friend, acquainted with him since the time when he was a student at "Tech," and as an officer of the Society, in close touch with his work, I find my pen inadequate to fully express my admiration and regard for him, and I feel sure that so long as the Society can attach to itself such men as Mr. French it will continue to grow in power and influence.

FRED J. MILLER.

The life work of Mr. French was such that every one is anxious to give him credit for the wonderful foundation he laid for the publications of the Society, especially MECHANICAL ENGINEERING.

His special qualifications as an editor included the highest ideals, vision and executive ability, and his permanent contribution to the Society was the realization of an ambition for the Society's publications in coöperation with the Publication Committee, and the building of an organization to carry on the work.

Mr. French's inspiration thus lives on to guide the work of the Society, and all will take great satisfaction in trying to make the publications of the Society attain Mr. French's ambition. CALVIN W. RICE.

It has been my pleasure to have known Mr. Lester Gray French for many years. His clear perception of engineering problems, his art as a writer, and his ability as an editor placed him in the front rank of engineering editors. While it was the professional side that brought us together, it is the fine personal qualities that stand out conspicuously now as I think of the many pleasurable occasions when we were brought together, either by painstaking suggestions for a revision of some of my contributions or in the general conferences connected with our society conventions. It was always a genuine pleasure and inspiration to meet him.

JAMES HARTNESS.

French gave what was best in him to our Society, which he served long and well. He was straightforward and upright and always ready to lend a helping hand. He will be remembered by all of his associates as a true and sincere friend. D. S. JACOBUS.

The services rendered by Mr. Lester G. French to The American Society of Mechanical Engineers have been greatly appreciated by those who have been close enough to know of his work. His first thought was always for the good of the Society. He was most diligent, intelligent, and conscientious. The results of his efforts to maintain the publications of the Society in volume and quality will be of lasting benefit. CHARLES T. MAIN.

As an ideal companion, a staunch friend, a true engineer and a remarkable editor, Lester Gray French will remain long in the hearts and memories of his friends and associates in his future-building work for the Society.
George A. Orrok.

In the passing of Lester G. French The American Society of Mechanical Engineers has lost one of the most faithful and efficient servants and many of us have lost a good friend and a pleasant companion. To those who have been in close contact with the work of the Society at its headquarters it is not necessary to dwell upon the importance of the work performed by Mr. French, but to those whose geographical situations make this contact difficult it may not be amiss to remind them of the extent to which a society of this kind is indebted to faithful workers, such as Mr. French, for the growth and prestige of the organization. Presidents, vice-presidents, and managers come and go, they establish policies and change methods of procedure. But no organization of this kind can grow and prosper that cannot command the services of such men as Mr. French, who by faithful and painstaking labor bring the policies of the management into full effectiveness.

It was my great pleasure during the several years I have served upon the Meetings and Program Committee to work very closely with Mr. French and I came to like and admire him greatly. His patience, enthusiasm and good judgment in the difficult task of procuring and selecting good papers for the Society did much to make service upon this Committee a real pleasure, and all who have had the experience of serving in any way in connection with the publications of the Society will join me in recording my profound regret that his usefulness and sunny influence have been brought to an untimely end. It is not too much to say that the present high standards of the publications of the Society and the success that has attended these publications financially are due in no small measure to his energy and good judgment.

The Society has lost a faithful servant, the world has lost a fine high-minded citizen, and many of us mourn the loss of a good friend, whose place will be difficult to fill.
Dexter S. Kimball.

Lester Gray French

During the summer of 1893 Mr. French was one of a group of four young college graduates occupying a room in the Coal Exchange Building, Scranton, Pa. These men were engaged in writing the original instruction papers for the Correspondence School of Mechanics, as it was then termed. Mr. French wrote several of the papers, his special contribution being the Applied Mechanics. Toward the close of the year he was transferred to another office and put in charge of the clerical force that examined student's work.

The papers written by Mr. French were certainly among the best that have been published by the International Correspondence Schools. They showed on the part of the author excellent grasp of the subject-matter, fine judgment in the selection and arrangement of topics, and power of clear exposition. This early experience in a rather unique field of technical writing was undoubtedly a good preparation for Mr. French's subsequent work as an editor.

The high character of Mr. French's work gained him the respect of his associates; his excellent social qualities gained their warm and lasting friendship. In his relations with his associates Mr. French was uniformly courteous and considerate; he was ever ready with suggestions or offers of assistance. Outside of the office he was the ideal companion for an excursion to the hills or a social evening.

The short summer passed too quickly. The group was broken up never to be reunited. But in the minds of each the memory of the association with Mr. French will ever remain.
G. A. Goodenough.

Lester G. French was editor of *Machinery* from 1897 to 1906, a nine-year period during which the machine-tool industry of this country was laying the solid foundations for the rapid development that was to follow. By education, extended study and practical shop experience, Mr. French was well equipped for the editorship of a technical journal in the metal-working field and rendered valuable service in that capacity. He had a natural talent for explaining mechanical principles and describing shop practice, especially for the practical man at work in the industries, who wants his information and data direct and hasn't the time, even if he has the taste, for fine writing. Mr. French knew his subjects and wrote with clearness and accuracy—valuable attributes in a writer whose work is essentially educational. A man of sound character, an associate it was a pleasure to work with.
M. J. O'Neill.

My acquaintance and association with Lester Gray French began in 1899 on joining the editorial staff of *Machinery*. At that time the trade and technical journals presented a variety of industrial and engineering topics before their readers; hardly one specialized as do so many now. We were then passing through an era of change in the industrial world when the importance of the machine shop was just beginning to be recognized and the upbuilding of our present great machine-tool industry was in the early stages. Although personally more interested in power engineering, Mr. French recognized the desirability of specializing on machine-shop practice, machine-tool design and development, and initiated a policy that has been successfully followed by those who came after him in the management of *Machinery*.

Mr. French was a man who endeared himself to his associates. Modest, unassuming and possessed of unusual ability, he rarely asserted his opinions in contradiction of others, but by the force of example and ability won the respect of those with whom he worked. It was with sincere regret that our business association was dissolved when I took on the burden of editorial management of *Machinery* in 1906.

The development of the A.S.M.E. Journal under his expert management was in large measure due to editorial foresight and wisdom. The Journal, in my opinion, stands preeminent among engineering publications. Variety of engineering interests today makes it difficult to edit a publication that will carry universal appeal to engineers of so many affiliations as represented in the A.S.M.E. membership, but Lester Gray French succeeded to a most notable degree. It is with profound sorrow that I write this brief tribute to his personal qualities and editorial ability.
Fred E. Rogers.

Lester French was a friend to me for seventeen years. First as my chief on the editorial staff of *Machinery*, later as a roommate in a house in the west 80's, and finally in the close coöperation of the work of the Society our lines have been in contact throughout that period.

His was a big heart and a high courage in a small body. Untiring energy and absolute honesty of workmanship were his also. He lived and spent himself for the Society. Its position in the professional world today is due in no small measure to his faithful and intelligent administration of the charge laid upon him.

It would be impossible to express in words what was the real beauty of his character; but those who knew him intimately will love best to remember the health and purity of his sentiments. It is not that he was sentimental; but for children, for home, for family, for friends, for country scenes, for all relations and situations that reach to the roots of our common human nature, he kept an open channel to his heart. To have really known him is to have enriched one's life to its end.
Ralph E. Flanders.

Lester French and I were classmates in college, taking the same course and becoming members of the same college fraternity. Later we were near neighbors and for some time lived together. This close personal relationship gave an opportunity for knowing the true man hidden away under his New England reserve and extreme modesty.

Capable and efficient, a quick and a hard worker in spite of ill health for years, he accomplished much in his profession. At the same time he was always interested in those things that make for the general good of the community. A man of high ideals, fond of music, art and literature, gifted with a keen sense of humor, always optimistic, he was the most interesting of companions and the truest and most loyal of friends. A more thoughtful and unselfish man in his home relations could not be found. It was his delight to anticipate every desire of those dear to him and to make the home circle one of constant happiness.

Proud we are of his life and his courageous end; happy, too, in the memory of all the joy he has brought into our lives and of the example he has given us of a life well lived.
Charles W. Aiken.

No activity of The American Society of Mechanical Engineers so directly reaches the great body of its membership as does its publishing business. Few of the Society's membership know to what a large extent the efficient

conduct of its publications has been due to the faithful and efficient service which Mr. French, as the Society's editor, has so long rendered. Under his leadership the Society's monthly journal has been transformed from a barren reprint of papers read at the meetings to a great, influential technical journal.

Mr. French's task has been no easy one. The editor of a publication carried on by a society has to serve many masters, and the masters change year by year. Under these circumstances, to maintain a continuity of policy and of development—and these are necessary to success—calls for rare patience, tact and wisdom.

We all owe a debt to this quiet, modest man whose use of his talents in the service of his profession has been a large factor in its upbuilding; and whose fine personality won for him a wide circle of friends.

Charles Whiting Baker.

I knew Mr. French from the time he first entered the editorial service of *Machinery*. It was my privilege to have been in close contact with him in editorial work upon which I was engaged. The most impressive fact about Mr. French to me was his invariable honesty—honesty to himself, to his ideals, and honesty in his work. This loss is a personal one to me which I feel keenly. The loss to the mechanical engineering profession is greater than anyone knows, even those who were closest to him.

The publication Mechanical Engineering is L. G. French's monument, a living monument and a wonderful one. I regard the success of this publication as being due to him more than to any other individual.

I hope the members of the Society will think of him with pride whenever they see this journal. G. M. Basford.

The life of Lester G. French was a refutation of the theory that an engineer does not concern himself with the human element. Accessible, cordial, never too busy to give his attention to any demand for coöperation or help, his personality was an important factor in the spirit of hospitality of the Engineers' Building. Forgetting himself, he went through the many months of ill health with the spirit of Stevenson. His contributions to engineering through his many years of devotion to the Journal of The American Society of Mechanical Engineers, where the best of engineering theory and practice is recorded, insure a high place for him in the history of engineering achievement, but his warm-hearted interest in humanity and its advancement mean more than this and mark his achievement as a giver of happiness minutes to the world. Frank B. Gilbreth.

My own experience with Mr. French leaves a very happy impression in my mind. He always seemed to have the interest of the Society at heart and to be high-minded about it. I went into his office many times and always came away with a feeling of having been helped. It will be very difficult to replace him. Ira N. Hollis.

The Society has lost a splendid servant, the engineering profession one of its outstanding spokesmen and all of us a loyal friend. We have experienced a very real loss. Morris L. Cooke.

The Society has lost a very useful and efficient member who had its interests a theart at all times and with whom it was a great pleasure for his associates to work. Frederick A. Scheffler.

All this he was—and more—to those whose privilege it was to be in daily association with him in his work, and who, having shared in his clean enthusiasms and experienced the unfailing kindliness and consideration it was ever his nature to bestow, will hold him in affectionate and enduring memory.

Memorial to Frederick Winslow Taylor

The Taylor Society, formerly the Society to Promote the Science of Management, has recently issued a volume as a memorial to Frederick Winslow Taylor. This volume contains addresses delivered at the funeral of Mr. Taylor on March 24, 1915; at a memorial meeting held under the auspices of the society at the University of Pennsylvania, October 22, 1915; and at Mr. Taylor's home, Philadelphia, October 23, 1915.

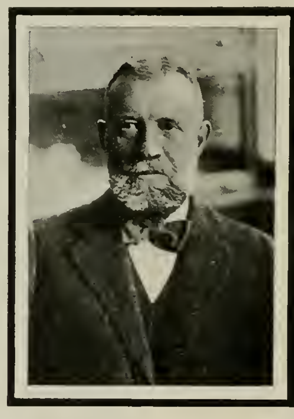
The speakers at the funeral of Mr. Taylor were James M. Dodge and Morris L. Cooke. Those who spoke at the memorial meeting on October 22 were Harlow S. Person, president of the society, Rudolph Blankenburg, mayor of Philadelphia, Carl G. Barth, Henry L. Gantt, Sanford E. Thompson, Louis D. Brandeis, and James M. Dodge. Papers by Charles de Freminville, Paris, Prof. A. Wallichs, of the Royal Polytechnic School of Aix-la-Chapelle, Germany, Henri Le Chatelier, Institute of France, and J. J. Sederholm, University of Helsingfors, Finland, abstracts of which were read at the memorial meeting, are printed in full in this volume.

Copies of the volume have been deposited in the principal public libraries and libraries of engineering societies of the United States and of foreign countries, where they may serve as an inspiration to the thousands who have accepted and are putting into practice his teachings.

GEORGE J. FORAN

George Jesse Foran, manager of the condenser department of the Worthington Pump and Machinery Corporation and the associated companies of the International Steam Pump Company, died Thursday afternoon, May 12, at his home in New York City, after an illness of some weeks.

Mr. Foran was born in Bosten, Mass., Jan. 22, 1862. He was graduated from the Massachusetts Institute of Technology in 1883 and in the fall of that year entered the works of The Deane Steam Pump Company, with which firm he remained until 1886. He then became associated with the George F. Blake Manufacturing Company, where he served as salesman in the engineering field for several years, later acting also as consulting engineer, with special reference to engineering design and construction of water works, condensing and air-compressor installations, and tests and investigations in New England. Upon the completion of the new Blake Works in East Cambridge he became office manager and head of the estimating and cost department, originating the cost



George J. Foran

system then installed. Later he returned to the engineering sales department.

In 1901, after the International Steam Pump Company was formed, Mr. Foran went to New York to accept the position which he filled up to the time of his death. During the war he served upon the committees on condensing apparatus of the U. S. Shipping Board and War Industries Board and as chairman of the American Engineering Service of the Engineering Council, which handled all questions of personnel between the various departments of the U. S. Government and the four national engineering societies.

Mr. Foran was a leader in the development of high-vacuum apparatus from the very beginning, and was responsible for the design of a large number of important installations of this type in the United States. He also accomplished a large amount of original investigation work in the several fields of mechanical engineering.

Mr. Foran was not only a collector of works of art and a connoisseur of considerable attainment, but was also especially well posted on tennis and a valued contributor to various publications, all of which is illustrative of the versatility of the man.

Mr. Foran became a member of The American Society of Mechanical Engineers in 1887 and was active in its committee work, especially as chairman of the Condenser and Heater Sections of the Power Test Code Committee and as a member of the Publication Committee. By virtue of his special knowledge of numismatics he was appointed on the new committee of the Council on Design for the A.S.M.E. Medal. He was also a member of the Verein Deutscher Ingenieure, the American Association for the Advancement of Science, the Engineers' Clubs of New York and Boston, and the Mohawk Golf Club, Schenectady; and an associate member of the American Society of Naval Engineers.

Mr. Foran's wise counsel will be missed at the Society's head-

quarters, where he was a frequent visitor. His interest in the work of the Society was uniformly great, and he was always ready and willing to render assistance to the Secretary's office upon any matter of inquiry. He was particularly close to the committee activities and to the work of the New York Section, and these especially will feel the loss of his friendly interest.

Faithfulness of Committees

The Society has been very proud of the devotion of ist Boiler Code and other Committees, who over a long period of years have turned out such valuable work at much personal sacrifice, but we doubt if there is any record of attendance on a protracted conference quite equal to the following:

The Joint Committee of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association, on Standard Specifications for Concrete and Reinforced Concrete, recently met in the rooms of the Society on a Wednesday at nine o'clock, and continued almost uninterruptedly until midnight. On Thursday they met again at nine o'clock, and with similar persistency remained in session until half-past three on the morning of Friday. They again assembled at nine-thirty on Friday, and continued until ten o'clock Friday night, convening for the fourth day on Saturday morning.

It is not to much to say that such sacrifice for the benefit of the industries and the engineering profession cannot fail to advance not only the progress of the arts and industries, specifically, but the general prosperity of our whole nation.

Calvin W. Rice.

Governor James Hartness Awarded John Scott Medal

In recognition of his development of the flat turret lathe, used in making artillery, James Hartness, governor of Vermont, was awarded the John Scott Medal at a meeting of the American Philosophical Society held on April 23 at Philadelphia.

In 1888 Mr. Hartness became associated with the Jones and Lamson Machine Company of Springfield, Vt., which specialized on turret lathes and was then manufacturing a practically standard lathe in the form of a high turret machine with various features of power feed, lever-operated back gears, etc. Mr. Hartness immediately began the development of the flat turret lathe, embodying the principles now universally used in all turret lathes for doing bar work. The principle feature of the improvements was the provision of adjustable blades and back rests in the same holder, to which the severe strains of cutting were thus confined without permitting deflection and lack of truth, even in turning the most slender variety of work.

The John Scott medal is provided for by the income of a fund bequeathed in 1816 to the City of Philadelphia by John Scott, a chemist of Edinburgh, Scotland. Up to the present year a sum of $20 has been presented with the medal, but the fund has accumulated to so large an amount that by a decree of Court the Board of Directors of City Trusts was authorized to increase the premiums to an amount not exceeding $800. The award to Governor Hartness is one of the first to be made according to the revised provisions.

THE HYDRAUCONE REGAINER, ITS DEVELOPMENT AND APPLICATIONS IN HYDROELECTRIC PLANTS

(Continued from page 380)

seen that the use of the hydraucone regainer on low-head plants is almost a necessity if reasonably good efficiencies are to be obtained. These comparative efficiencies are based on the wheels operating at their best speed and best efficiency, that is, when the discharge from the runner is nearly axial. At any other speed or gate opening the discharge of the water wheel is accompanied by more or less whirling, that is, the absolute velocity of the water leaving the runner is much greater at full load than given in Table 1. Furthermore the whirling action of the water in the discharge is much more effectively used in the hydraucone regainer than it is in the curved draft tube, because of the radially extending passages within which this whirling action produces outward pressure by centrifugal force.

The field of application of the hydraucone regainer will be greater on low-head plants, although it is now being installed in connection with two 40,000-hp. units which are to operate under a head of 421 ft. Hydraucone regainers are in operation or in course of construction in twenty-five hydroelectric power plants, being used with horizontal-shaft as well as vertical-shaft wheels. These hydraucone regainers are to operate under heads varying from 8 ft. to 421 ft. and with water wheels developing from 150 to 40,000 hp.

The most notable installation of the hydraucone is that in Station No. 3 Extension of the Niagara Falls Power Company at Niagara Falls, New York. Unit No. 16 is equipped with a hydraucone regainer of the flat-plate type, as shown in Fig. 17. At the time of the purchase of the water wheel for this unit it was still argued by some that curved draft tubes of proper design would

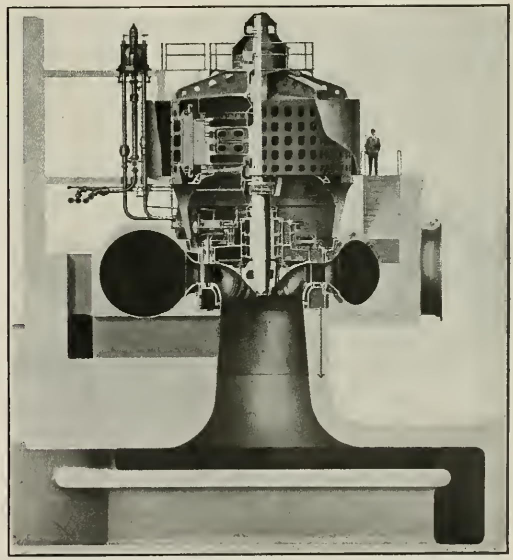


Fig. 17 Hydraucone Regainer of Flat-Plate Type Installed in Station No. 3 Extension of the Niagara Falls Power Company

give as high an efficiency as that claimed for the hydraucone regainer. The engineers of the Power Company accordingly conducted a long series of experiments with various devices, which finally resulted in the development of a conoidal chamber with a cone center similar to that shown in Fig. 1 for units Nos. 16 and 17. The best model with cone center had the proper-shaped conoidal chamber for regain, and when the cone center was removed from the model, it was found that the efficiency was no lower than with the cone in place. The use of the new substitutes for curved draft tubes at this plant resulted in a water-wheel efficiency of 93 per cent being obtained, which is corroborative evidence of the value of the hydraucone principle for the regaining of pressure from velocity

Every one familiar with hydroelectric power-house operation where curved draft tubes are employed has frequently noticed the boiling and disturbance of the water at the outlet from the curved tubes. This disturbance is clearly an evidence of inefficiency and loss of energy which should be more effectively utilized. The hydraucone regainer provides a means for efficiently regaining the energy discharged from the runner for useful effect upon the water wheel within the limited space available in the power-house foundations.

The Essentials of an Engineering Education

Joint Meeting of New York Section of A.I.E.E. and Metropolitan Section of A.S.M.E. Discusses Training of Practical and Theoretical Engineers

THE problem of engineering education has received much attention during these years of reconstruction following the war. That phase of the problem dealing in particular with the theoretical engineer was considered at the evening session devoted to the subject of engineering education by the New York Section of the American Institute of Electrical Engineers and the Metropolitan Section of The American Society of Mechanical Engineers on April 22, 1921.

Dr. Comfort A. Adams acted as chairman and in opening the meeting emphasized the fact that there are two ways of carrying on an engineering educational institution. One is to offer courses which will supply the students with the superficial knowledge of the practical side of the subject, and the other is to provide the scientific foundation upon which engineering is built; to teach him to scrutinize the data upon which he bases the analysis for the solution of any problem, and then to build on that foundation a structure of his own. Unless engineering education is scientific, in its foundation and in its method, it is not education at all.

Walter Rautenstrauch, professor of mechanical engineering at Columbia University, was introduced as the first speaker. He stated the topic of the evening as The Theoretical Engineer—What Is He? Is There a Place for Him? And How Shall He Be Trained? In his treatment of the subject he divided engineering into two general classes, theoretical and practical. The practical engineer he defined as one able to follow a precedent; of the operating type, able to construct something new but within rather limited range. To illustrate what he meant by the theoretical engineer, Professor Rautenstrauch outlined some developments in mechanical engineering and showed how men of genius well grounded in the science of mathematics and physics, such as Unwin, Fairbairn and Rankine, studied the failures in machine parts and developed therefrom the science of the strength of materials and machine design. He also used the work of Rankine, Clausius and Hirn in thermodynamics, and Reuleaux, Unwin, Robinson and MacCord in kinematics as examples of the scientifically trained theoretical engineer. He further explained the capacity of the theoretical engineer as one who not only is informed on scientific facts and laws but also is able to recognize their embodiment or absence in any engineering project. In the ability to do this Professor Rautenstrauch drew a fine distinction between the purely scientific or academic type of mind and the engineering type of mind. The academic type is illustrated by the student who is able to solve a complete mathematical problem when all the facts are clearly set before him. It requires an entirely different type of mind, however, to take a particular problem, to determine the scientific principles applying, to set forth the facts clearly and to arrive at a conclusion through the capacity to recognize just what the problem is. This type of mind is the engineering type of mind.

Professor Rautenstrauch was positive that there is a place for the theoretical engineer, especially as we are now entering upon an era of refinement when the rough constructive work formerly performed is no longer found satisfactory. The speaker felt that the young engineer should be encouraged to enter industries which have not been touched at all by the scientific engineer, such as cotton and rubber mills, where the engineer is generally the master mechanic. In the training of the theoretical engineer he emphasized the importance of teaching the complete theory, not a partial theory, and of imparting the theory of engineering which bases engineering not only on the sciences of mathematics, physics and chemistry, but also upon economics.

Unless a machine can be built cheaply enough to meet the demands, it should never be built; and there is absolutely no use in designing a machine if its cost of production or operation exceeds what can properly be paid.

The effect of a proper amalgamation of the purely scientific and technological aspects of engineering with the economic and commercial principles upon which successful practice is founded, is to create in the student that sense of proportion and judgment which tends to economize his efforts in contributing to scientific progress and invention.

Professor Rautenstrauch also stated that there is no question in the minds of thoughtful men that the most important thing in an engineering education, or in a college education in general, is the inspirational value of the instructor. Unless the student is guided to a desire for service; unless he is inspired with his work so that he loves it and wishes to use his talents for the service of his fellowman, that student fails to be educated.

F. L. Bishop, dean of the school of engineering at the University of Pittsburgh, in his opening remarks endorsed Professor Rautenstrauch's words urging the young engineer to enter new industries. He divided engineers into two classes, the general engineer and the theoretical engineer. The general engineer is the man who has a broad general knowledge of engineering subjects, and can apply that knowledge in an effective way to present engineering problems. The theoretical engineer is a man highly trained in the fundamentals of science and mathematics who can apply research results to engineering. Dean Bishop likened the theoretical engineer to the pioneers who link up the discoveries of the explorer with the known world. He takes the new discoveries of pure science, examines them, determines their application to a given industry, and indicates the manner in which they may be effectively applied. The general engineer then carries on the manufacturing of this material according to the laws laid down.

In the training of the theoretical engineer Dean Bishop said that the theoretical engineer should have a knowledge of the industries and how scientific discoveries as such are applied which can be obtained only by actual experience in industry, and which should be obtained at as early an age as possible. A portion of this knowledge of industry can best be obtained in some form of the so-called coöperative system of engineering education, the object of which is to give the student a background upon which he can base his theoretical courses and to provide him with a very necessary inspiration. It makes the college courses real; he appreciates their value.

Criticism that the engineering schools have weakened their theoretical and laboratory courses in order to introduce more practical work is appearing with greater frequency. The faculties of engineering schools receive many recommendations from practicing engineers who believe that the curriculum should be made stronger in their particular fields.

However, teaching is in itself possibly the greatest of all professions, and the members of a faculty understand quite clearly just what the boy from high school can absorb. The practicing engineer seldom has any conception of these limitations.

Dean Bishop then proceeded to discuss the report of the Joint Committee on Engineering Education presented by Dr. Mann and the study by Professor Walters on scholarship and eminence in engineering, reaching the conclusion that taken together the two furnish an instance of positive correlation between intellect and character. In other words, those men who rank high in the knowledge of fundamentals also rank high in character, judgment and efficiency. Thus the scholastic standing of the engineering graduate is a measure of his character, his judgment, and his efficiency.

In closing, Dean Bishop stated that there is such a person as a theoretical engineer, and that his place is between the pure scientist and the general engineer. He can be trained, but there will not be any large number of men so trained because the pay of such men at present is entirely inadequate and the engineering schools of the country are not sufficiently well manned or equipped. There is, Dean Bishop affirmed, no first-class engineering school to be found in America.

In support of the last and rather startling statement made by Dean Bishop the chairman said that he would guarantee to take the graduates in electrical engineering from any institution in this

country and prove in a five-minute oral examination of each one, in 98 or 99 per cent of the cases, that the men do not understand in any thorough fashion the fundamentals of the subject; that in most cases they do not even know the meaning of the words they use; that they are carried through analyses of comparatively complicated problems, but in a machine-like superficial way, neglecting most of the variables, so that they get into the habit of a kind of loose thinking which so affects all their work that they cannot be counted on for any sound results.

C. R. Dooley, of the personnel and training department of the Standard Oil Company of New Jersey, told of the need in that company of the intensely trained research man and his importance to engineering development. In the training of engineers he stressed one point as most important, and that is that the process of education should be one that would help the man along the line in which his tendencies lie.

In the discussion following the presentations of the evening, H. B. Shaw, of the Henry L. Doherty Company, spoke about the work that his company does in the selection of technical graduates. Mr. Shaw quoted some of that company's specifications for technical graduates: "The graduates should be men who have been trained to think for themselves, have conservative judgment but are not bound by precedent; who can be trusted to try out new and untried methods; men who think straight and think through to conclusions; men who having will for action, act promptly, effectively and justly; men who quickly familiarize themselve swith a situation, all its vital factors, and then form sound judgments which they have the ability to express so as to convince and stimulate others." In closing he stated as his belief that engineers should be trained thoroughly in fundamentals, and should gain an understanding of the larger problems of life, even if they later specialize theoretically.

Capt. O. S. Beyer, consulting engineer, New York City, emphasized the need of the engineers' having a more complete understanding of the economic principles governing their work.

Dr. Harlow S. Person, managing director of the Taylor Society, made three points: First, engineering means something bigger than it meant when the term was first used. It embraces the discovery of new principles and laws, the application of these practically, development work, management work and large administration work. Engineering education is responsible for training men for these functions.

Second, engineering curricula do not contain enough subjects in management, administration and business in general.

Third, training must be fundamental, making the student familiar with fundamental principles common to the various fields of engineering, including management engineering and human engineering.

Mr. Farley Osgood, chairman of the New York Section of the A.I.E.E., emphasized the need of training the student to think for himself. The problem of an engineering education, he stated, resolves itself into straight thinking.

Prof. W. I. Slichter bespoke a broad training for the engineer in the cultural subjects, such as history, economics, etc. He desired to see engineers taking a larger part in the entire activities of the human race.

News of the Federated American Engineering Societies

Participation in Government Reorganization

THE American Engineering Council has recently made several important decisions in regard to its relation to the reorganization of Government departments. Acting upon the recommendation of its Committee on Public Affairs, it will not concern itself with the general reorganization activities of the Government but will confine itself to promoting a nation-wide movement for the establishment of a National Department of Public Works. It is felt that the membership of the Federation can be of greatest service to the nation by confining their efforts to public matters closely related to the engineering profession.

The organization and equipment of the National Public Works Department Association has been taken over by the American Engineering Council and state organizations will assist in the program. At a meeting of the Council to be held in St. Louis on June 3 a detailed plan for renewing the public works campaign in every state will be considered.

Many leading industries, universities and technical organizations are represented in the national organization. Among the educators are Dean George B. Pegram of Columbia; Professors George F. Swain of Harvard, W. B. Gregory of Tulane, T. U. Taylor, University of Texas, J. W. Votey, University of Vermont, W. H. Kenerson of Brown, and C. E. Condra, University of Nebraska, and Dean John H. Dorroh, University of Mississippi.

At a hearing before the Senate Committee on Education and Labor early in May, Mr. Wallace, speaking in behalf of the F.A.E. S. and of the National Public Works Department Association, proposed joint consideration with the public works plan and suggested that modifications be made in the bill for the establishment of a Department of Public Welfare.

Mr. Wallace stated that the Federation does not take a definite stand either for or against the establishment of a Department of Public Welfare, but does urge the vital necessity of a proper distribution of bureaus if Government reorganization is to be effected. The Federation advocates that all the major engineering, construction and research work of the Federal Government be centered in a Department of Public Works, to supersede the Department of the Interior. Other bureaus now in the Department of the Interior must therefore be placed in other departments. Inasmuch as the provisions of the bill for the Department of Public Welfare which is under consideration by the Senate Committee provides for a number of such bureaus and activities, the Federation believes that the bill should be so modified as properly to assign those bureaus that would not be included in the proposed Department of Public Welfare.

Among the bureaus which the McCormick bill, which provides a Department of Public Welfare and a Department of Public Works, would place under the jurisdiction of the latter department, are the General Land Office, the Geological Survey, the Bureau of Mines, the Reclamation Service, the National Park Service, the Division of Capitol Buildings and Grounds, and the Alaskan Engineering Commission.

Licensing of Engineers Exciting Widespread Interest

Interest in the subject of licensing or registering of architects, engineers and land surveyors has become widespread and persistent. Eleven states have passed laws, some providing for licensing of all three professions, some for only one or two of them. These are Colorado, Florida, Idaho, Illinois, Iowa, Louisiana, Michigan, New York, Oregon, Virginia and Wyoming.

In New York the law passed May 14, 1920, has been amended by recent legislation to make it more workable. When these amendments were being considered at a hearing before the State Board for Licensing Professional Engineers, the Department of Education and the Senate Judiciary Committee in February, it was proposed by a group of engineers to further amend the law by eliminating the clause exempting corporations and partnerships from the necessity of being licensed. It was argued that lawyers and doctors cannot incorporate to practice their professions and that engineers ought to be on the same basis. The elimination of the clause was strongly opposed by a second group of engineers and the bill as finally signed by the Governor on May 6 retains it.

The clause in the New York State law is in effect Section 14 of the Recommended Uniform Law for Registration of Architects, Engineers and Land Surveyors, drawn up in 1919 by a committee of Engineering Council. This clause states that "a corporation or partnership may engage in the practice of architecture, engineering, or land surveying provided the person or persons connected with such corporation or partnership in responsible charge of such practice is or are registered as herein required of architects, engineers and land surveyors, or is or are otherwise authorized to practice."

The New York State Engineers' License Bill (now Chapter 581, laws of 1921) took effect upon the date the Governor affixed his signature. All engineers practicing in the State must be registered before May 1922, no matter what branch of engineering they are following.

A printers' strike in Albany has held up the distribution of copies of the bill and of application blanks. Persons who desire blanks should, however, write immediately to the Bureau of Education, Albany, N. Y., and request that their names be placed on file. They will then receive applications blanks as soon as they are available.

At a meeting of the Executive Board of the American Engineering Council on April 16 a representative of those who object to exempting corporations from the necessity of being licensed asked to have this "Model Bill" of Engineering Council referred to a special committee for revision with respect to reconsideration of the rights of engineers to practice their profession through partnerships and corporations. The Executive Board decided to do this, but considered the Licensing Committee which drew up the "Model Bill" a more appropriate body than a new special committee to take under consideration both sides of this important question.

Formation of the Personnel Research Federation

The formation of the Personnel Research Federation under the auspices of the National Research Council and Engineering Foundation links together 250 scientific, engineering, labor, management and educational bodies for the purpose of bringing about interchange of research information about men and women in industry and commerce, encouraging research through individuals and organizations, and coördinating research activities on a nation-wide scale. It aims to increase the efficiency of all the personnel elements of industry—employer, manager, worker—and to improve safety, health, comfort and relationships. Its immediate purposes will be to learn what organizations are studying one or more problems relating to personnel and the scope of their endeavors, and to determine whether these endeavors can be harmonized, duplication minimized, neglected phases of the problems considered, and advanced work undertaken.

Robert M. Yerkes, representing the National Research Council, has been elected chairman of the Federation, and Samuel Gompers, representing the American Federation of Labor, vice-chairman. Robert W. Bruere, who represents the Bureau of Industrial Research, was chosen treasurer, and Alfred D. Flinn, representing Engineering Foundation, secretary. Beardsley Ruml, assistant to the president of the Carnegie Corporation of New York, was selected as acting director.

Dr. James R. Angell, president of Yale University and past-chairman of the National Research Council, in an address delivered before the preliminary conference at Washington in November 1920, summarized in the following words the kinds of problems which should receive attention from the organization then proposed:

> Certain of the hygienic problems of modern industry exemplify cases in which a thoroughly scientific study of causes and effects is possible with convincing conclusions regarding practice which will safeguard the health and vigor of all concerned. Not a few highly important results have already been attained in this field. The effects upon industrial productivity on the one hand, and physical vitality on the other, of good and bad ventilation, of good and bad light, of high temperatures, of irritant fumes, of dust and other similar features are, theoretically, at least, within the field of scientific analysis and the ascertainment of demonstrable fact. Similarly, and in a different zone of inquiry, it should be possible to secure thoroughly reliable data regarding the dominant causes of unrest in our industries, of excessive turnover and the like. Many other instances of the same kind will suggest themselves to all who have experience in the industrial field.

U. S. Patent Office Relief Imperative

In an address before the Washington Section of the A.S.M.E. on April 28, Hon. Thomas E. Robertson, U. S. Commissioner of Patents, gave statistics showing the serious situation existing in the Patent Office because of the low salary scale which is causing an exodus of both patent examiners and clerical force to private employment. In a little over a year, it was stated, 110 of the force of examiners numbering 437 have resigned. During the first three weeks of March six highly trained experts resigned to accept outside positions offering salaries two or three times as great as those they were receiving in the Patent Office. In the past year, according to Commissioner Robertson's figures, 142 of the 560 clerical workers have left the service. There are thirty clerks in the Patent Office who receive only $720 a year; under the new salary bill they would receive $1100.

The immense amount of work turned out yearly by the Patent Office was also shown by the Commissioner's statistics. The stock of the Office is about 75,000,000 copies of some 1,500,000 patents, and new patents at the rate of from 600 to 1000 a week add 50,000 more copies to be taken care of each week. There is a stenographic department handling legal work that turned out 13,000,000 words in the past year and brought $62,000 revenue.

Major Amasa M. Holcombe, formerly chief of Patent Section, General Staff, U.S.A., speaking at the same meeting, said that patents play an increasingly important part in proportion to the degree of specialization in industry. He stated that abuse of the patent laws is partly due to the failure of business men and engineers to appreciate and utilize patents. Both speakers urged that engineers aid the present patent legislation.

Mr. E. J. Prindle, chairman of the Patents Committee of the American Engineering Council, in a recent statement said that it was the unqualified opinion of the important engineering, research and manufacturing associations of the United States that the scientific and industrial interests of the country are being jeopardized by Patent Office conditions. The National Research Council, the American Chemical Society, and the National Association of Manufacturers were cited by him as among the organizations favoring Patent Office relief. "The European countries, taught by the war," he said, "are already strengthening their patent systems. America must not lag."

In connection with American patents in Europe, American Engineering Council announces the organization of a Foreign Relations Committee with L. B. Stillwell of New York as chairman. Discrimination against American patents in Europe ceased with the passage of the Nolan Treaty Patent Bill on March 3, and American inventors are therefore no longer at a disadvantage in foreign countries because of the lack of proper legislation.

American Engineering Council urges again that the engineers of the country support the pending patent legislation to increase salaries in the United States Patent Office.

Fred M. Feiker, vice-president and chairman of the editorial board of the McGraw-Hill Company, who has been active in the formation of the F.A.E.S. and of great assistance in the development of the plan for the elimination of waste in industry, has been appointed personal assistant to Secretary Hoover in the task of organizing and developing those branches of the Department of Commerce which relate directly to commerce and industry.

Alcohol as Automobile Fuel

It is stated in a recent issue of *Commerce Reports* that pure alcohol of from 41 to 42 degrees has been found to answer the requirements of automobile motors satisfactorily, with but a slight alteration in the carburetor and the substitution of metal floaters for the varnished cork floaters which are attacked by the alcohol. The amount of alcohol consumed is said to be practically the same as the amount of gasoline which would be consumed for the same work. A distinct advantage in the use of alcohol is that its combustion is much more complete, and therefore very little carbonized matter is deposited in the combustion chamber or ejected through the exhaust.

A Correction

In the May issue of Mechanical Engineering, page 351, reference was made to a paper on Developments in Organizing Personal Relationships in Industry presented at the March 25th meeting of the New York Section of the A.I.E.E. and the Metropolitan Section of the A.S.M.E. by Mr. L. P. Alford, editor of *Management Engineering*. Mr. E. W. Tree, associate editor of *Management Engineering*, whose name was inadvertently omitted, was co-author with Mr. Alford.

The A.E.S.C. Issues First Annual Report

IN THE form of an attractively printed pamphlet the American Engineering Standards Committee has just issued its first Annual Report outlining the Committee's progress during 1920.

Although the A.E.S.C. has been actively at work for only slightly more than a year, and much of the time and effort of the Committee has necessarily been spent in laying a basis for work the fruition of which will require at least two or three years, yet considerable progress has already been made in the unification of the more important standards and in overcoming the confusion that was being produced by the numerous organizations (more than 100) that hitherto published engineering standards without systematic coöperation among themselves.

Prior to December 31, 1920, there had been approved by the Committee "Tentative American Standard Specifications and Tests for Portland Cement," "Tentative American Standard Specifications for Fire Tests of Materials and Construction," and "American Standard Pipe Threads." Moreover, there had been submitted for approval by the Committee the "National Electrical Code" as an American Standard, and "Standard Test for Toughness of Rock," "Standard Method of Distillation of Bituminous Materials for Road Treatment," and "Standard Method of Sampling Coal," as Tentative American Standards, with the "Safety Code for Head and Eye Protection" submitted for approval as Recommended American Practice.

The Committee itself is now composed of 47 members representing 17 bodies or groups of bodies, including six national engineering societies, five governmental departments and 13 national industrial associations. As is generally known, its function is merely to see that each body or group interested in a standard shall have opportunity to participate in its formulation, which is in the hands of a working committee, technically called a "Sectional Committee." Each Sectional Committee is organized by, and under the leadership of, one or more of the principal bodies interested, such bodies being known as "Sponsors." Sponsorships have been arranged for the following projects under way by the beginning of this year:

Electrical Projects: Rating of Electrical Machinery; Term Markings for Electrical Apparatus

Mechanical Projects: Ball Bearings; Plain Limit Gages; Gears; Machine-Tool Elements; Nut and Bolt Heads; Pipe Flanges and Fittings; Screw Threads; Shafting

General Projects: Passenger and Freight Elevators; Color Scheme for Piping Installations; Steel Shapes; Zinc Ores and Zinc

Safety Codes: Aviation Safety Code; Construction Work; Electrical Fire Code; Electrical Safety Code; Floor Openings; Railings and Toe Boards; Foundries; Gas Safety Code; Grinding Wheels; Head and Eye Protection; Ladder Code; Lighting Code; Lightning Protection; Logging Operations and Sawmill Machinery; Machine Tools; Mechanical Transmission of Power; Paper and Pulp Mills; Electrical Power Control; Power Presses; Mechanical Refrigeration; Industrial Sanitation; Stairways, Fire Escapes and Other Exits; Textiles; Ventilation; and Woodworking Machinery.

As will be seen from the above lists, much of the Committee's attention is given to safety codes. Active work is now in progress on 24 such codes with hearty coöperation among the state commissions, associations of insurance companies, national engineering societies, manufacturers' and industrial associations, labor and civic organizations, and technical bureaus of the Federal Government. As is true of all work under the auspices of the American Engineering Standards Committee, such of the bodies as are interested in a particular code are represented in the committees responsible for the formulation of that code.

Copies of the report may be obtained on request to the American Engineering Standards Committee, 29 West 39th St., New York.

Japan Adopts the Metric System

In Comptes Rendus des Séances de l'Académie des Sciences for March 29, 1921, pages 795–796, reference is made to a telegram from Shirio Kikkawa, director of the Bureau of Weights and Measures of Tokyo, stating that in a recent session of the Japanese Parliament a law was passed making the use of the metric system obligatory in Japan. Since 1893 the metric system has been in "legal use" in Japan, but in practice its adoption has been greatly retarded by the prevalence of the local systems. The 1893 law giving the legal sanction to the metric system contained a series of suggestions and recommendations for the gradual substitution of the local units for the metric units. The new law makes the metric system compulsory in the Japanese Empire.

As regards other countries of the Far East, a provisional project for the obligatory adoption of the metric system was introduced in the Chinese Parliament in 1913 with a provision that the system would become officially the only system of measures in China within ten years, and similar projects have been enacted in Siam.

A.S.M.E. Presents Resolution of Thanks to Henry Hess

At a meeting of the Philadelphia Local Section held at the Philadelphia Engineers' Club on April 26, Henry Hess was presented with an engrossed copy of the following resolution of appreciation of the services rendered by him in the cause of standardization:

> The President and Council of The American Society of Mechanical Engineers by resolution gratefully acknowledge the service rendered to the cause of standardization by Henry Hess, who was one of the first to foresee the advantages that would accrue from the coöperation of manufacturers, consumers, and technical societies in standardization work, and who has been tireless in his efforts to bring about such coöperation in engineering standardization in this country.
>
> His foresight and devotion to the cause have been largely responsible for the broad principles now being followed by the American Engineering Standardization Committee, which is so successfully coördinating and directing the work of the various organizations engaged in engineering standardization.

Mr. Hess became a member of this Society in 1906. He was manager for the years 1911–1914 and vice-president for the period 1914–1916. He attended the meeting in person and received the resolution from D. Robert Yarnall, who made the presentation address.

Dr. Edward B. Rosa Dies

Dr. Edward Bennett Rosa, chief physicist of the United States Bureau of Standards, died suddenly in his office in the Bureau on May 17. Dr. Rosa had done notable work in the scientific field, particularly in electrical research. He was born in Rogersville, N. Y., on October 4, 1861. After graduation from Wesleyan University in 1886 he entered Johns Hopkins University where he later received the degree of Doctor of Philosophy. He served for short periods as instructor in the University of Wisconsin and as professor of physics at Wesleyan, and in 1901 became chief physicist of the Bureau of Standards.

Dr. Rosa developed the physical side of the respiration calorimeter and with Dr. Dorsey as collaborator in 1907 began work on the determination of the ampere which has now been perfected until it is possible to define this unit satisfactorily. His collection of known formulas for computing induction is known widely as a model. Another of Dr. Rosa's achievements was to establish definitely the laws governing electrolytic corrosion. During the war he developed a sound-ranging device for locating big guns, and the geophone for detecting mining operations. He also interested himself in the development of aircraft radio apparatus and improved the radio direction finders by which enemy ships and aircraft could be located. Under his direction the Bureau of Standards has established what is perhaps the finest radio research laboratory in the country.

He was a member of many scientific societies, among them being the International Commission of Electric Units and Standards, of which he was secretary, the National Academy of Sciences, the American Philosophical Society, the American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Physical Society, the Illuminating Engineering Society, the Société Française de Physique, the Washington Academy of Sciences, and the Philosophical Society of Washington.

NEWS OF OTHER SOCIETIES

Society of Industrial Engineers

Spring Meeting in Milwaukee on April 27, 28 and 29. Industrial leadership was the subject for discussion. The speakers emphasized the need for increasing attention to public matters in directing the affairs of industry. This was particularly stressed by L. W. Wallace, executive secretary of the American Engineering Council, who in his presidential address insisted that the industrial leader who does not concern himself with the social, political and economic life of his community is a failure. Turning to industrial problems in the United States, Mr. Wallace believed that the question of production should be considered as a whole rather than from the standpoint of the individual plant. He attributed the dissatisfaction of labor to the alternating phases in industry of intense activity and blighting stagnation. The antidote does not lie, he said, in an indiscriminate reduction of wages, but in regulating production and distribution economically.

Chester B. Lord, works manager, Advance-Rumely Co., Battle Creek, Mich., in Methods of Determining a Fair Day's Work and a Fair Day's Pay, related processes by which fatigue had been eliminated in his plant. In some experiments performed with a view to introducing rhythmic sequence, punch presses were taken which were used for blanking small armature disks continuously. The presses ran at 200 r.p.m. and had a 2-in. stroke. As the production of each press averaged between 35,000 and 40,000 pieces per day the man operating it had to stand on one foot or rest his weight on one side of his stool and trip a lever 35,000 times per day, moving his hands in synchronism. The stroke of one of the presses was reduced to $^3/_4$ in. and the speed coincidently lowered to 100 r.p.m. The result was that instead of from 80 to 85 blanks an average of 90 was secured per minute, noise and the wear and tear of the machine were sensibly reduced, and the efforts of the operator were diminished because he moved his work in rhythm with the press and no longer had to trip it. Similar studies were made of the operation of drill presses by women. In this instance the presses were altered so that the spindles would reciprocate automatically and in synchronism, and the speeds were adjusted to the requirements of the motion.

The educational requirements of a plant executive were discussed by S. E. Stout, betterment manager, Whiting Corporation, Harvey, Ill. The graduate, he said, should have had included in his schooling a definite class of industrial work, such as engineering, accounting, production, etc., which would prepare him for a definite class of positions; but no industry can expect colleges to train men for its own peculiar need. On the other hand, the graduate who knows a little of everything, but nothing in particular, is of no special value to any industry.

Standardization of products was urged both as an aid to production and as a necessary requirement to compete successfully with foreign manufacturers. Commenting on papers which treated this subject, President Wallace observed that whereas the national engineering societies of mechanical, electrical, mining and civil engineers are spending $50,000 a year for the working out of engineering standards in Europe, where a keen competition for industrial supremacy exists among the nations, the governments are appropriating hundreds of thousands of dollars for the same kind of research.

American Electrochemical Society

General meeting at Atlantic City, N. J., on April 21, 22 and 23. A symposium on corrosion and professional papers on electric arc welding, electric furnaces and electric-furnace problems in the steel and non-ferrous industries, and on electrolytic nickel were the technical arrangements of the program. Corrosion was discussed under four aspects: atmospheric corrosion; corrosion by water; chemical or acid corrosion; and electrochemical corrosion. Professor W. H. Walker, of the Massachusetts Institute of Technology, strongly advocated the corrosion-resisting ability of copper-bearing steel. The superior quality in this respect of pure commercial iron was maintained in a written discussion by J. A. Aupperle, chief chemist, American Rolling Mill Co., Middletown, Ohio. The argument for copper-bearing steel was supported by D. M. Buck, metallurgical engineer, American Sheet & Tin Plate Co., Pittsburgh, who presented additional evidence in confirmation of his theory that the alloy of copper and iron is less electropositive to the film of rust formed than is non-copper steel and the consequent decrease in difference of potential lessens the corrosion.

Practical Means of Preventing Corrosion of Iron and Steel Where Not Exposed Directly to the Atmosphere, was the title of a paper presented by F. N. Speller, metallurgical engineer, National Tube Co., Pittsburgh. Mr. Speller gave practical illustrations of "deactivating" apparatus for removing the oxygen in hot-water systems and spoke of the unusual beneficial results obtained. Boiler-tube corrosion was discussed by B. G. Worth, vice-president, Walter Kidde & Co., New York. Another paper by J. A. Aupperle and D. M. Strickland, both connected with the American Rolling Mill Co., Middletown, Ohio, dealt with acid corrosion. It presented a record of tests on pure iron made in open-hearth furnaces, copper iron, plain steel and copper steel to determine their resistance to corrosion by sulphuric acid. In all cases cited pure iron made in open-hearth furnaces had the smallest corrosion. A plea for the intelligent use of metallography and metallurgical principles in attempts to find non-corrodible alloys was made by Oliver P. Watts, associate professor of chemical engineering, University of Wisconsin, Madison, Wis.

Three papers were submitted treating of non-ferrous corrosion. In the first, Dr. John F. Thompson, manager technical department, International Nickel Co., enumerated the anti-corrosive properties of monel metal under varying conditions. Henry S. Rawdon, of the United States Bureau of Standards, discussed examples of interior corrosion of certain brasses, muntz metal particularly, where in many instances a dezincification takes place, resulting in a breaking down of the alloy. The third paper was on the Electrolytic Corrosion of Lead by Continuous and Periodic Currents, by E. R. Shepard, electrical engineer, United States Bureau of Standards.

Dr. Colin G. Fink, who acted as chairman at the sessions of the symposium, summarized the main points brought out. According to Dr. Fink the following facts were established: (1) That iron or steel containing about 0.25 per cent copper is anti-corrosive under most atmospheric conditions; (2) that iron or steel containing about 0.25 per cent copper when immersed in tap water or acidulated media does not endure as well as commercially pure iron; (3) oxygen in boiler or hot-water systems accelerates corrosion, but this influence is removable by extracting the oxygen; (4) corrosion is caused by carbon dioxide in boiler water containing soluble iron, but this condition can be corrected; (5) chromium, nickel and silicon added to iron tend to reduce corrosion; and (6) special steel and other alloys reduce corrosion possibilities, but a coördination of results is still lacking.

The list of professional papers on other subjects included the following: Phenomena of Arc Welding, by O. H. Eschholz; Electrodynamic Forces in Electric Furnaces, by Dr. Carl Hering; Recent Progress in High-Frequency Induction Heating, by E. F. Northrup; and Regulation of Electric Steel Arc Furnaces Using Movable Electrodes, by W. G. Mylins.

American Gear Manufacturers' Association

Convention at Cincinnati, on April 27–30. The reports from seven committees indicated that substantial progress has been made during the year in the standardization of gears. The Association and The American Society of Mechanical Engineers have been for some time working jointly for the formulation of standards which will be recognized as the United States standards. The recommendations of the various committees were discussed at great length and a number of them were adopted by the convention, while many others were referred back to the committees for further investigation. From the report of the spur-gear committee, for example, the following clauses were approved: The width of face for industrial spur gearing shall be 10 divided by the diametral pitch; the thickness of rim for spoked spur gears for industrial work shall be 4 divided by the diametral pitch, or 1.3 times the circular pitch; the diameter of hub for spoked spur gears for industrial work shall be 2 times the diameter of bore.

In a paper on The Ideal Chain and Sprocket Drive, G. M. Bartlett, Diamond Chain & Mfg. Co., Indianapolis, referred to the work of the committee on standardization of The American Society of Mechanical Engineers on steel roller chains, and that of the roller chain division of the Society of Automotive Engineers on the same subject. This work is now being done coöperatively by the two committees. British chain makers have also organized and have standardized to a great extent, and where differences occur they are not sufficiently great to prevent American chains from operating over British sprockets.

Erik Oberg, editor of *Machinery*, one of the committee of editors of technical magazines that recently conferred with Secretary Hoover of the Department of Commerce, conveyed the message from the secretary as to what the department aims to accomplish in the way of helping industry, and the assistance which it would like to secure from industrial associations in the way of furnishing statistics of the respective industries. The association went on record as favoring the assistance of the Department of Commerce as far as possible.

This report has been prepared from the extensive account of the convention published in *Iron Age* for May 5.

National Metal Trades Association

Annual meeting in New York on April 20 and 21. The belief was expressed that the worst of after-war industrial difficulties have passed, but complete recovery of business was not expected to take place this year. The outcome of recent conflicts between employers and union workers, it was thought, had demonstrated the soundness of the principle of the open shop.

A progress report was presented by the committee on industrial education. As a result of their studies during the year, the committee find that: (1) There is a shortage of efficient workers for normal production; (2) too few companies train workers; (3) many of those who do attempt to train have nothing even approximating a definite schedule for this work, and have not definitely determined responsibility for instruction and training as part of the duties of some person or group; (4) very few foremen are able to give proper instructions in the training necessary; (5) conditions within the various plants determine the type of training necessary. They offer the following recommendations: (1) That a definite number of specialists or apprentices be trained in each shop, this number to be proportionate to the total number employed; (2) that a committee on industrial education and training be formed in each branch, such committee to coöperate with local educational or training institutions on questions pertaining to technical, vocational, part-time and continuation schools, and to consider ways and means of furthering training and education within the plants of members of the association.

George A. Seyler, works manager, Lunkenheimer Co., related his experience in installing a training department. In planning and selecting a location the decision was reached to isolate the training department from the production departments. By this arrangement it was intended to prevent any confusion arising in the beginner's mind from comparing himself with trained workers. A director of training and several assistants are always on hand to give information and help to the apprentices. The training course lasts two weeks. As to how the students qualify in comparison with men trained under the old method, the foremen have reported that the students at the time of entering are equal to men who have been working in the shop from six to nine months.

The methods pursued by the University of Cincinnati in training instructor foremen were outlined by D. J. McDonald, professor of vocational education at that university. W. C. Wilson of the American Institute of Weights and Measures, New York, spoke briefly on the Britton bill, which was introduced in the House of Representatives on April 11 "to fix the metric system of weights and measures as the single standard of weights and measures for certain uses."

Further particulars of this meeting may be found in *Iron Age* for April 28.

LIBRARY NOTES AND BOOK REVIEWS

Aluminium. By George Mortimer. Sir Isaac Pitman & Sons, Ltd., London and New York. (Pitman's common commodities and industries.) Cloth, 5 × 7 in., 152 pp., illus., tables, $1.

This little book gives a clear description, suited to the needs of lay readers and business men, of the processes by which aluminium is made and of its uses in industry, particularly in automobile and aircraft construction, the chemical industry, electro and electrical engineering.

Cam Design and Manufacture. By F. B. Jacobs. D. Van Nostrand Co., New York, 1921. Cloth, 6 × 9 in., 121 pp., illus., $2.

This book is intended for machine designers and cam makers, as a practical aid in laying out and cutting cams. The writer has avoided mathematical formulas.

Chilton Tractor Index. Vol. 4, No. 1. Chilton Co., Philadelphia. 1921. Paper, 7 × 10 in., 456 pp., illus., tables, $2.

This semi-annual handbook is a reference book for those interested in tractors and farm-power machinery. It includes a directory of manufacturers of tractors, specifications of those on the market, with illustration, of most of them, a directory of manufacturers of farm-power machinery, electric plants, motor trucks, etc., and a list of makers of tractor parts and equipment. General articles and tables of data valuable to makers and users are also included.

Cost Accounting To Aid Production. By G. Charter Harrison. The Engineering Magazine Co., New York, 1921. Cloth, 6 × 9 in., 234 pp., plates, $7.50

The author of this volume believes that the customary methods of cost accounting are entirely unsuited to the needs of modern industry. Cost accounting, in his opinion, should not be a compilation of information concerning past events, but a method of predetermining costs. His book discusses the proper functions of an accounting system, and how to secure them, but is chiefly intended to stimulate thought and provoke discussion of the subject.

The Electrification of Railways. By H. F. Trewman. Sir Isaac Pitman & Sons, Ltd., London, 1920. (Pitman's technical primer series.) Boards, 4 × 7 in., 78 pp., diagrams, $1.

This little volume is an outcome of the discussions as to the advisability or otherwise of electrifying the railroads of Great Britian, a subject of general interest because of the necessity for relieving railway congestion and utilizing coal in the most economical manner. Without going into technical details covered in books on electric traction, the author brings forward the commercial aspect of the matter and calls attention to some of the main questions to which attention must be paid. Sufficient electrical information is given to enable these points to be understood by readers who are not electricians.

Élements de Mecanique Á L'usage des Ingenieurs: Resistance des Materiaux. By Robert d'Adhémar. Gauthier-Villars et Cie Paris, 1921. Paper, 6 × 9 in., 185 pp., diagrams.

In writing this book the author has attempted an introduction to the theory of the resistance of materials, in which the hypotheses that have been adopted to simplify the subject in practice are set forth as briefly and simply as is possible.

Ergebnisse der Aerodynamischen Versuchsanstalt zu Gottingen. By L. Prandtl. Part 1. R. Oldenbourg, München und Berlin, 1921. Paper, 8 × 11 in., 140 pp., plans, illus., tables, 40 marks.

This publication, the first of a series of bulletins devoted to the experimental investigations undertaken by this research laboratory, gives the hitherto unpublished results of recent researches. These are chiefly concerned with the shapes and profiles of propeller blades, although minor investigations of the reciprocal ef-

fect of wings and propellers and bodies and propellers and of the frictional resistance of wing fabrics are included. The bulletin gives results of tests of almost all the blade forms that have been used or investigated in Germany during recent years. The work also describes the organization, equipment and methods of the laboratory, and a summary introduction to the theory of air resistance, including the new theory of flight.

Fire Tests of Building Columns by Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters, and the Bureau of Standards, jointly conducted at Underwriters' Laboratories, Chicago, 1917–1919. Cloth, 6 × 9 in., 388 pp., illus., charts, tables; $2.50.

This pamphlet presents the results of an investigation undertaken to ascertain the ultimate resistance against fire of protected and unprotected columns as used in the interior of buildings, and their resistance against impact and sudden cooling from hose streams when highly heated. The results of 91 fire and 15 fire and water tests are given, including tests of representative types of steel, cast iron, concrete-filled pipe and timber columns, protected and unprotected, and reinforced-concrete columns. It is stated to be the most complete investigation ever made.

Foundry Moulding Machines and Pattern Equipment. By Edwin S. Carman. Second edition. Cloth, 6 × 9 in., 225 pp., illus.

Contents: general moulding principles; the theory of jolt ramming; roll over jolt moulding machines; roll over jolt moulding machines for large-size, medium-size and small-size rolls; jolt moulding machines in brass and aluminum foundries; plain jolt moulding machines; air-operated squeezer machines; jolt stripper moulding machines; pattern equipment; flask equipment; machine moulded cores; foundations for jolt ramming moulding machines.

As shown by its contents, this book is intended to explain the construction of moulding machines and their use for various kinds of molds. The methods of pattern mounting and moulding are described in detail and very fully illustrated by photographs.

Gas Torch and Thermit Welding. By Ethan Viall. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 442 pp., illus., $4.

This is a careful summary of American practice and equipment, selected from the existing literature, from shop data, and from the experience of experts. The materials and apparatus used, the methods and their application to particular kinds of work, are described in detail, providing a large amount of practical information for workmen and engineers.

Gasoline Automobiles. By James A. Moyer. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 5 × 8 in., 261 pp., illus., $2.

The purpose of this book is to present clearly, briefly and interestingly, the essential principles of automobile construction. It is expected to furnish practical help to drivers who wish to know the causes of ordinary operating troubles and the ways to remedy them.

Herbert Hoover, the Man and His Work. By Vernon Kellogg. D. Appleton and Co., New York, 1920. Cloth, 5 × 8 in., 375 pp., portraits, $2.

Dr. Kellogg's book is the attempt of an observer, associate and friend to tell, simply and straightforwardly, the personal story of the man and his work up to the present. His boyhood, education, work in Australia, China and London are recounted briefly, and much space given to his work for the relief of Belgium, as food and relief administrator. As appendixes are given four important addresses by Mr. Hoover.

Human Engineering, a Study of the Management of Human Forces in Industry. By Eugene Wera. D. Appleton & Co., New York, 1921. Cloth, 5 × 8 in., 378 pp., $3.50.

This volume is a contribution to the discussion of the relationship of labor, capital and society in the industrial development of the world. Neither the old nor the modern school of management has succeeded in removing labor unrest, owing, in the author's opinion, to the ignoring of labor as a social group and disregard of the social purpose of industry. To present the principle of stimulating labor as a whole toward production at large for social purposes is the object of the present work.

The author studies the evolution of the ideas governing industrial relations, interprets the essentials of present issues, presents certain democratic tendencies and develops a typical organization for class coöperation. Other sections analyze the different psychological associations of men involved in industry, discuss the principles of human engineering and outline their application.

Marine and Stationary Engines. By A. H. Goldingham. Second edition, revised and enlarged. Spon and Chamberlain, New York, 1921. Cloth, 5 × 8 in., 233 pp., illus., plates, tables, $3.15.

This treatise is offered to designers and operators in need of concise, practical information on the various types and designs of Diesel engines. The book opens with a brief account of the theory of the engine. This is followed by a description of the details of construction, and discussions of indicator diagrams, of the advantages and disadvantages of Diesel engines, and of their operation and maintenance. These general topics are followed by descriptions and drawings of many types of engines.

The Mariners' Handbook. By International Correspondence Schools, Third edition. International Textbook Co., Scranton, Pa. 1920. Cloth. 4 × 5 in., 405 pp., plates, illus., $1.50.

A small pocketbook of information on nautical matters, intended for young men in the naval and merchant marine service, and for laymen interested in nautical affairs. Although the treatment is brief, it is sufficient for ordinary reference purposes.

Metallography. By Samuel L. Hoyt. Part 2, The Metals and Common Alloys. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 462 pp., illus., tables, $5.

The second volume of this treatise on metallography describes the more important metals and alloys. This description includes the constitution and microstructure, the physical and mechanical properties for different heat and mechanical treatments, the effects of the common impurities and a brief discussion of the uses. Those compositions of particular importance have been treated in more detail and measured values of their important properties are included.

Modern Pulp and Paper Making. A Practical Treatise. By G. S. Witham, Sr. Book Dept., The Chemical Catalog Co., Inc., New York, 1920. Cloth, 6 × 9 in., 599 pp., illus., tables, $6.

This treatise is the work of a writer with long practical experience in the industry, and is intended to fill the need for a practical work on paper manufacture as carried on in America. It is not too abstruse and technical for the average papermaker, but is thorough enough to be of real value. The book describes the equipment and processes in actual use, and also treats of plant design and personnel.

Neue Grundlagen der Technischen Hydrodynamik. By L. W. Weil. R. Oldenbourg, Munich and Berlin, 1920. Paper, 6 × 9 in., 219 pp. illus., diagrams, 26 M.

This work is concerned with some of the problems of hydrodynamics, for which no exact elucidation or analytical solution has yet been obtained, as, for example, eddies in streams and pipes, the effect of expansions or contractions in channels, orifice problems, water hammer and the theory of turbines and of rotary flow of liquids. The author advances certain principles, based on long theoretical and practical study, which he considers correct and in accordance with experimental results.

The New Thermodynamics; the non-postulated rationale of motive power of heat. By Jacob T. Wainwright. Privately printed, 1921. Boards, 7 × 10 in., 44 pp.

Believing that the second law of thermodynamics, which is the foundation for present-day teaching of that branch of thermodynamics which treats of the motive power of heat, is untrue, the author presents his arguments for its repudiation. The monograph sets forth his views as to the rationale of the motive power of heat and his grounds for claiming that the Carnot principle conflicts with the principle of the conservation of energy and with observed results.

Patent Law. By John Barker Waite. Princeton University Press, Princeton, N. J., 1920. Cloth, 6 × 9 in., 316 pp., $5.

In this volume the professor of law in the University of Michigan Law School presents a concise but complete and thorough discussion and exposition of the principles of patent law, intended for inventors, engineers and all that class of laymen who from time

to time want information concerning their rights in respect to patents and inventions. It purports to cover only the substantive law of patents, their nature, validity, effect and their characteristics as property; and the author has attempted to present every issue that has come before the courts.

Patternmaking. By Ben Shaw and James Edgar. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Pitman's Technical Primer Series.) Boards, 4 × 7 in., 108 pp., illus., $1.

This little volume gives a birdseye view of the subject, for use by students, apprentices, young journeymen and others who wish some knowledge of the principles that underly it.

Producer Gas. By J. Emerson Dowson and A. T. Larter. Fourth edition. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 361 pp., illus., $7.50

Contents: Theory of producer gas; furnace work; heating work; engine work; suction plants; gas from bituminous coal for engine work; producer gas from peat; gas traction on roads; gas propulsion of vessels; stand-by losses; comparison of gas and steam power; fuel; analysis of fuel and of producer gas; calorific power of solid and gaseous fuels; practical notes. Appendices.

The table of contents shows the scope of this treatise, which gives a general survey of present practice in the production and utilization of producer gas. This edition has been thoroughly revised.

Space and Time in Contemporary Physics; an Introduction to the Theory of Relativity and Gravitation. By Moritz Schlick. Rendered into English by Henry L. Brose. Oxford University Press, American Branch, New York, 1920. 10 + 89 pp., cloth, 6 × 9 in., $2.50.

The theory of relativity consists of two parts, the old special theory, and the more recent general theory. This book is intended as an introduction to the whole set of ideas contained in this theory and should interest especially those who are concerned with the general conceptions rather than the details. Its essential purpose is to describe these physical doctrines with particular reference to their philosophic significance. The present edition varies from the previous one only in minor improvements.

Taschenbuch fur Schiffsingenieure und Seemaschinisten. By E. Ludwig and E. Linder. Third edition. R. Oldenbourg, Munich and Berlin, 1920. Cloth, 5 × 7 in., 514 pp., tables, diagrams, illus., 24 M.

This book is a third edition, under a new title and with new compilers, of G. Bauer's Kalender für Seemaschinisten. In its present form it is a volume of convenient size, intended for marine engineers, and covering concisely all the mechanical equipment of ships. The volume contains the necessary physical and mathematical tables and formulas, sections on reciprocating steam engines, steam turbines, turbine reducing gear, boilers, boiler accessories, piping, combustion engines, auxiliary mechanical equipment, electrical equipment, measuring instruments, ship construction, navigation, laws and regulations. All these subjects are treated from a modern point of view, particular attention being given to methods likely to be used in the future.

Technischer Literaturkalender. Second edition. R. Oldenbourg, München-Berlin, 1920. Cloth, 6 × 8 in., 441 pp., frontispiece, 40 Marks.

This is a "Who's Who" of living German writers on technical subjects, compiled by the chief librarian of the German Patent Office. About seven thousand names are included. The information includes date of birth, address, education, occupation, writings and specialty. This edition contains a thousand names more than that of 1918, and has also an index by specialties and a list of deaths during 1918 and 1919.

The Testing of Motive-Power Engines. By R. Royds. Second edition. Longmans, Green and Co., New York, 1920. Cloth, 6 × 9 in., 392 pp. diagrams, tables, $7.50.

This book is intended for students with an elementary knowledge of motive-power engineering, who desire information on the practical testing of motive-power engines. Special attention is given to the variable conditions under which a plant may operate and the necessity for systematic arrangements where a series of trials is contemplated. This edition has been revised and modified to meet modern developments.

A Text Book of Chemical Engineering. By Edward Hart. The Chemical Publishing Co., Easton, Pa., 1920. Cloth, 6 × 9 in., 223 pp., illus., diagrams.

Contents: Materials; Location of Works; Boilers; Prime Movers; Plumbing; Crushing; Dissolving; Filtration; Tanks; Evaporation; Crystallization; Drying; Distillation; Absorption of Gases; Mixing and Kneading; Containers. The contents give an indication of the scope of Dr. Hart's new book, which is based upon his courses in Lafayette College. The treatment of the subject is brief and elementary, but thoroughly practical.

Text-Book of the Materials of Engineering. By Herbert T. Moore. With a chapter on concrete, by H. F. Gonnerman. Second edition, first impression. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 327 pp., illus., charts, tables, $3.

This text-book contains a concise presentation of the physical properties of the common materials used in structures and machines, together with brief descriptions of their manufacture and fabrication. It is primarily intended for use in connection with courses on the mechanics of materials, but the author hopes that it will also be useful to draftsmen, inspectors, machinists and others who use these materials. In this edition the chapter on concrete has been rewritten, a chapter added on rubber, leather and hemp rope, and other sections have been enlarged or revised.

The Theory of Machines. By Robert F. McKay. Second edition. Edward Arnold, London, 1920. Cloth, 6 × 9 in., 448 pp., diagrams, $6.75.

Contents: Mechanics; Kinematics of Machines; Dynamics of Machines. Although many books exist which cover one or two special parts of this subject, the author believes this to be the first attempt at a systematic, comprehensive review of the whole. The volume is intended for students and engineers, many exercises being included for use by the former. This edition is practically identical with the first, only minor additions and alterations having been made.

The Ventilation Hand Book. By Charles L. Hibbard. Second edition, revised and enlarged. The Sheet Metal Publication Co., New York, 1920. Cloth, 6 × 8 in., 231 pp., illus., diagrams, $2.50.

This book is intended to present in convenient form, the principles of warm-air heating and ventilation, with simple methods for computing the sizes of the various parts of a system of this kind. The subject matter is arranged in the form of questions and answers, and the descriptions and mathematical data are given in very simple form.

The Welding Encyclopedia. Compiled and edited by L. B. Mackenzie and H. S. Card. Welding Engineer Publishing Co., New York, 1921. Cloth, 6 × 9 in., 224 pp., illus., $5.

This book is a collection of information on oxy-acetylene, electric and thermite welding, arranged in concise alphabetical form for ready reference. The material has been largely selected from the files of the *Welding Engineer*, and is practical rather than theoretical in character.

Winning the Public. By S. M. Kennedy. First edition. McGraw-Hill Book Co., Inc., New York, 1920. Cloth, 6 × 9 in., 168 pp., port., $2.50.

This volume includes the substances of various addresses delivered before technical and trade associations during recent years. They discuss the relations of public utilities with those whom they serve and the methods by which public confidence and good will can be secured.

THE ENGINEERING INDEX

(Registered U. S. Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Dust Explosions Dust Explosions, Cause, Effect and Prevention, David J. Price. Eng. News. Rec., vol. 86, no. 15, April 14, 1921, pp. 634–636, 6 figs. Ignition and propagation of flame. Changes in construction to prevent high pressures from being built up within heavy concrete wall construction.

AERIAL PHOTOGRAPHY

Cameras. Eastman Kodak Aerial Cameras. Flight, vol. 13, no. 10, Mar. 10, 1921, pp. 167–168, 7 figs. Automatic types

AERONAUTICS

Bureau of Naval Aeronautics. The Need of a Bureau of Naval Aeronautics. Aviation, vol. 10, no. 16, April 18, 1921, pp. 506–507. Suggests organization.

AEROPLANE ENGINES

B.M.W. The B.M.W. 6 Cyl. 185 Hp. Engine. Aviation, vol. 10, no. 12, Mar. 21, 1921, pp. 370–371, 1 fig. Characteristics: Number of cylinders, 6; bore, 5.906 in.; stroke, 7.086 in.; total piston displacement; 1,164.50 cu. in.

Constant-Compression. Aeroplane Engines Injecting Constant Mass of Fuel and Effecting Constant Compression at all Altitudes (Moteur d'aviation admettant une masse constante et effectuant une compression constant à toute altitude), M. A. Witz. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 11, Mar. 14, 1921, pp. 641–644. Possibilities of such motor for flight at high altitudes.

Developments. Army and Navy Development of Aero Engines. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 390–391, 1 fig. Types of engines approved by Secretary of War and Secretary of Navy for development of army and navy air services.

Supercharging. The Calculated Performance of Airplanes Equipped with Supercharging Engines, E. C. Kemble. Nat. Advisory Committee for Aeronautics, report no. 101, 1921, 52 pp. 26 figs. Theoretical discussion of performance of aeroplane as affected by use of supercharging engine, together with comparative study of respective merits of different types of superchargers.

AEROPLANES

Caproni. Caproni's Latest Creation. Aeronautics, vol. 20, no. 388, Mar. 24, 1921, pp. 210, 2 figs. Flying boat with three triplane bodies. Specifications: Width, 33 meters, length, 24 meters: chord of wing, 275 meters, average speed, 140 km. per hr.; air endurance, 5–6 hr.

The Giant Caproni Tandem Triplane. Aerial Age, vol. 13, no. 5, April 11, 1921, pp. 103–104, 4 figs. Specifications: Power plant 8 Liberty 12-400 hp. engines; span, 100 ft.; length, 74 ft.; height, 31 ft. 6 in.; chord, 8 ft. 7 in.; empty, 30,000 lb.

Classification. Naming and Classifying Airplanes. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 391. System adopted by Engineering Division of U. S. Army Air Service.

Design. The Extended Logarithmic Polar for the Calculation of Aeroplanes (Die erweiterte logarithmische Polare zur Flugzeugberechnung), Richard Vogt. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 5, Mar. 15, 1921, pp. 69–73, 7 figs. It is shown that by means of a simple extension of the Eiffel logarithmic polars for determination of relations between carrying capacity, speed, plane-surface area and engine power, general graphic charts can be developed, and simple examples are given to illustrate their use.

The Factors That Determine the Minimum Speed of an Aeroplane, F. H. Norton. Aerial Age, vol. 13, no. 3, Mar. 28, 1921, pp. 57–60, 6 figs. It is computed that wing section affects minimum speed 26 per cent; aspect ratio, 4 per cent; gap chord ratio, 4 per cent; longitudinal control, 20 per cent; lateral control, 15 per cent; power in level flight, 5 per cent; vertical component of air screw thrust, 3 per cent; stagger, 2 per cent; scale, 2 per cent; and slip-stream on wings, 1 per cent.

German. German Aerial Developments, Erik Hildesheim. Aeronautics, vol. 20, no. 388, Mar. 24, 1921, pp. 198–200, 4 figs. Survey of types of aeroplanes under construction in German works.

Helicopters. See HELICOPTERS.

Military. Recent Progress in Military Aviation, H. S. Martin. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 335–338, 7 figs. Military aeroplanes recently developed by U. S. Army Air Service.

Stability. Aeroplane Stability. Times Eng. Supp. no. 557, Mar. 1921, p. 102. Methods of longitudina equilibrium.

[See also AVIATION, Soaring Flight.]

Wings. Some Experiments on Thick Wings with Flaps, C. D. Hanscom. Aerial Age, vol. 13, no. 4, April 4, 1921, pp. 79–82, 30 figs. Tests made in wind tunnel at Mass. Inst. Technology.

AIR LIFT

See PUMPS, Air-Lift.

AIRCRAFT

Design. Some Practical Points in the Structural Design of Aircrafts, A. P. Thurston. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 335–337, 8 figs. Also in Flight, vol. 13, no. 11, Mar. 17, 1921, pp. 194–197, 8 figs. Determination of maximum loads under various conditions of loading. Paper read before Instn. Aeronautical Engs.

AIRCRAFT CONSTRUCTION MATERIALS

Fabrics. Airship Fabrics, J. W. W. Dyer. Aeronautics, vol. 20, nos. 387, 388 and 389, Mar. 17, 24 and 31, 1921, pp. 182–183, 200–202, and 225–226. Tensile properties and resistance to tearing. Bursting tests on larger models. Strength under sustained load. Methods of production. Fabrics for rigid airships.

AIR COMPRESSORS

Regulation, Automatic. Automatic Regulation of Compressors (Selbsttätige Regelung von Kompressoren), Robert Nitzschmann. Feuerungstechnik, vol. 9, no. 9, Feb. 1, 1921, pp. 74–75, 3 figs. Arrangement for remote control from compressed-air plant.

AIR FLOW

Meters. Notes on Small Flow Meters for Air, Especially Orifice Meters, Edgar Buckingham. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 183, Dec. 20, 1920, 15 pp., 1 fig. Note on selection, design and properties of small flow-meters for air.

AIRSHIPS

Rigid. The Technique of German Rigid Dirigibles (La technique des dirigeables rigides allemands), J. Tanzi. Aérophile, vol. 29, nos. 3 and 4, Feb. 1–15, 1921, pp. 50–54, 6 figs. Developments during war.

Zeppelin. The Hull of the Rigid Airships, E. H. Lewitt. Aeronautics, vol. 20, no. 390, April 7, 1921, pp. 234–236, 7 figs. Study of stresses in hull of airships of Zeppelin type.

[See also BALLOONS.]

ALCOHOL

Industrial. Raw materials for Industrial Alcohol Production, Chas. F. Juritz. So. African Jl. of Industries, vol. 4, no. 2, Feb. 1921, pp. 167–175. Yields from sugar-beet, prickly-pear fruit, molasses, potatoes, sweet potatoes, maize, acorns, prickly-pear leafstems, straw and sawdust.

Recovery from Coke-Oven Gas. Alcohol from Coke-Oven Gas, Cecil F. Tidman. Colliery Guardian, vol. 121, no. 3141, Mar. 11, 1921, p. 713. Also Iron & Coal Trades Rev., vol. 102, no. 2767, Mar. 11, 1921, p. 350. Experiments at Skinningrove Works, England. Paper read before joint meeting of Soc. Chem. Industry & Cleveland Instn. Engrs.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Burrowlite. Imparts Odd Properties to Steel. Iron Trade Rev., vol. 68, no. 14, April 7, 1921, pp. 974–975, 1 fig. Alloy discovered by Dr. L. P. Burrowlite while experimenting with nickel ores. It is made from nickeliferous ore obtained in Sudbury district of Ontario. Alloy gives steel property of machinability even when showing qualities of extreme hardness.

ALLOYS

Ternary. Coefficients of Equivalence in Ternary Alloys, Léon Guillet and Albert Portevin. Chem. & Metallurgical Eng., vol. 24, no. 14, April 6, 1921, pp. 609–612, 4 figs. General discussion of effect of adding little of third element to binary alloy. Mathematical development of equations defining isomicrographic lines, and boundaries of zones showing two well-defined constituents. (Abstract.) Translated from Revue de Métallurgie.

AMMONIA

Synthesis. Some Interpretations of the Ammonia Synthesis Equilibrium, R. S. Tour. Jl. Indus. & Eng. Chem., vol. 13, no. 4, April 1921, pp. 298–300, 3 figs. Curves showing effect on equilibrium of ammonia content of variation of any one of conditions involved when others are held at arbitrary values.

AMMONIA COMPRESSORS

Apeldoorn. Apeldoorn Ammonia Compressors and the Apeldoorn Two-Pressure Evaporator System of Refrigeration. Practical Engr., vol. 63, no. 1777, Mar. 17, 1921, pp. 164–168, 7 figs. Double-acting horizontal compressors with multiple-opening disk valves in cylinder body.

Rod Packing. Ammonia Compressor-Rod Packing, W. H. Motz. Power, vol. 53, no. 14, April 5, 1921,

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

pp. 543–545, 4 figs. Comparative value of different types of packing.

APPRENTICES, TRAINING OF

Machine Industry. Training Men for the Machine Industry, Erik Oberg. Machy. (N.Y.), vol. 27, no. 8, April 1921, pp. 779–782, 6 figs. Organization of educational and training departments established by Norton Co., Worcester, Mass., with view to qualifying men for various classes of occupations in machine industry.

National Apprenticeship Council. Apprenticeship Plan Drawn Up by Joint Conference Board. Contract Rec., vol. 35, no. 14, April 6, 1921, pp. 336–339. Formation of National Apprenticeship Council governing local councils is suggested. Apprenticeship agreement enforces employers to provide time for education along technical lines.

ASHES

Weight of Conical Pile. The Weight of a Conical Pile of Ashes, N. G. Near. Power Plant Eng., vol. 25, no. 8, April 15, 1921, p. 418, 1 fig. Chart giving weight of conical pile of ashes.

AUTOMOBILE ENGINES

Assembling. Methods of Motor Assembly. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 641–645, 14 figs. Practice in assembling of Essex motor.

Gray-Beall. New Four-Cylinder Engine to be a Stock Product, J. Edward Schipper. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 694–695, 2 figs. Gray-Beall $3^1/_2$ by 5 in. four-cylinder overhead-valve engine.

High-Speed. High-Speed Engines of Small Piston Displacement, Louis Chevrolet and C. W. Van Ranst. Jl. Soc. Automotive Engrgs., vol. 8, no. 4, April 1921, pp. 368–374, 8 figs. Racing engine designed by Frontenac Motor Co., Indianapolis.

Oldsmobile. To Produce New Eight-Cylinder Engine for Use in Oldsmobile Chassis, J. Edward Schipper. Automotive Industries, vol. 44, no. 12, Mar. 24, 1921, pp. 642–646, 7 figs. Engine will be produced in quantity, using new tool equipment especially designed for purpose. Cylinders will have rolled finish in place of ground surface. Blocks and beads to be interchangeable. Pressure lubrication and high speed, two-bearing crankshaft among features.

Starters. Instantaneous Current and Voltage Values in Battery, G. W. Vinal and C. L. Snyder. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 319–327 and 364, 17 figs. Experiments conducted at Bur. of Standards to determine effects of temperature, compression, lubrication, distributor action and flywheel velocity upon operation on starter system.

Turmo. A New Four-Cylinder Engine of Conventional Design, J. Edward Schipper. Automotive Industries, vol. 44, no. 15, April 14, 1921, pp. 800–802, 5 figs. Turmo engine intended for passenger car or light truck applications. Four $3^1/_4$ by 5-in. cylinders develop maximum of 47 hp. at 2200 r.p.m. Full pressure-feed lubrication and ample water-jacket space are provided.

AUTOMOBILE FUELS

Alcohol. Forest Products as Motor Fuels, E. C. Scherrard. Sci. Lubrication, vol. 1, no. 2, Feb. 1921, pp. 8–13 and 25. Possibilities of ethyl alcohol as susbtitute for gasoline or as auxiliary for blending purposes.

Progress in Tests of Alcohol as Fuel. Power Wagon, no. 197, April 1921, p. 20. Report of British Empire Motor Fuels Committee.

The Carburetion of Alcohol, A. W. Scarratt. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 328–330, 2 figs. Characteristic curves of four-cylinder engine equipped with special hot-spot manifold for burning alcohol.

Benzol. Benzol for Motor Fuel. Gas & Oil Power, vol. 16, no. 186, Mar. 3, 1921, p. 84. Specifications of British Eng. Standards Assn. Benzol is defined as mixture of benzene and not more than 30 per cent by volume of toluene and xylenes.

Kerosene. Utilization of Kerosene as Automobile Fuel(L'emploi des pétroles lampants dans les moteurs d'automobiles), A. Grebel. Génie Civil, vol. 78, no. 14, April 2, 1921, pp. 289–295. Technical study of carburetion of kerosene and account of experiments conducted at Schneider works in France.

Natalite. Data Concerning the Advantages, Production, and Cost of "Natalite" Motor Fuel. Int. Sugar Jl., vol. 23, no. 267, Mar. 1921, pp. 147–153, 2 figs. Mixture consisting of 55 per cent alcohol, 44.9 per cent ether, and 0.1 per cent ammonia. (To be continued.)

Palm Oil. Palm Oil as Engine Fuel. Gas & Oil Power, vol. 16, no. 186, Mar. 3, 1921, pp. 85–86. Tests in Brussels with palm oil and other vegetable oils grown in Belgian Congo.

Research. Motor Fuel. So. African Eng., vol. 32, no. 3, Mar. 31, 1921, pp. 55–56. Research on utilization of gasoline substitutes as automobile fuels. Report of Empire Motor Fuels Committee of Imperial Motor Transport Council.

Semi-Water Gas. Utilization of Water Gas as Automobile Fuel (Utilisation du gaz pauvre a l'alimentation des moteurs d'automobiles), E. H. Lemonon. Nature (Paris), no. 2445, Feb. 12, 1921, pp. 105–112, 10 figs. Records of experiments. Apparatus used for operating Ford car by means of gas.

AUTOMOBILES

Carburetors. See CARBURETORS.

Clutch and Gear-Box Design. Developments in Transmission, S. Bramley-Moore. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 350–364, 25 figs. Developments in clutch and gear box design which have been suggested with a view to reducing cost of upkeep.

Drive Gears. Gears for Motor Transmissions, Fred H. Colvin. Am. Mach., vol. 54 no. 14, April 7, 1921, pp. 606–609, 14 figs. Machining and assembling operations.

Research. Much Useful Automotive Research in Progress at Bureau of Standards, Herbert Chase. Automotive Industries, vol. 44, no. 14, April 7, 1921, pp. 750–755, 7 figs. Work now proceeding includes tests of brake linings made with view to standardizing apparatus for this purpose, efficiency and endurance tests of truck axles, study of flame propagation and detonation phenomena, and test of lubricants intended to determine definitely what physical characteristics render oil best suited for use in automotive engines.

Transmission Units. Methods Used by Transmission Specialists. Fred H. Colvin. Am. Mach., vol. 54, no. 13, Mar. 31, 1921, pp. 537–540, 12 figs. Frame-case and bell-case types of transmission. Machining operations on two types. Special tools, fixtures and methods for economical production.

AVIATION

Aerial Transportation. Aerial Transportation as a Business Proposition, Glenn L. Martin. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 347–349. Reliability of air transportation. Survey of developments of commercial transportation.

Airplane Efficiency in Public Transportation, H. White Smith. Aviation, vol. 10, no. 16, April 18, 1921, pp. 498–501, 3 figs. Records of European commercial services. Paper read at Efficiency Exhibition, London.

Canadian Air Progress—1920. Aviation, vol. 10, no. 12, Mar. 21, 1921, pp. 372–375.

Commercial Future of Aviation (L'avenir commercial de l'aviation), M. Maurice Duval. Ingenieur, vol. 36, no. 11, Mar. 12, 1921, pp. 199–203. Economical advantage of aerial transportation.

Cloudy Weather. Aerial Navigation in Cloudy Weather (La navigation aérienne par temps de brume), M. de Gramont de Guiche. Aérophile, vol. 29, nos. 3 and 4, Feb. 1–15, 1921, pp. 42–45, 3 figs. Technical study. Report submitted to French commission of aerial transportation.

Commercial. Commercial Aviation in Germany, W. Wronsky. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 402–403, 1 fig. Possibilities of developments. Translated from Der Luftweg.

The Next Steps in Commercial Aviation, Jesse J. Vincent. Flying, vol. 10, no. 3, April 1921, pp. 87–90, 3 figs. Visualizes probable future developments in design of aeroplanes for commercial purposes.

Customs Regulations. French Aircraft Customs Regulations. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 392–393. Regulations and customs formalities to be applied to all aircraft entering or leaving France.

Flight Tests. Accelerations in Flight, F. H. Norton and E. T. Allen. Nat. Advisory Committee for Aeronautics, no. 99, 1921, 8 pp., 34 figs. Tests at Langley Field station conducted to obtain magnitude of load factors in flight and to procure information on behavior of airplane in various maneuvers.

Military. Angles of Attack and Air Speeds During Maneuvers, E. P. Warner and F. H. Norton. Nat. Advisory Committee for Aeronautics, no. 105, 1921, 12 pp., 9 figs. Experiments on direct measurement of angles of attack during maneuvers.

Soaring Flight. Dr. Nimführ's Solution of the Soaring Flight Problem, Alfred Gradenwitz. Aeronautics, vol. 20, no. 388, Mar. 24, 1921, pp. 203–204. Automatic stabilizer for aeroplanes.

Sailing Flight, R. DeVillamil. Aeronautics, vol. 20, no. 387, Mar. 17, 1921, pp. 180–181, 4 figs. Mechanics of soaring flight.

The Characteristics of Soaring Flight (Segelflugwesen), E. Rumpler. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 4, Feb. 28, 1921, pp. 50–53. Discusses expediency of different types of soaring airplanes, especially those figuring in the Rhön soaring-flight contest: and recommends that the study of soaring flight should replace that of gliding.

AVIATORS

Tests. Intelligence Tests at High Altitudes, Alfred Gradenwitz. Aeronautics, vol. 20, no. 389, Mar. 31, 1921, pp. 221–222, 3 figs. Results of intelligence tests in diluted air.

B

BALANCING

Machine Members. Loss of Energy through Unbalance in Rapidly Rotating Machine Parts (Energieverlust durch Unbalanz), Hans Heymann. Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 363–366, 9 figs. Study of such sources of errors in the mass distribution of a rotating machine part as interfere with the smooth running of the body during operation of machine.

BALLOONS

Pilot. The Rate of Ascent of Pilot Balloons, B. J. Sherry. U. S. Dept. of Agriculture, Monthly Weather Rev., vol. 48, no. 12, Dec. 1920, pp. 692–694, 1 fig. Factors controlling rate of ascent of pilot balloons. Records of experiments.

Predetermination of Form. Predetermination of the Form of an Inflated Balloon (Prédetermination de la forme d'un ballon gonflé). Technique automobile et Aerienne, vol. 12, no. 112, 1921, pp. 11–14, 3 figs. Graphical study of forces acting within envelope of non-rigid dirigible balloon.

BEAMS

Buckling of. Flexural Buckling, Albert E. Guy. Army Ordnance, vol. 1, no. 5, March-April 1921, 256–261, 15 figs. Laws of buckling of cantilever beams on uniform rectangular sections.

Reinforced-Concrete. Effect of Repeated Reversals of Stress on Double-Reinforced Concrete Beams, W. A. Slater, G. A. Smith and H. P. Mueller. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 182, Dec. 20, 1921, 51 pp., 33 figs. For all of beams tested failure was by tension in steel. Generally beams in which highest stresses were developed in test withstood smaller number of repetitions of load than those in which measured stresses were smaller.

Torsion on Rectangular Cross-Sections, C. R. Young. Can. Engr., vol. 40, no. 12, Mar. 24, 1921, pp. 315–318, 2 figs. Formulas for determining stresses in beams of rectangular section. Method of reinforcing concrete beams for torsion.

BEARINGS, BALL

Lubrication. Requirements for Ball Bearing Lubrication, J. B. Castino. Sci. Lubrication, vol. 1, no. 2, Feb. 1921, pp. 18–19 and 31, 4 figs. Specifications for greases and oils.

BENZOL

Uses. Benzole—Its Recovery, Rectification, and Uses. Gas Jl., vol. 153, no. 3008, Jan. 5, 1921, pp. 31–33. Review of book by S. E. Whitehead published by Benn Bros., London.

[See also AUTOMOBILE FUELS, Benzol.]

BLAST-FURNACE GAS

Dust Recovery. Blast-Furnace Flue Dust Recovery, George B. Cramp. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 775–778, 1 fig. Automatic apparatus for wet recovery of flue dust.

Handling Flue Dust Economically, George B. Cramp. Iron Trade Rev., vol. 68, no. 12, Mar. 24, 1921, pp. 836–839, 1 fig. Plan for recovery of blast-furnace flue dust and charging it in form of sludge into top of stack.

BLASTING

Liquid-Oxygen. Blasting with Liquid Oxygen, S. P. Cortland. Sci. Am. Monthly, vol. 3, no. 4, April 1921, pp. 333–336, 6 figs. Equipment and procedure.

BOILER EXPLOSIONS

Abo, Finland. Steam-Boiler Explosion in the Abo Electrical Works (Finland) (Dampfkesselexplosion im Elektrizitätswerk Abo), M. Klein. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 11, Mar. 12, 1921, pp. 266–267, 3 figs. Account of explosion and results. Action of difference of temperature in the shell plates of upper boiler. Similarity of explosion to that in the central power plant Franken in Nuremburg, Germany.

BOILER FEEDWATER

Treatment. Economic Production of Distilled Water for Steam Central Stations (Production économique de l'eau distillée pour les centrales thermiques), M. J. Leleu. Chaleur & Industrie, vol. 2, no. 2, Feb. 1921, pp. 75–78, 4 figs. Triple-effect distiller operated by exhaust steam from pumps or turbine.

BOILER INSPECTION

National Board of Boiler Inspectors. Constitution and By-Laws of National Board of Boiler Inspectors. Boiler Maker, vol. 21, no. 4, April 1921, pp. 107–109. Object of association is to promote uniformity of construction and inspection of boilers in U. S.

Regulations. Regulations for Inspection of Railway Steam Boilers, other than Locomotive Boilers. Can. Ry. & Mar. World, no. 278, April 1921, p. 179. General order passed on Feb. 16, 1921, by Board of Ry. Commissioners for Canada.

BOILER OPERATION

Combustion. Heating Value in Connection with Steam-Boiler Investigations (Der Heizwert bei Dampfkesseluntersuchungen), H. Hilliger. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 11, Mar. 12, 1921, pp. 270–272, 4 figs. Notes on quantity of saturated vapor in combustion gases: importance of the separation of water from the combustion gases for operation and boiler efficiency; consideration of higher heating value in tests.

Instruments. Boiler Operation at the Power Plant of the Mesta Machine Company, C. Fischer. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 239–247, 9 figs. Installation of mechanical devices and instruments.

BOILERS

Electrically Heated. Bergeon-Frédet Electric Boiler (Le générateur de vapeur "Bergeon-Frédet" à chauffage électrique). Houille Blanche, vol. 20, nos. 49 and 50, Jan.-Feb. 1921, pp. 24–25, 3 figs. Three-phase current of 50 periods is applied at pressure of 6500 volts.

Heat Transmission. Tests on Heat Transmission in Steam Boilers (Considération sur la transmission de la chaleur dans les générateurs de vapeur dé-

duites d'essais de vaporisation), Victor Kammerer. Bulletin de la Société Industrielle de Mulhouse, vol. 86, no. 8, Nov. 1920, pp. 519-582, 10 figs. Experiments on water-tube boiler. Empirical equations are constructed from results found.

Marine. See MARINE BOILERS.

Sectional. Sectional Boilers Composed of Sections Connected in Series and Surrounding the Feeding Chute and a New Device for Testing the Feeding Chute [Gliederkessel aus hintereinander geschalten den Füllschacht umschliessenden Gliedern und Füllschacht-Prüfungseinsatz (D.R.P.)]. Gesundheits-Ingenieur, vol. 44, no. 12, Mar. 19, 1921, pp. 134-135, 4 figs. Describes new patented device.

BOILERS, WATER-TUBE

Marine. Advantages of the Use of the Water-Tube Boiler in the Mercantile Marine, James Kemnal. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 37, part 4, Feb. 1921, pp. 185-192 and (discussion), pp. 193-208, 8 figs, partly on 3 supp. plates. Chief advantages claimed for water-tube boiler over cylindrical boiler are greater safety, possibility of using higher pressures and saving in weight.

BRAKES

Train, Automatic. Successful Test of the Automatic Straight Air Brake on the Norfolk & Western Railway. Ry. & Locomotive Eng., vol. 34, no. 4, April 1921, pp. 91-98, 12 figs.

Train, Tests. Handling 9,000 Tons Down a 1.6 per cent Grade. Ry. Rev., vol. 68, no. 14, April 2, 1921, pp. 515-521, 9 figs. Tests conducted by Norfolk & Western on control of 70-car train with automatic straight air brakes.

BRASS

Aluminum in. Influence of Small Quantities of Aluminum Upon the Properties of Brass, J. Czochralski. Brass World, vol. 17, no. 3, Mar. 1921, p. 64. Tests showed that aluminum content greater than about 0.06 per cent exerts injurious influence upon brass.

BROACHES

Burnishing. Burnishing Broaches, E. A. Dixie. Am. Mach., vol. 54, no. 14, April 7, 1921, pp. 599-601, 8 figs. How to make and use broaches. Kinds of spoiled work that may be reclaimed by their use. Turning broached work with diamond.

BROACHING

Keyways. Guide Bushings for Keyway Broaching, Carl H. Briggs. Machy. (N.Y.), vol. 27, no. 8, April 1921, pp. 767-769, 4 figs. Formulas for designing bushings for broaching accurate keyways.

BUILDING CONSTRUCTION

Electric Welding in. Electrically-Welded Structural Steelwork. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 323, 3 figs. Welding used for extension of foundry building.

BULKHEADS

Deflections. Notes on Deflections of Bulkheads and of Ships, A. M. Robb. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 407-410, 21 figs. Application of theory of beams to investigation of bulkhead stiffening.

Spacing. On the Spacing of Transverse Bulkheads, K. G. Finlay. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 403-405, 6 figs. Scheme for determining subdivisions of bulkheads.

BUSES

London. Motor Omnibus for the London General Omnibus Company, Limited. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 391-392, 9 figs. partly on supp. plate. Double deck buses with total seating capacity of 54 passengers.

C

CALCULATING MACHINES

Manufacture. Calculating Machines. Times Eng. Supp., no. 557, Mar. 1921, p. 99. Principles involved in manufacture of machines for performing divisions and extracting square roots automatically.

CAMS

Design. Calculation of Inertia Forces in Mechanisms Operated by Cams (Calcul des efforts d'inertie dans les mécanismes commandés par des cames) P. Cayére. Arts et Métiers, vol. 74, no. 4, Jan. 1921, pp. 28-30, 6 figs. Construction of acceleration graphs for typical mechanisms.

Manufacture. Production of Accurate Cams, E. A. Dixie. Am. Mach., vol 54, no. 13, Mar. 31, 1921, pp. 553-556, 15 figs. Fixtures employed in manufacture of typical cams.

CAR AXLES

Manufacture. The Manufacture of Railway Axles Ry. Engr., vol. 42, no. 494, Mar. 1921, pp. 85-87, 4 figs. Special machinery and equipment developed by British manufacturers.

CAR CONSTRUCTION

Support on Trucks. New Type of Support of a Railway Car on Trucks (Nouveau type de suspension pour voiture a bogies), M. Lehoucher. Revue générale des Chemins de Fer, vol. 39, no. 12, Dec. 1920, pp. 271-294, 28 figs. Method developed by French Southern Ry. Springs possessing variable flexibility and having no friction between their elements. Records of service of cars fitted with system.

CAR COUPLINGS

Automatic. Automatic Couplings for Railway Rolling-Stock. Ry. Engr., vol. 42, no. 495, April 1921, pp. 135-136, 4 figs. Automatic coupling on railways and terminals systems in Switzerland.

The Boonzaier Automatic Coupling. Ry. Engr., vol. 42, no. 495, April 1921, p. 129, 3 figs.

CAR WHEELS

Chilled Iron. Manufacture, Properties and Uses of Chilled Iron Wheels (Les roues en fonte trempée, leur fabrication, propriétés et usages), M. E. Polushkin. Revue de Métallurgie, vol. 18, no. 1, Jan. 1921, pp. 143-57, 10 figs. Heat-treating process. Interpretation of photomicrographs. Bibliography. (Concluded.)

CARBOCOAL

See FUELS, Carbocoal.

CARBURETORS

Manifolds, Vaporizing in. Vaporising in the Manifold, Robert W. A. Brewer. Autocar, vol. 46, no. 1324, Mar. 5, 1921, pp. 429-431, 7 figs. Study of conditions of carburation and of correct methods of insuring vaporization of fuel.

CARS, FREIGHT

Container System. Container System Extended on the New York Central. Ry. Rev., vol. 68, no. 16, April 16, 1921, pp. 600-602, 4 figs. Container system was first operated for express car and is now being extended to freight service.

Draft-Gear Tests. Draft-Gear Tests of the Railroad Administration. Ry. Mech. Engr., vol. 95, no. 4, April 1921, pp. 229-232, 4 figs. Investigations conducted by inspection and test section of Baltimore & Ohio Railroad.

Gondola. New Norfolk & Western 100-Ton Coal Cars, John A. Pilcher. Ry. Age, vol. 70, no. 15, April 15, 1921, pp. 923-928, 9 figs. Body supported on side bearings instead of center plate. New type six-wheel truck.

CARS, PASSENGER

Steel. Safety of Passengers in Steel Cars, Frank M. Brinkerhoff. Official Proc. New York Railroad Club, vol. 31, no. 5, Mar. 18, 1921, pp. 6399-6413 and (discussion) pp. 6413-6433, 12 figs. Suggests protection of steel cars with special arrangement of cable loops at ends, to prevent telescoping in accidents.

The Safety of Passengers in Steel Railway Cars, Frank M. Brinckerhoff. Ry. Mech. Engr., vol. 95, no. 4, April 1921, pp. 223-227, 8 figs. Also in Ry. Age, vol. 70, no. 12, Mar. 25, 1921, pp. 781-785, 8 figs. Discussion of action of cars in accidents and methods which will avoid telescoping. Paper read before New York Railroad Club.

The Steel Passenger Cars of the Prussian-Hessian State Railroad (Die eisernen Personenwagen der preussisch-hessischen Staatsbahnen), H. Speer. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 11 and 12, Mar. 12 and 19, 1921, pp. 261-265 and 295-297, 15 figs. Objections to steel cars with regard to rusting, loosening of parts, influence of heat and use of material are said not to be justified; the consumption of ore is offset by the saving effected in coal with the operation of the lighter-weight steel cars. Economy in construction and maintenance is set forth.

CAST IRON

Filtering. The Filtering of Cast Iron (Le filtrage de la fonte), D. Mathu. Fonderie Moderne, no. 1, Jan. 1921, pp. 9-16, 15 figs. Brunelli process for filtering cast iron by pouring it through special funnel which removes impurities.

Nickel, Influence on. Influence of Nickel on Cast Iron. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 705. Results of tests on cast iron with nickel and cobalt additions. Addition of one per cent nickel increased compressive and transverse strength 30 per cent while tensile strength increased 25 per cent and hardness 18 per cent. Effect of cobalt is reverse of that of nickel, except in respect to hardness.

CASTINGS

Centrifugal. Centrifugal Castings. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 311-312, 6 figs. Methods and machines employed for casting cylindrical articles under centrifugal pressure at works of Stokes Castings, Ltd., Mansfield, England.

Cleaning. Cleaning and Dressing Castings, F. W. Wilson. Foundry Trade Jl., vol. 23, no. 239, Mar. 17, 1921, pp. 243-246, 4 figs. Cleaning chamber for intricate castings. Paper read before Manchester Assn. Engrs.

Cleaning and Dressing Castings—II, F. W. Wilson, Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 775-777, 4 figs. Details of sand-blasting apparatus.

CEMENT

Analysis. Chemical Analyses of Cement as Indicators of Behavior. Eng. News-Rec., vol. 86, no. 15, April 14, 1921, pp. 637-639, 2 figs. Rearrangement of stock analyses recommended so as to show true content of active agents.

Slabs. New Design Data for Cement Slabs. Am. Architect, vol. 119, no. 2359, Mar. 9, 1921, pp. 287-291, 10 figs. Tests at Lehigh University on slabs poured with mixture under pressure from nozzle.

CEMENT GUN

Uses. The Application of Cement Mixtures by Machinery, George J. Young. Eng. & Min. Jl., vol. 111, no. 13, Mar. 26, 1921, pp. 537-543, 6 figs. Summary of properties and examples of use of gunite in mining and metallurgical industry. Fireproofing of underground timber and surface structures. Prevention of slabbing by sealing rock surfaces and obviating action by air and moisture.

CEMENT, PORTLAND

Cal, Effect of. Effect of Cal in Portland Cement. Public Works, vol. 50, no. 14, April 2, 1921, pp. 278-279. Result of investigation by Bur. of Standards indicates acceleration of setting without reduction of ultimate strength.

Testing. Japanese Standard Rules for Testing Portland Cement. Eng. World, vol. 18, no. 4, April 1921, pp. 273-274. Issued by Dept. of Agriculture and Commerce on Feb. 10, 1905, revised Dec. 10, 1909, and June 20, 1919. Translated by Japan Portland Cement Assn.

Portland Cement, R. E. Stradling. Concrete & Constructional Eng., vol. 16, no. 3, Mar. 1921, pp. 169-177, 13 figs. Comparative study of British and foreign standards and methods of testing portland cement. (To be concluded.)

CENTRAL STATIONS

Electric-Furnace Operation. Electric Furnaces and Central Station Charges, H. O. Swoboda. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 190-193, 3 figs. Curves illustrating decrease of cost of electric energy with increasing load factor for various maximum demands. Comparison of electric-station load in industrial districts with and without electric furnace.

Mine-Mouth. A Mine-Mouth Super-Power Station. Power, vol. 53, no. 14, April 5, 1921, pp. 532-542, 22 figs. Total capacity is to be 300,000 kw., in units of 60,000 kw. Power is generated at 12,000 volts and is stepped up to 66,000 volts through bank of three 23,600-kva. transformers in power house. Station is located near coal mine about 50 miles from Pittsburgh.

Colfax Power Station of the Duquesne Light Company, Pittsburgh, D. L. Galusha and C. W. E. Clarke. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 4, April 1921, pp. 281-294, 44 figs. Installation of two 60,000-kw. units first step in proposed 300,000 kw. power station for Pittsburgh district.

Reliability and Simplicity—Characteristics of New Colfax Station. Elec. World, vol. 77, no. 16, April 16, 1921, pp. 865-872, 19 figs. Generating station of Duquesne Light Co., designed for ultimate rating of 300,000 kw. Groups of six moderately rated stations under one roof operating in parallel on duplicate high-tension buses.

Colfax—A Superpower Plant at the Mouth of a Coal Mine. Elec. World, vol. 77, no. 14, April 2, 1921, pp. 753-760, 14 figs.

CHAINS

Anchor. New Method for Manufacture of Anchor Chain, Hubert Hermanns. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 156-158, 3 figs. German method of rolling chain from flat strip of wrought iron. Scarf weld is eliminated, making stronger and more uniform anchor chain.

CHARCOAL

Manufacture. The Production of Artificially Dense Charcoal, L. F. Hawley. Jl. Indus. & Eng. Chem., vol. 13, no. 4, April 1921, pp. 301-302, 1 fig. Report for distillation of briquets under mechanical pressure.

CHIMNEYS

Height. A New Method for Proportioning Chimney Heights, Robert Sibley and C. H. Delany. Jl. Electricity & Western Industry, vol. 46, no. 6, Mar. 15, 1921, pp. 299-300, 1 fig. Diagram showing available draft at chimney base for various rates of gas flow and chimney diameters. Rule for determining altitude.

CHROMIUM STEEL

Chromium-Tungsten. Recent Work on Chromium: Tungsten Steel—Method of Magnetic Analysis. Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 573-575, 3 figs. Review of literature of chromium-tungsten steels, specially work Japanese investigators. First of series of articles.

Microstructure. Microstructure of Chromium Steels Chem. & Metallurgical Eng., vol. 24, no. 16, April 20, 1921, pp. 703-706, 16 figs. Brief review of literature, especially from Japanese investigator Murakami, presenting structural diagram, photomicrographs and explanation of changes in transformation temperature following various reheatings

CHUCKS

Drill. Application of Interchangeability to Drill Chuck Manufacture. Machy. (Lond.), vol. 17, no. 441, Mar. 10, 1921, pp. 693-699, 9 figs. Tooling and gaging equipment in manufacturing Casler twinscrew drill chuck.

Magnetic. Magnetic Chucks—V, Ellsworth Sheldon. Am. Mach., vol. 54, nos. 14 and 15, April 7 and 14, 1921, pp. 602-605, 9 figs., and 650-652, 7 figs. Chucks manufactured by Blanchard Machine Co.

COAL

Carbonization. The Assay of Coal for Carbonisation Purposes, Thomas Gray and James G. King. Colliery Guardian, vol. 121, no. 3141, Mar. 11, 1921, pp. 716-717, 2 figs. Laboratory method. Technical paper of British Fuel Research Board.

Research. Fuel Research Bureau Advocated to Solve Problems of Scientific Use and Handling of Coal, F. R. Wadleigh. Coal Age, vol. 19, no. 13, Mar. 31, 1921, pp. 581–583. Lancashire and Cheshire (England) coal research association, suggested as model, resembles U. S. war research board, but is broader in scope. Has coal-testing plant and laboratory and also makes commercial investigations. Plan for American commission outlined.

Spontaneous Combustion. Causes of Spontaneous Combustion in Coal and Method of Treatment of Underground Fires, K. Neville Moss. Iron & Coal Trades Rev., vol. 102, no. 2769, Mar. 25, 1921, pp. 425–426, 3 figs. Effect of presence of iron pyrites in connection with underground fires.

COAL DUST

Combating Dangers of. Mine Dusts. Sampling, Testing and Treatment, W. H. McMillan. Iron & Coal Trades Rev., vol. 102, no. 2767, Mar. 11, 1921, pp. 345–346. Methods of combating dangers arising from accumulations of coal dust, with reference to regulations recently enacted by British Government. Paper read before South Midland Branch, Nat. Assn. Colliery Managers.

COAL HANDLING

Belt Conveyor. Belt Conveyor Transfers Coal Across River with Suspension Bridge as Support, R. W. Shumway. Coal Age, vol. 19, no. 12, Mar. 24, 1921, pp. 525–527, 2 figs. With mine on one side of river and railroad on other it was necessary to move coal across stream without interfering with navigation. This was accomplished by means of suspension bridge carrying belt conveyor.

COAL WASHING

Froth Flotation. Froth Flotation as Applied to the Washing of Industrial Coal, Ernest Bury, Walter Broadbridge and Alfred Hutchinson. Trans. Insto. Min. Engrs., vol. 60, part 3, Feb. 1921, pp. 243–253, 4 figs. Principles of froth flotation and account of operation of froth-flotation process. Representative results obtained on various types of material. Economical aspects of process specially as applied to preparation of coal for production of metallurgical coke.

COKE

Testing. Standardizes the Testing of Coke. Iron Trade Rev., vol. 68, no. 15, April 14, 1921, pp. 1037–1038, 2 figs. Committee report of Southern Ohio Pig Iron Assn

COMBUSTION

Surface. The Development of Surface Combustion. (Zur Entwicklung der Oberflächenverbrennung), Otto Essich. Stahl u. Eisen, vol. 41, no. 7, Feb. 17, 1921, pp. 228–232, 16 figs. Gives experiences with small furnaces which, it is claimed, taking into consideration change of conditions, can also be applied to large furnaces.

COMPRESSED AIR

Metering. The Metering of Compressed Air, John L. Hodgson. Trans. Instn. Min. Engrs., vol. 60, part 3, Feb. 1921, pp. 271 280 and (discussion) pp. 280–287, 17 figs. Construction and operation of various types of meters.

CONCRETE

Blast-Furnace Slag. Tests with Blast-Furnace Slag (Versuche mit Hochofenschlacke), H. Burchartz. Stahl u. Eisen, vol. 41, no. 6, Feb. 10, 1921, pp. 193–200, 2 figs. Concrete from blast-furnace slag of the kind tested is said to harden just as well in salt water and is just as durable as gravel concrete. Results of tests show that blast-furnace slag is just as suitable for the production of concrete as natural gravel; and also that the resistivity of cement concrete in salt water is dependent primarily on the density of the concrete material.

Expansion and Contraction. Expansion and Contraction in Concrete Structures, Albert M. Wolf. Eng. World, vol. 18, no. 4, April 1921, pp. 233–236, 1 fig. Experimental results found by various investigators. Derivation of empirical formula for determining net contraction of concrete.

Proportioning. Proportioning Concrete on Job by Exact Methods, R. B. Young and T. V. McCarthy. Eng. News-Rec., vol. 86, no. 11, Mar. 17, 1921, pp. 456–458, 2 figs. Method developed by Hydro-electric Power Commission of Ontatio.

Scientific Concrete (Hormigon científico), Roderick B. Young. Ingenieria Internacional, vol. 5, no. 5, May 1921, pp. 272–275, 4 figs. Method for proportioning aggregates of concrete based on surface of gravel units and experiments conducted to determine best proportions.

The New Methods of Proportioning Concrete in Theory and Practice, Roderick B. Young. Jl. Boston Soc. Civil Engrs., vol. 8, no. 3, Mar. 1921, pp. 73–108, 13 figs. Investigations of hydroelectric power commission of Ontario.

CONCRETE BLOCKS

Casting. The Calculation of Concrete Blocks (Note sur le calcul des pièces en béton de ciment fondu), A. V. Magny. Revue de l'Ingénieur, vol. 28, no.

brick, tile and architectural trim stone.

CONCRETE MIXERS

Sprenger Type. New Process of Making Concrete (Un nouveau procédé de fabrication du béton), E. Weiss. Nature (Paris), no. 2444, Feb. 5, 1921, pp. 95–96, 4 figs. Mixing apparatus invented by M. Sprenger. Wet sand and gravel are blown through atmosphere saturated with cement.

CONCRETE CONSTRUCTION, REINFORCED

Steel Forms. Steel Forms for Concrete Columns and Floor Slabs. Am. Architect, vol. 119, no. 2360, Mar. 16, 1921, pp. 332–334, 6 figs. Description of metal forms used in construction of Columbia Graphophone Co.'s new seven-story structure in Baltimore.

CONCRETE, REINFORCED

Reinforcing Steel. Tests on High Tension Steels in Reinforced Concrete Design, H. Kempton Dyson. Concrete & Constructional Eng., vol. 16, no. 3, Mar. 1921, pp. 161–168, 1 fig. Report of special committee on high tension steel in reinforced concrete of British Concrete Inst.

CONDENSERS, STEAM

Surface. Installations for the Prevention of Scale Formation in Surface Condensers (Anlagen zur Verhütung von Wassersteinbildung in Oberflächen-Kondensationen), Hans Rissmann. Zeit. des Oberschlesischen Berg- u. Hüttenmännischen Vereins, vol. 59, no. 6, 1920, pp. 185–205, 33 figs. Discusses means employed heretofore in prevention of scale formation from the cooling water; describes the Balcke inoculation process as a protection against incrustation and silting up with mud and demonstrates its economic value.

COPPER

Tests. Experiments on Copper Crusher Cylinder, Alexander I. Krynitsky. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 185, Feb. 1, 1921, 32 pp. 15 figs. Compression tests on standard Riehlé testing machine Length of cylinders decreased considerably under repeated application of load.

COPPER ALLOYS

Copper-Nickel. Copper-Nickel Alloys, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 558–560, 4 figs. Notes on structure and properties of alloys used for driving bands, condenser tubes and coinage. Various names and analyses for nickel silver are tabulated, with notes upon their most common uses.

Copper-Tin. The Constitution of the Alloys of Copper with Tin, III. John L. Haughton. Metal Industry, (Lond.) vol. 18, no. 13, April 1, 1921, pp. 241–247, 7 figs. Transformations other than formation of eutectic, occurring below 250 deg. cent. Range of composition studied was from about 40 per cent tin to 100 per cent tin.

Heat Treatment. Heat Treatment of Copper Alloys, J. S. Glen Primrose. Foundry Trade Jl., vol. 23, no. 241, Mar. 31, 1921, pp. 291–296, 10 figs. Experimental study of effect of heat-treatment upon tensile properties of copper-aluminum and copper-zinc alloys. Paper read before Instn. British Foundrymen.

Properties. Plastic Deformation of Some Copper Alloys at Elevated Temperatures, C. A. Edwards and A. M. Herbert. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 341–344, 11 figs. Also in Metal Industry (Lond.), vol. 18, no. 12, Mar. 25, 1921, pp. 221–229, 11 figs. Apparatus designed by writers for making indentation tests under dynamic stresses. Results of experiments with copper-zinc and copper-aluminum alloys. Paper read before Inst. of Metals.

CORROSION

Boiler Tubes. Unusual Boiler Tube Corrosion by Carbon Dioxide, Barzillai G. Worth. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, no. 28, pp. 329–335, 2 figs. Corrosion was located as due to soluble iron bicarbonate in water used, which gave off large quantities of carbonic acid gas when heated in boiler.

Heating Systems. Practical Means of Preventing Corrosion of Iron and Steel Were Not Exposed Directly to the Atmosphere, F. N. Speller. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 5, pp. 37–46, 2 figs. Method sof deoxidizing water to prevent corrosion in hot-water heating systems.

Iron and Steel. Experiments on the Corrosion of Iron and Steel, T. S. Fuller. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, no. 29, pp. 337–346, 16 figs. Observations of behavior of drops of water standing on pure iron and other metals, also standing partly on iron and partly on zinc or brass. Oxidation is usually perceptible in one minute and quite marked in 15 min.

Some Observations on the Mechanism of the Increased Corrosion Resistance of Steel and Iron Due to Small Copper Contents, D. M. Buck. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 6, pp. 47–53, 3 figs. Results of experiments.

some were in fair condition and others in poor condition.

Iron and Steel Pipe. Control of Corrosion in Iron and Steel Pipes, F. N. Speller. Jl. Eng. Inst. Canada, vol. 4, no. 4, April 1921, pp. 233–237, 2 figs. Causes of corrosion, external and internal, in iron and steel pipe mains with summary of control methods.

Non-Ferrous. Some Types of Non-Ferrous Corrosion, H. S. Rawdon. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 9, pp. 73–79, 8 figs. Examples of each of four types of corrosion: Selective attack of certain constituents; intercrystalline brittleness; internal oxidation; and simultaneous action of stress and corrosion.

Prevention. Principles of Alloying to Resist Corrosion, Oliver P. Watts. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 10, pp. 81–84, 1 fig. General principle is laid down that less corrodible alloys are either metallic compounds of simple chemical formula or solid solutions of more resisting metals in each other. Test proving protective action of copper in steel is given.

Theories. A Practical Aspect of the Corrosion Problem, John F. Thompson. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21–23, 1921, no. 30, pp. 347–354. Comparative study of various corrosion theories.

CRANES

Gantry. Special Storage Gantry. Iron Age, vol. 107, no. 16, April 21, 1921, p. 1041, 1 fig. Gantry crane of special design installed at storage yard of Peerless Motor Car Co., Cleveland.

Hammerhead. A Hammerhead Crane for the Harbor of Christiana, Norway (En Stor Kran). Teknisk Ukeblad, vol. 68, no. 2, Jan. 14, 1921, pp. 20–22, 2 figs. Cranes lifts 100 tons to a height of 25 m. and is intended mainly for installation and removal of boilers and ship engines. Its largest radius is 28 m.; motors, operated by alternating current at 220 volts, have a total capacity of 238 hp.

Traveling. Electromagnetic Traveling Crane of Five Tons Capacity and Twenty-Five Meters Radius (Pont-roulant électrique special de 5 tonnes et 25 mètres de portée), W. Druey. Bulletin technique de la Suisse romande, vol. 47, no. 6, Mar. 19, 1921, pp. 66–69, 4 figs. Installed at Oerlikon works for transporting structural steel.

CUTTING TOOLS

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, (special no.) vol. 3, no. 11, Mar., 1921, pp. 147–152, 7 figs. Proposed new standards for hand wheels, grain-milling rolls, and cutting tools.

CYLINDERS

Block Production. Utilization of Special Machines in Cylinder Block Production, J. Edward Schipper. Automotive Industries, vol. 44, no. 14, April 7, 1921, pp. 756–759, 22 figs. Manufacture of Paige cylinder blocks.

D

DIE CASTING

Developments. Die-Casting Methods and Metals—I, M. H. Potter. Foundry, vol. 49, no. 8, April 15, 1921, pp. 303–306. Advantages and limitations of die casting are discussed and development and present-day practice are outlined.

DIES

Bending. The Design and Construction of Press Tools. Eng. Production, vol. 2, nos. 24 and 26, Mar. 17 and 31, 1921, pp. 346–348, 8 figs., and 404–405, 6 figs. Design of bending and curling dies.

Shells. Dies for Producing a Conical Part, N. T. Thurston. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 772–775, 14 figs. Operations in manufacturing system.

DIESEL ENGINES

Marine. Adjustment of Crosshead-Pin Bearings and Main Bearings of Marine Diesel Engines, Louis R. Ford. Power, vol. 53, no. 14, April 5, 1921, pp. 546–547, 3 figs. Details of procedure.

Building Diesel Marine Engines for Seagoing Vessels—II, Fred B. Jacobs. Mar. Rev., vol. 51, no. 5, May 1921, pp. 221–229, 23 figs. Practice at works of Busch-Sulzer Bros., St. Louis, Mo.

The Polar Marine Diesel Engines. Practical Engr., vol. 63, no. 1775, Mar. 3, 1921, pp. 134–137, 4 figs. Four-cylinder type developing 500 b.hp. at 150 r.p.m.

Nordberg. Largest Stationary Diesel Engine in the United States. Power, vol. 53, no. 13, Mar. 29, 1921, pp. 498–501, 7 figs. Nordberg 2000 b.hp. vertical Diesel engine of valve-in-head scavenging two-stroke-cycle, single-acting type. Four power cylinders, 500 b.hp. each, scavenging pump and air compressor driven by crankshaft. Engines to be direct-connected to 1350-kw. a. c. generators to supply electrical service to copper mines.

Oil-Fuel Injection. Some Experiments in Connection with the Injection and Combustion of Fuel Oil in Diesel Engines, C. J. Hawkes. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 37, part 2, Dec. 1920, pp. 37-92, 28 figs. Experiments carried out at British Admiralty Engineering Laboratory in connection with development of high-speed engines for naval purposes.

Standardization. Standardized Diesel Engines—II, H. R. Setz. Mar. Eng., vol. 26, no. 4, April 1921, pp. 324-328, 8 figs. Discussion of construction involving four valves in cylinder head. Study of propelling characteristics.

Werkspoor. The "Werkspoor" Diesel Engines (Inleiding tot het bezichti gen vande Diesel-motoren voor de Billiton-Maatschappij) and (Inleiding tot een bezoek aan de Dieselmotoren-afdeeling van "Werkspoor"), G. J. Lugt. Ingenieur, vol. 36, no. 5, Jan. 1921, pp. 82-87 and 87-94, 25 figs. Describes two large stationary engines, constructed for the Billiton Co., with six cylinders of 5600 by 1000 mm. and 600 r.p.m. which are directly coupled with 3-phase generators; the cylinders are arranged on a distance piece which is tied to base plate; pressure lubrication, combined crankshafts, 3-stage compressors, and cooling of pistons through telescopic tubes. In second paper author discusses certain constructions intended for marine engines only.

DRILL CHUCKS

Manufacture. Application of Interchangeability to Drill Chuck Manufacture—II. Machy. (Lond.), vol. 17, no. 442, Mar. 17, 1921, pp. 725-730, 18 figs. Tooling and gaging equipment employed in manufacturing Casler twin-screw drill chuck.

DRILLING MACHINES

Automatic. Special Automatic Drilling Machines. Iron Age, vol. 107, no. 15, April 14, 1921, p. 975, 1 fig. Machine designed to drill six holes within slotted space 1 in. long on door-lock cylinder. Manufactured by Langelier Mfg. Co., Providence, R. I.

Inverted-Spindle. Defiance Inverted-Spindle Drilling Machine, J. V. Hunter. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 633-634, 2 figs. Machine constructed by Defiance Machine Works, Defiance, Ohio.

Radial. The Advantage of Rigid Construction in Radial Drilling Machines (Der Vorteil der stabilen Durchbildung von Radial-Bohrmaschinen), Fritz Hensel. Betrieb (special no.), vol. 3, no. 11, Mar. 1921, pp. 302-305, 6 figs. Demonstrates approved construction and economical drive of modern radial drilling machines, and presents curves showing difference in the performance of modern rigid types as compared with older forms of machines.

DRILLS

Standard. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 171-180, 11 figs. Proposals of the Board of Directors for tool tapers, Morse tapers, conical reamers for Morse and metric tapers, and metric tapers. As a basis for the standardization of the Morse tapers the original table of the Morse Twist Drill & Machine Co., New Bedford, Mass., is used.

Twist. The Utilization of Broken Twist Drills (Die Wiederverwendung von gebrochenen Spiralbohrern), H. Kummer. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 267-269, 1 fig. Patented device by means of which it is possible to make use of broken twist drills.

Wood Bits and Center Drills. Wood Bits and Adjustable Center Drills (1. Holzbohrer. 2. Verstellbare Zentrumbohrer), Otto Wenzel. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 272-278, 45 figs. Wood bits: Classification of bits according to drilling work; comparison of different kinds with regard to shape and use in auxiliary tools and machines. Adjustable-center drills: Investigation of the different types with regard to cutting angle, adjustability, renewal of separate parts, formation of cutting and strength.

DROP FORGINGS

Malleable Iron versus. Why Drop Forgings Are Replacing Malleable Iron Castings, F. B. Fairbanks. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 173-175, 8 figs. Comparative study of photomicrographs.

E

EDUCATION, ENGINEERING

Industrial Production. The Scarcity of the College-Trained Engineer in Production, John Airey. Eng. Education, vol. 11, no. 6, Feb. 1921, pp. 290-297. Suggests college engineering institution spend transitory period as foremen in factory instead of in office or laboratory. This, it is believed, would fit them better to direct production in industry properly.

ELECTRIC DRIVE

Steel Mills. The Frequency Problem in the Steel Industry, B. G. Lamme. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 4, April 1921, pp. 294-300. Possibilities for utilization of 50 cycles. Comparative advantages and disadvantages of 25 and 60 cycles.

ELECTRIC FURNACES

Electrodynamic Forces in. Electrodynamic Forces in Electric Furnaces, Carl Hering. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21-23, 1921, advance paper no. 19, pp. 201-211, 4 figs. Utilization of electrodynamic forces to cause liquid metal to flow rapidly through heat-developing resistor, thereby enabling furnace to be forced and to cause strong upward circulation in adjoining bath, by which metal is refined of suspended impurities and made homogeneous.

Heroult. Electric-Furnace Practice at Treadwell, W. E. Cahill. Min. & Sci. Press, vol. 122, no. 16, April 16, 1921, pp. 535-537, 2 figs. Heroult electric furnace used by Alaska Treadwell Gold Mining Co.

Inductive. Recent Progress in High Frequency Inductive Heating, E. F. Northrup. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21-23, 1921, paper no. 18, pp. 179-200, 13 figs. Furnaces of certain types are described and actual performances given, showing them to run at 30 to 40 per cent electrothermal efficiency.

Muffled Arc. Develops New Non-Ferrous Melting Furnace. Iron Trade Rev., vol. 68, no. 16, April 21, 1921, pp. 1115, 2 figs. Muffled-arc type manufactured in two sizes by Gen. Elec. Co.

Muffled Arc Electric Furnace for Non-Ferrous Metals. Iron Age, vol. 107, no. 15, April 14, 1921, pp. 985-986, 4 figs. Type manufactured by Gen. Elec. Co. in two sizes, a 1500-lb. unit and a 50-lb. unit.

New Types of Electric Furnaces. Metal Industry, (N. Y.) vol. 19, no. 4, April 1921, pp. 149-150, 4 figs. Muffled arc furnaces developed by Gen. Elec. Co. for melting non-ferrous metal.

Non-Ferrous Alloys. Electric Furnaces for Non-Ferrous Alloys, H. W. Gillett. Am. Electrochemical Soc., Thirty-Ninth Gen. Meeting, April 21-23, 1921, no. 24, pp. 277-295. Tabulates in detail all electric furnaces in U. S. melting non-ferrous metals giving kind of furnace, users, and capacity per heat. There are 323 electric furnaces in 144 different plants with capacity of 193 tons per single heat and using 42,350 kw.

Non-Ferrous Industry. Electric Melting in Non-Ferrous Industry, Edwin F. Cone. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 770-772. Present status in U. S. Marked increase in last year. Furnaces sold total 408.

New Electric Furnace for Non-Ferrous Industry. Iron Age. vol. 107, no. 12, Mar. 24, 1921, pp. 772-773, 4 figs. Patented H. & H. reverberatory furnace. Heat is changed by means of arcs drawn between vertical electrodes and conducting horizontal bed within furnace.

Open-Hearth Versus. Makes Comparison of Melting Costs. Foundry, vol. 49, no. 8, April 15, 1921, pp. 315-318, 3 figs. Ohio Steel Castings Co. operating both electric and open-hearth furnace gives data covering two processes from which estimated costs are calculated.

Steel Manufacture. Electric Furnaces for Making Steel—II, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 263-266, 5 figs. Classification of electric steel-making furnaces. General features and advantages of arc furnace and resistance furnace. Operating features of electric furnaces.

Electric Furnaces in Steel Manufacture (Le chauffage dans les fours électriques d'aciérie), M. M. Gillot and M. V. Guillermin. Revue de l'Industrie minréale, no. 5, Mar. 1, 1921, pp. 249-257, 10 figs. Types used.

The Regulation of Electric Steel Arc Furnaces Using Movable Electrodes, W. G. Mylius. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21-23, 1921, advance paper no. 20, pp. 213-225, 8 figs. Discussion of difficulties of operating arc furnaces for melting steel, particularly when melting cold scrap, and of kinds of arc current regulators which have been devised to maintain some function of power imput constant, such as current, voltage, watts, or a combination of these.

ELECTRIC LOCOMOTIVES

Swiss. Swiss Electric Locomotive Progress. Elec. Ry. Jl., vol. 57, no. 16, April 16, 1921, pp. 724-727, 9 figs. Details are given of recent locomotives manufactured by leading two builders of electrical apparatus in Switzerland. Particular attention is given to machines for federal railways. Some experiments with new types of drive are included, indicating leaning toward gears as substitute for side rods.

ELECTRIC WELDING, ARC

Rate of Cutting. Solving Arc Welding Problems, A. M. Candy. Iron Trade Rev., vol. 68, no. 12, Mar. 24, 1921, pp. 829-835, 19 figs. Graphs showing rate of cutting cast iron, malleable iron and steel by arc process. Tests of welds. Paper read before Am. Foundrymen's Assn.

Theory of. Phenomena of Arc Welding, O. H. Eschholz. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21-23, 1921, advance paper no. 8, pp. 59-71, 16 figs. Study of metal deposition, fusion and arc stability during electric welding.

ELEVATORS

Safety Factor for Cables. The Safety Factor in Elevator Cables (Om säkerhetsfaktorn vid hisslinor), Nils Melander. Teknisk Tidskrift (Mekanik), vol. 51, no. 1, Jan. 12, 1921, pp. 14-18. Calculation of the cables. Official regulations for safety factor. Two calculating methods are described, one of which is officially used in Prussia and is recommended by author for use also for self-operating elevators.

EMPLOYEES

Rating. Giving the Worker a Card-Index Rating, Frank H. Williams. Iron Age, vol. 107, no. 16, April 21, 1921, pp. 1033-1035, 1 fig. Practice of S. F. Bowser & Co., Ft. Wayne, Ind., manufacturers of storage systems for oil and gasoline. Employees are marked monthly on 10 points. Records form bases for production.

EMPLOYMENT MANAGEMENT

Employees Lists. What About Your Labor Force When Business Picks Up? Factory, vol 26, no. 7, April 1, 1921, pp. 831-834, 1 fig. Advises record of names, addresses and qualifications of workers applying for positions, even though at time of application they cannot be hired, with a view to insure sufficient supply of workers when production again demands.

Promotion Methods. Keeping Employees in Line for Promotion, Robert I. Clegg. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 761-763, 2 figs. Forms for keeping perpetual inventory of employees giving record of service, successive promotions, personal elements, outside activities, education and hobbies.

ENGINEERS

Civic Duties. Engineering in a Broader Aspect, Dean Mortimer E. Cooley. Michigan Technic, 34, no. 1, Mar. 1921, pp. 18-24. Urges organized cooperation of engineers among themselves and their participation in civic affairs as duties engineers owe to modern complex civilization.

Professional Practice. Operating Costs of Engineering Practice. Eng. News-Rec., vol. 86, no. 13, Mar. 31, 1921, pp. 542-543, 3 figs. Factors include education, capacity, class of work, and direct and indirect expenses of business. Organization chart of an engineering firm. Forms for cost keeping.

Registration. Licensing of Engineers. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 3, April 1921, pp. 326-335. Abstract covering present status of legislation for licensing of engineers in various states. Report of Publication Committee, Am. Soc. of Heat & Vent. Engrs.

Remuneration. Fees for Practicing Engineers. Eng. World, vol. 18, no. 4, April 1921, pp. 247-251, 4 figs. Progress report made by committee of Am. Assn. of Engrs.

EXCAVATORS

Mechanical. Mechanical Excavators (Les excavateurs mécaniques). Génie Civil, vol. 78, no. 9, Feb. 26, 1921, pp. 185-190, 12 figs. Survey of recent developments and uses.

EXPLOSIONS

Grain Dust. Dust Explosion at Large Chicago Grain Elevator. Eng. News-Rec., vol. 86, no. 13, Mar. 31, 1921, pp. 560-562, 2 figs. Explosion in Chicago grain elevator of Chicago & Northwestern Railway. Six men were killed and 4 injured, and about 500,000 bushels of grain were lost or damaged.

F

FACTORIES

Construction. Auto Body Plant Built of Reinforced Concrete, V. E. Winell. Concrete, vol. 18, no. 4, April 1921, pp. 160-164, 6 figs. Plan and layout of Fisher Body Ohio Co.'s plant.

Layout. Plant Layout Studies by Concrete Institute Committee. Eng. News-Rec., vol. 86, no. 12, Mar. 24, 1921, pp. 505-507, 4 figs. Report submitted at annual convention embodies description of, and comparative costs upon seven fundamental types.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FATIGUE

Steel Works. Fatigue and Efficiency in Iron and Steel Works—IV, H. M. Vernon. Eng. & Indus. Management, vol. 5, no. 11, Mar. 17, 1921, pp. 320-323, 2 figs. Investigations undertaken for British Industrial Fatigue Research Board. Influence of reduction of hours on rolling-mill output.

FERRONICKEL

Anomaly of Expansion. Effect of Additions in the Anomaly of Expansion of Ferronickels—Application to Ferro-Nickel-Chrome Alloys (L'action des additions sur l'anomalie de dilatation des ferronickels; application aux alliages fer-nickel-chrome), M. P. Chevenard. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 10, Mar. 7, 1921, pp. 594-596, 2 figs. Graphs plotted from results obtained in experiments.

FILES

Handles. Steel Files with Attachable Handles. (Bezugfeilen), Karl Küssner. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 263-265, 7 figs. Sets forth advantages of described type and points out that for special purposes special files of this system are made with which the inside walls of steam-engine cylinders can be treated.

Revolving. Rotating Files (Rotierende Feilen), F. Karpinski. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 259-263, 9 figs. Describes new method using a rapidly revolving round file which, it is claimed, in many cases and particularly for special purposes, effects considerable saving in labor and greater accuracy of work.

FIREBRICK

Tests. Comparing Brick for Boiler Furnace Linings, R. C. Brierly. Combustion, vol. 4, no. 4, April 1921, pp. 20-22 and 41, 2 figs. Records of tests.

FLOW OF LIQUIDS

Short Tubes. The Flow of Liquids Through Short Tubes, Winslow H. Herschel. Proc. Am. Soc. Civil Engrs., vol. 47, no. 3, Mar. 1921, pp. 35-36. Tests on "inverted" Saybolt Universal viscosimeter. Determination of kinetic energy correction for turbulent flow from experiments of Couette. (Abstract.)

FLOW OF WATER

Measurements. Measuring Water Flow for Power Purposes, N. R. Gibson. Mech. Eng., vol. 43, no. 4, April 1921, pp. 247–248, 1 fig. Description of Gibson method and apparatus and account of its application in efficiency tests of 37,500-hp. turbines of Niagara Fall Power Co. Mean velocity of column of water in penstock by recording changes of pressure at point in pipe line when flow of water therein is gradually brought to rest by closing valve or turbine gates. Mean change or pressure recorded is measure of velocity destroyed.

FOUNDRIES

Mechanical Equipment. Pulleys Predominate in Unique Shop, Pat Dwyer. Foundry, vol. 49, no. 8, April 15, 1921, pp. 293–299, 12 figs. Practice in handling materials at foundry of Hill Clutch Co., Cleveland.

Stove. Specialty Shop Shows Versatility. Foundry, vol. 49, no. 7, April 1, 1921, pp. 265–270, 10 figs. Method and process of foundry at Fanner Mfg. Co., Cleveland, manufacturers of stoves and other articles.

FREIGHT HANDLING

Bibliography. Bibliography on Freight Handling, R. F. Emerson. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 371–380. List of articles on general subject of material handling that have appeared in technical press since 1914.

FUELS

Ash, Fusibility of. What Constituents in Ash Cause It to Fuse, G. A. deGraaf. Coal Age, vol. 19, no. 12, Mar. 24, 1921, pp. 534–539, 5 figs. Graphs showing relation of fusing temperature of ash to percentage of silica, iron oxide and sulphur.

Calorific Value. A Proposed New Measure of Calorific Power, E. Damour. Gas Jl., vol. 154, no. 3021, April 6, 1921, pp. 29–30, 1 fig. Measurement of calorific power of fuels, particularly wood, peat and lignite and other substitutes for coal. Duplex-combustion producer furnace for utilization of low-grade fuels. Translated from Chimie et Industrie.

Carbocoal. The Smith Continuous System of Carbonization, George H. Thurston. Jl. Soc. Chem. Industry, vol. 40, no. 5, Mar. 15, 1921, pp. 51T–56T, 4 figs. Combination of low and high temperature carbonization. Coal is crushed to pass 3/8-in. mesh screen and is subjected to primary carbonization at temperature of about 480 deg. cent. to reduce its volatile content to uniformly low figure, whereby it is converted into friable residue containing 7 to 10 per cent of volatile matter, called semi-carbocoal. After passing through retort material is ground and mixed with suitable percentage of pitch and briquetted.

Carbozite. Carbozite (Karbozit), H. R. Trenkler. Feuerungstechnik, vol. 9, no. 11, Mar. 1, 1921, pp. 93–95, 2 figs. Said to be a refined product of lignite, wood or peat, which is not a coked material but a kind of artificial rough coal, differing in this respect from carbocoal which is a semi-coke from anthracite. The chemical and thermotechnical basic principles of process are discussed.

Colloidal. Properties and Characteristics of Colloidal Fuel, Lindon W. Bates and Haylett O'Neill. Power Plant Eng., vol. 25, no. 7, April 1, 1921, pp. 368–369, 2 figs. Graphs showing heating value of colloidal fuel of different compositions. Papers read before Royal Soc. Arts.

Domestic. The Relative Efficiency of Coal, Gas, and Electricity for Domestic Purposes, E. Marsden and (Miss) E. W. J. Fenton. New Zealand Jl. Sci. & Technology, vol. 3, nos. 5 & 6, Jan. 1921, pp. 257–270, 7 figs. It was found in tests that gas is over three times and electricity over four times more expensive for general domestic purposes than coal.

Economical Utilization. Work of the Committee on Utilization of Fuels (Travaux de la commission d'utilisation des combustibles), V. Kammerer. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 120, no. 3, Mar. 1921, pp. 286–301. Committee report submitted to French Ministry of Public Works. Instructions are formulated for engineers and assistants and suggestions are given in regard to economical production and utilization of steam. From Journal officiél, Feb. 20, 1921.

Recovery from Furnace Residues. Recovery of Fuel from Furnace Residues (Brennstoffgewinnung aus den Feuerungsrückständen), H. Winckel. Gesundheits-Ingenieur, vol. 44, no. 3, Jan. 15, 1921, pp. 31–32. Describes process and the Kolumbus ash separator of firm of Benno Schilde, Hersfeld, according to which the fine ashes and the large pieces of slag are sifted from the residue after which the heavy slags are separated from the light coke in a liquid of 25 to 30 deg. Baumé by means of the specific weight.

The Kolumbus Separator and the Schilde Process for the Treatment of Furnace Residues (Der Kolumbus-Separator und das Schildeverfahren zur Aufbereitung der Fererungsrückstände), H. Pradel. Elektrotechnischer Anzeiger, vol. 38, no. 30, Feb. 23, 1921, pp. 155–156, 2 figs. Describes new wet process introduced by firm of Benno Schilde, Hersfeld, Germany, in which separating liquid is used which is heavier than water, and the Kolumbus separator used in connection therewith, said to be a comparatively simple and cheap apparatus produced in three sizes. Its economical advantages are set forth.

[See also ASHES LIGNITE; OIL FUEL; PEAT; PULVERIZED COAL.]

FURNACES, ANNEALING

Sheet. Heating Furnaces and Annealing Furnaces, W. Trinks. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 267–272, 20 figs. Comparison of different types of sheet furnaces.

FURNACES, BOILER

Construction. Working Pressures on Furnaces, John S. Watts. Boiler Maker, vol. 21, no. 4, April 1921, pp. 112–114, 1 fig. Chart for calculating thickness of boiler furnaces to conform with requirements of principal classification societies.

Types. The Behavior of Fuels in Boiler Furnaces and Measures for Heating Them (Das Verhalten der Brennstoffe in den Kesselfeuerungen und die Massnahmen für ihre Verheizung), H. Deinlein. Zeit. des Bayerischen Revisions-Vereins, vol. 25, nos. 3 and 4, Feb. 15 and 28, 1921, pp. 17–19 and 28–30. Notes on influence of the heating value of coal on utilization of heat, draft requirement of a fuel, water content, rate of combustion, and air requirement. Discussion of horizontal-grate, step-grate and traveling-grate furnaces.

FURNACES, FORGING

Gas-Fired. The Application of Gas to Forging Furnaces. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 178–181. Results of tests. Paper read before Am. Gas Assn.

FURNACES, HEATING

Ingot. Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 3, Mar. 1921, pp. 159–161, 8 figs. Critical comparison of different types of furnaces in use for heating of heavy forging ingots.

FURNACES, HEAT-TREATING

Oil Burning. Heat Treating Plant at Nash Motor Works. Iron Age, vol. 107, no. 14, April 7, 1921, pp. 895–898, 5 figs. Double carbonizing furnaces heated by oil. Automatic signal system on columns indicates furnace temperatures. Corrugated steel wall shuts heat from room.

G

GAGES

Dial. Capstan Dial Gauge. Engineering, vol. 121, no. 2881, Mar. 18, 1921, pp. 322–323, 5 figs. Indicator gages constructed by Coventry Gauge & Tool Co., England.

Precision. Precision Gauge Manufacture, Arthur G. Robson. Engr., vol. 131, no. 3404, Mar. 25, 1921, pp. 312–314, 26 figs. Jigs and fixtures employed. Example of calculations involved.

Spline. Making Inserted Spline Gauges. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 768–770, 6 figs. Method of milling splines and flats.

GAS ENGINES

Waste-Heat Utilization. The Utilization of Waste Heat from Gas Engines (Abwärmeverwertung bei Gasmaschinen), W. Schlachter. Oel- u. Gasmaschine, vol. 18, nos. 1 and 2, Jan. and Feb. 1921, pp. 9–12 and 22–23. Method of utilizing waste heat of cooling water.

GAS TURBINES

Developments. Gas Turbines (Ueber Gasturbinen), H. Sickel. Elektrotechnischer Anzeiger, vol. 38, nos. 32 and 33, Feb. 26 and Mar. 1, 1921, pp. 165–166 and 177–178, 3 figs. Notes on present and future development.

GEAR CUTTING

Fixtures. Efficient Fixtures Used in Gear Cutting, Douglas T. Hamilton. Can. Machy. vol. 25, no. 13, Mar. 31, 1921, pp. 33–36, 10 figs. Methods of testing truth of arbor and work.

GEAR DRIVE

Friction Losses. Running Loss and Temperature Increase in Gear Drives (Arbeitsverlust und Temperaturerhöhung bei Triebwerken), H. Bonin. Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 377–378. It is shown that the increase in temperature of gear drive due to friction is an indication of the running losses caused by the friction, for the numerical evaluation of which, however, extended experimental data are necessary.

GEARS

Bevel. Turning Bevel Gear Blanks. Eng. Production, vol. 2, no. 26, Mar. 31, 1921, pp. 411–414, 13 figs. Production on automatic machines.

Helical. The Production of Helical Gears. Eng. Production, vol. 2, no. 27, April 7, 1921, pp. 440–443, 8 figs. Procedure in works of Citroën Gear Co., France.

Involute. Angles of Approach, Recess and Contact of Involute Gears, A. B. Cox. Am. Mach., vol. 54, no. 13, Mar. 31, 1921, pp. 559–561, 6 figs. Derivation of formulas.

Involute Gear Problems, H. E. Kitchen. Machy. (London.), vol. 18, no. 445, April 7, 1921, pp. 11–14, 6 figs. Enlarging gears without backlash. Avoidance of undercut.

The Evolution of the Involute Gear Tooth, A. Fisher. Machy. (Lond.), vol. 17, nos. 441 and 444, Mar. 10 and 31, 1921, pp. 714–718, 9 figs., and 806–809, 11 figs. Early solutions of odontoid; general rolled curve or roulette solution.

Maag System. The Maag System of Gearing—I. Engr., vol. 131, no. 3403, Mar. 18, 1921, pp. 283–285, 5 figs. Generating cutting machine. Involute teeth are generated by means of reciprocating rack cutter with straight-side teeth.

Production System. Quantity Production in a Gear Shop—I, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 763–766, 10 figs. Practice of Dittmer Gear & Mfg. Corp., Lockport, N. Y., in manufacture of gears for tractors, trucks and automobiles.

Worm. Calculating Chart for Worm Gear as a Basis for Standardization (Berechnungstafel für Schneckengetriebe als Grundlage für die Normung derselben), Friedrich Woltzendorff. Betrieb, vol. 3, no. 9, Feb. 10, 1921, pp. 234–238, 2 figs. Recommendations for standardization of worm gear supplementary to those published in same journal (vol. 14, no. 2, 1920). An improved chart is presented and calculation thereof explained.

GOLD METALLURGY

Antimonial Ore Treatment. Treatment of Antimonial Gold Ore at the Globe and Phoenix Gold Mine, Southern Rhodesia, V. E. Robinson. Jl. Chem., Metallurgical & Min. Soc., vol. 21, no. 7, Jan. 1921, pp. 117–119. Owing to stibnite present and also possibly to ferrous iron, tailing cannot be treated directly by cyanide, but if it be allowed to partially oxidize by weathering, it becomes amenable to cyaniding.

GRINDING

Cylindrical. Points to Consider in Cylindrical Grinding, W. H. Chapman. Can. Machy., vol. 25, no. 13, Mar. 31, 1921, pp. 41–44, 2 figs. Factors which determine wheel-wearing action. Laws relating to draw-in and traversed cuts. Production costs.

Fixtures. The Use of Special Fixtures in Grinding Operations, Ellsworth Sheldon. Am. Mach., vol. 54, no. 13, Mar. 31, 1921, pp. 545–548, 14 figs. Use of gear as chuck upon which to finish another gear. Grinding tapers without traverse.

GRINDING MACHINES

British-Built. The Coventry Centreless Grinder, H. A. Dudgeon. Machy. (Lond.), vol. 17, no. 444, Mar. 31, 1921, pp. 789–792, 14 figs. Machines manufactured by B.S.A. Tools, Birmingham.

German. Modern Grinding Machines (Neuere Schleifmaschinen), W. Pockrandt. Zeit des Vereines deutscher Ingenieure, vol. 65, no. 12, Mar. 19, 1921, pp. 289–291, 37 figs. on 2 supp. plates. Cylindrical surface and piston-ring grinding machines built by Reinecker (Chemnitz).

H

HACK-SAWING MACHINES

Automatic. Automatic Hack Sawing Machine. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 784–785, 4 figs. Manufactured by Edward G. Herbert, Manchester, England.

HANDLING MATERIALS

Electrically Operated Machinery. The Field for Electrically Operated Material Handling Machinery, F. T. Smith. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 361–365, 6 figs. Typical installations.

Freight-Handling Devices. A Brief Directory of Material Handling Apparatus, R. H. McLain. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 306–317, 46 figs. Descriptions and illustrations of freight-handling devices which are suitable for handling different classes of material through horizontal and vertical motion over long and short distances.

Routing. The Application of Power-Driven Machinery to the Horizontal Transference of Miscellaneous Freight, J. A. Jackson. Gen. Elec. Rev., vol. 24, no. 4, April 1921, pp. 325–330, 6 figs. Fundamental principles of routing that must be observed to secure efficient system for transferring miscellaneous freight or material within building.

HARDNESS

Testing. The Study of Bar Hardness Tests (Étude sur l'essai de dureté a la bille), René Guillery. Mémoires et Compte rendu des Travaux de la Société des Ingenieurs Civils de France, vol. 73, nos. 10, 11 and 12, Oct.-Dec. 1920, pp. 591–606, 22 figs. partly on supp. plate. Research on the elimination of time elements in Brinell tests. Apparatus measuring by impact given by hammer.

HEATING AND VENTILATION

Fire Hazards. Fire Hazards Connected with Heating and Ventilating Work, Ira H. Woolson. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 3, April 1921, pp. 286–292. Suggestions based upon statistics of insurance losses paid by companies reporting to Actuarial Bur. of Nat. Board of Fire Underwriters for five years 1915–1919 inclusive.

HEATING, ELECTRIC

Heating and Cooking Apparatus. The Status of Electric Heating and Cooking Apparatus (Der Stand der elektrischen Heiz- und Kochapparate), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 38, no. 44, Mar. 19, 1921, pp. 253–258, 4 figs. Review of foreign and domestic patented improvements.

Switzerland. The Employment of Electricity for Heating (Die Verwendung der Elektrizität in der Heizungstechnik), R. Gautschi. Gesundheits-Ingenieur, vol. 44, no. 2, Jan. 8, 1921, pp. 13–17, 6 figs. Describes construction and operation of electric central and separate heating installations in Switzerland. Comparison of the cost of heating with use of black and white coal. Notes on hot-water heating operated with night current; heat storage tanks, electrically heated high-pressure boilers, etc.

HEAT TRANSMISSION

Building Materials. The Heat Conduction Coefficients of Building and Insulating Materials and the Coefficient of Permeability of New Building Types (Die Wärmeleitzahl von Bau und Isolierstoffen und die Wärmedurchlässigkeitzahl neuer Bauweisen), Osc. Knoblauch, E. Raisch and H. Reiher. Gesundheits-Ingenieur, vol. 43, no. 52, Dec. 25, 1920, pp. 607–623, 4 figs. Part I gives results of experiments carried out in years 1912–1920 for determination of heat conductivity of building and insulating materials. Part II gives results of tests carried out consecutively since 1918 on experimental houses for determination of permeability of certain wall constructions. The most important conclusions are summarized. See also same journal, vol. 44, no. 9, Feb. 26, 1921, pp. 100–101. (Remarks by H. Chr. Nussbaum.)

Radiation. Present Status of the Constants and Verification of the Laws of Thermal Radiation of a Uniformly Heated Inclosure, W. W. Coblentz. U. S. Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 406, Dec. 20, 1920, 48 pp. Examination into various determinations and methods employed in determining radiation constants by different experimenters. Comparison of accuracy of results obtained therewith.

HELICOPTERS

Berliner. The New Berliner Helicopter. Aviation, vol. 10, no. 13, Mar. 28, 1921, pp. 393, 2 figs. Helicopter invented by H. A. Berliner of Washington, D. C.

Modern Types. Independent Sustentation of an Aeroplane in Air (Vers la sécurité: la sustentation indépendante), M. Lamé. Aérophile, vol. 29, nos. 3 & 4, Feb. 1–15, 1921, pp. 46–49, 6 figs. Details of modern helicopters—Crocker-Hewitt, Alérion, Pescara Oehmichen.

Oehmichen. Flight Tests Performed with Oehmichen Helicopter in January 1921 (Vols d'essai realisés avec un hélicptère libre monté, système Oehmichen (janvier 1921). Génie Civil, vol. 78, no. 11, Mar. 12, 1921, pp. 237–238, 1 fig. Apparatus is provided with two 2-bladed propellers of 6.40 meters diameter rotating in opposite directions in same horizontal plane.

Study of. The Helicopter—I, M. A. S. Riach. Aeronautics, vol. 20, no. 389, Mar. 31, 1921, pp. 223–224, 1 fig. Technical study. (To be continued.)

HOISTS

Skip. Provisions that Enable the Skip Hoist at Coal Mines to Give Maximum Service, Andrews Allen and John A. Garcia. Coal Age, vol. 19, no. 12, Mar. 24, 1921, pp. 529–533, 4 figs. Where skip hoisting is employed bottom layout differs radically from that used with cage hoisting. Although four kinds of dumps are available rotary is variety most generally installed. Paper read before Am. Inst. Min. & Metallurgical Engrs.

HOUSE ORGANS

Editorial Policies. Industrial Publicity and the House Organ, Charles E. Carpenter. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 247–249. Developments of industrial publicity. Note on editorial policies to follow in house organs.

HOUSES, CONCRETE

Construction. Recommended Practice for Concrete House Construction. Eng. & Contracting, vol. 55, no. 12, Mar. 23, 1921, pp. 278–279. Report of committee on concrete houses, Am. Concrete Inst.

Fireproofing. Fireproofing a Concrete Block House, Wharton Clay. Eng. World, vol. 18, no. 4, April 1921, pp. 275–276. Recommendation of Nat. Conference of concrete house construction.

Ingersoll-Rand System. How the Ingersoll-Rand Company is Solving Its Housing Problem with Concrete. Concrete Age, vol. 33, no. 6, Mar. 1921, pp. 18–23, 6 figs. Wooden forms are set up for making complete house in one operation.

Machine-Made. Machine-Made Reinforced Concrete Houses and Other Structures, F. G. Engholm. Can. Engr., vol. 40, no. 13, Mar. 31, 1921, pp. 337–342, 6 figs. Details of machine-made parts for concrete structures.

HYDRAULIC TURBINES

Design. The Modern Hydraulic Turbine, Frank H. Rogers. Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 77–90, 25 figs. Modern requirements. Tests on models as adjunct to design. General and special features of design.

Development. The Present Trend of Turbine Development, Lewis F. Moody. Mech. Eng., vol. 43, no. 4, April 1921, pp. 235–244, 17 figs. Also Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 106–123, 25 figs. Brief survey of past history and recent progress, together with discussion of theoretical problems involved in hydraulics of modern high-speed turbine, notably determinations of turbine and pump efficiencies as related to specific speed.

Efficiency. Economic Importance of the Efficiency of Hydraulic Turbines for New Construction and Reconstruction (Wirtschaftliche Bedeutung des Wirkungsgrades der Wasserturbinen für Entscheidungen beim Neubau und Umbau), H. Leiner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 9, Feb. 26, 1921, pp. 222–224. Development of equations to be considered in the determination of economic efficiency of turbines. It is shown that old installations have for the most part lost their significance from an economic standpoint. In the case of new construction, selection of construction type should be made with due regard to economic influence of its efficiency.

Maximum Efficiency of Turbines (Sur le rendement maximum des turbines), M. de Sparre. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 10, Mar. 7, 1921, pp. 561–564. Formulas.

Thermometric Method for Measuring Efficiency of Hydraulic Turbines (Sur une méthode thermométrique de mesure du rendement des turbines hydrauliques), L. Barbillion and A. Poirson. Houille Blanche, vol. 19, nos. 47 and 48, Nov.–Dec. 1920, pp. 217–221, 2 figs. Principle of method consists in assuming that quantity of heat corresponding to energy loss is employed in heating water.

Efficiency Tests. The Application of a New Method of Water Measurement in the Efficiency Tests of the 37,500 H.P. Turbines of the Niagara Falls Power Company, N. R. Gibson. Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 90–101, 18 figs. Description of Gibson method and apparatus for measuring flow of water in penstocks. Comparison of volumetric and Gibson measurements.

Speed Regulation. Speed Regulation of the Hydraulic Turbine, Raymond D. Johnson. Mech. Eng., vol. 43, no. 4, April 1921, pp. 245–246 and 248, 2 figs. Also Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 101–106, 7 figs. Notes on design of surge tanks. Graph showing typical variations of water level in both tank and standpipe of differential regulator.

HYDROELECTRIC PLANTS

California. An Emergency Hydroelectric Plant, Geo. H. Bragg. Jl. Electricity & Western Industry, vol. 46, no. 7, April 1, 1921, pp. 340–342. Construction work on Pacific Gas & Elec. Co. of California during 1920 power shortage.

Canada. Canada's Superpower Zone, Robert G. Skerrett. Sci. Am., vol. 124, no. 13, Mar. 26, 1921, pp. 246 and 258, 1 fig. Scheme worked out by Ontario hydroelectric power commission.

Hydro-Electric Progress in Canada During Past Year, J. B. Challies. Contract. Rec., vol. 35, no. 12, Mar. 23, 1921, pp. 298–301. In 1920, 650,000 hp. was completed or under construction. Active government development of power resources. Canada next to Norway in amount developed.

France. Utilization of the Hydraulic Energy in the Vienne River in West of France (Usines électriques de la Société des Forces motrices de la Vienne), Auguste Pawlowski. Génie Civil, vol. 78, no. 14, April 2, 1921, pp. 285–289, 10 figs. Construction of three plants, one of 6000 hp., one of 8000 hp. and one of 9000 hp.

Electrical Features. Electrical Features of Hydro-Electric Power, David Barker Rushmore. Jl. Engrs. Club of Phila., vol. 38–3, no. 195, Mar. 1921, pp. 123–129. Enumeration of electrical apparatus involved.

Queenston-Chippewa Project, Ontario. 50,000-Hp. Wheels for 500,000-Hp. Plant, E. T. J. Brandon. Elec. World, vol. 77, no. 13, Mar. 26, 1921, pp. 697–699, 6 figs. Five 45,000-kva. generators already on order for Queenston-Chippewa project in Ontario. Unit system followed for electrical layout. Generators set below floor level. Control pedestals at generators.

Sweden. The Glomfjord Hydroelectric Plant, Sweden (Glomfjord Kraftanlæg), Ragnvald Lie. Teknisk Ukeblad, vol. 68, nos. 5 and 6, Feb. 4 and 11, 1921, pp. 50–53 and 61–65, 10 figs. The available volume of water is 25 cu.m. per sec. and is supplied from a number of lakes located in high altitudes; the entire water supply is 585 million cu.m., the head, 450 m. At present six turbines for 160,000 hp. are to be installed, of which 25,000 hp. are to be held as reserve. Notes on preliminary construction work.

Switzerland. New Hydroelectric Plant under Construction in the Canton of Grisons, Switzerland (Die Landquartwerke der "Bündner Kraftwerke"), R. Moor. Schweizerische Bauzeitung, vol. 77, no. 12, Mar. 19, 1921, pp. 127–130, 7 figs. Details of Kloster-Kublis power plant designed by and being constructed under supervision of writers. Plant is first stadium of large project for harnessing Landquart river and its tributaries.

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ICE PLANTS

Electric vs. Steam Drive. Electrification of the Ice Industry, Donald Cole. Ice & Refrigeration, vol. 60, no. 3, Mar. 1921, pp. 175–176. Comparison of manufacturing costs in electrically driven and steam-driven ice plants.

IGNITION

Coil Sparks. Phenomena of the Ignition of Gaseous Mixtures by Induction Coil Sparks, John David Morgan and Richard Vernon Wheeler. Jl. Chem. Soc., vols. 119 & 120, no. 701, Mar. 1921, pp. 239–250, 10 figs. Experiments on different mixtures of methane and air.

INDICATORS

Steam-Engine. Determination of the Continuous Output of Reciprocating Steam Engines (Die Feststellung der Dauer-Betriebsleistung von Kolbendampfmaschinen). Kali, vol. 15, no. 4, Feb. 15, 1921, pp. 53–58, 6 figs. Power meter and load indicator with recording device constructed by Anton Böttcher, Hamburg, and power meter by Gümbel, Charlottenburg.

INDUSTRIAL MANAGEMENT

Attitude of Organized Labor. Union Labor and the Enlightened Employer, Samuel Gompers. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 235–239. Attitude of organized labor toward management, open shop crusade, collective bargaining, and present day economic problems.

Accident Prevention. Safety and Accident Prevention, Fred G. Lange. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 257–259. Explains accident prevention as phase of industrial management.

Central Control. Central Control System in the Franklin Plant, Franklin D. Jones. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 745–749, 6 figs. Also in Machy. (Lond.), vol. 18, no. 445, Apr. 7, 1921, pp. 1–5, 6 figs. System employed by H. H. Franklin Mfg. Co., for regulating output according to demand, and for controlling manufacturing operations by mechanical boards or charts and pneumatically operated dispatch system.

Developments. The Evolution of Industrial Management, Henry R. Towne. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 231–233. Review of developments during last 30 years.

Thirty Years of Management Literature, John R. Dunlap. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 279–283 and 311. Survey of developments in industrial management. (To be continued.)

Gantt's Method of Inquiry. Principles of Industrial Philosophy, Walter N. Polakov. Mech. Eng., vol. 43, no. 4, April 1921, pp. 249–252 and (discussion) pp. 253–254, 5 figs. Gantt's method of inquiry into co-relation of social needs and industrial services. Application and influence of principles enunciated by Gantt.

Incentives to Workers. Incentives to Better Workmanship Appeal to a Variety of Instincts, Norman G. Shidle. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 712–714. Plan of classification of employees and opportunities offered for their advancement at plant of Sperry Gyroscope Co.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 12, Mar. 10, 1921, pp. 84–85. Proposals of Committee for Economic Production for instruction sheet for the handling and erection of machine tools.

Production Systems. Making Pay Envelopes Reflect Merit, R. A. Ilg. Factory, vol. 26, no. 7, April 1, 1921, pp. 837–839, 3 figs. Production records are posted where employees can see them. Bulletin board causes workman's natural pride to show itself in increased production. Bonuses are paid for increased production.

Production in a General Engineering Shop. Eng. Production, vol. 2, no. 25, Mar. 24, 1921, pp. 385–390, 16 figs. Works and methods of Messrs. Peter Brotherhood, Ltd., London.

The Trend Toward Automatic Production, A. L. DeLeeuw. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 251–255. Developments in production systems during last 30 years.

Works Organization. Eng. Production, vol. 2, no. 25, Mar. 24, 1921, pp. 391–395, 15 figs. Production systems of British automobile manufacturer.

Routing Materials. Co-Ordinating the Industrial Plant Through Intra-Factory Transportation, W. F. Merrill. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 261–265, 5 figs. Economics of intra-factory transportation.

Toolroom Organization. Distribution of Tools (Die Werkzeugausgabe), Th. Damm. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 282–284, 3 figs. Fundamental aspects are discussed, and practical equipment, arrangements and organization methods are suggested which have proved successful in practice.

INDUSTRIAL RELATIONS

American Industries. What America Faces, Herbert Hoover. Indus. Management, vol. 61, no. 7, April 1, 1921, pp. 225–229. Review and forecast of fundamental relationships between employer and employee. It is pointed out that although there are no conflicts of interest between employee and employer, there are also "wide areas of activity in which their interests should coincide, and it is the part of statesmanship on both sides to organize this identity of interest in order to limit the area of conflict."

Electrical Construction Industry. National Labor Council for the Electrical Construction Industry. Monthly Labor Rev., vol. 12, no. 3, Mar. 1921, pp. 126–127. Plan adopted in April 1920, by Nat. Assn. of Elec. Contractors and Dealers and Nat. Brotherhood of Elec. Workers. Purposes of Council are said to be "promotion of peace and harmony in electrical industry, the adjudication of disputes between employers and employees, the establishment of friendly relations between all parties interested, which should ultimately result in the elimination of distrust, suspicion, and the wasteful methods of the old-fashioned strikes and lockouts."

Pennsylvania Railroad. Joint Reviewing Committee of the Pennsylvania Railroad System. Monthly Labor Rev., vol. 12, no. 3, Mar. 1921, pp. 122–125. Duty of Reviewing Committee is "amicable settlement, by joint conference, of all controversial questions affecting engine and train service men." Plan was adopted at meeting held on Dec. 29, 1920 by representatives of employees and representatives of administrative force of railroad.

Plans. Industrial Relations Work Pays, James W. Brown. Iron Trade Rev., vol. 68, no. 13, Mar. 31, 1921, pp. 906–908. Outlines plan to promote family spirit in industrial life of all employees. Paper read before Am. Foundrymen's Assn.

Shop Councils. One Year of the Shop Council System in Germany. Am. Mach., vol. 54, no. 16, April 21, 1921, pp. 682. Occasional strikes, steady rise in wages, unwarrantable interference and failure in increasing production are conditions reported by managers of industrial works.

INDUSTRIAL TRUCKS

Electric. Electric Vehicles for Railway Cartage Work. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 426–427 and 429, 5 figs. Trucks used by Great Northen Ry., England. Data on running costs.

Electric Trucks and Industrial Locomotives. Engr., vol. 131, nos. 3403 and 3404, Mar. 18, and 25, 1921, pp. 290–292 and 294, 10 figs., and 318–319, 6 figs. Typical British designs.

INTERNAL-COMBUSTION ENGINES

Compensation Gear. Tappet Clearance Compensating Gear. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 352–353, 5 figs. Gear providing for automatic cancellation of effects of expansion differences.

Design. The Internal Combustion Engine—Fuel, Valves and Ignition, A. W. Bradbury. Trans. Inst. Mar. Engrs., vol. 32, Feb. 1921, pp. 381–404, 14 figs. Design features of typical engines.

Thermodynamic Cycles in Relation to the Design and Future Development of Internal-Combustion Engines, William J. Walker. Jl. Instn. Mech. Engrs., no. 10, Feb. 1921, pp. 1235–1261 and (discussion) pp. 1261–1311, 24 figs. Classification of engine types. Variable specific heat relationship between maximum pressure and mean effective pressure in variable volume cycle. Study based on results obtained in tests of internal-combustion engine, including those operated by coal-gas and producer-gas, oil engines of Diesel and semi-Diesel types, hot-bulb engines and also high-speed gasoline engines of automotive class.

Exhaust-Gas Utilization. The Carbonization of Wood by the Exhaust Gases from Internal Combustion Engines (La carbonisation du bois par l'échappement des moteurs à explosion), Louis Tissier. Chimie & Industrie, vol. 5, no. 2, Feb. 1921, pp. 136–142, 1 fig. Tissier furnace. Exhaust gases pass through pile of wood. High temperature of gases carbonizes wood.

Uses. Internal Combustion Engines, C. S. Darling. Beama, vol. 8, no. 3, Mar. 1921, pp. 248–263, 5 figs. General considerations determining use with reference to power generation.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GAS TURBINES; LUBRICATION, INTERNAL-COMBUSTION ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES; TRACTOR ENGINES.]

IRON

Corrosion-Resisting. The Effect of Copper and Silver Salts on the Corrosion of Iron by Acids, Oliver P. Watts and Harold C. Knapp. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 14, pp. 135–140, 1 fig. Record of tests on corrosion of iron by sulphuric acid in absence or presence of various salts of copper and silver. Conclusion drawn is that in general corrosion is stimulated by presence of these salts.

L

LABOR

Hours of Work. One Year of the Eight-Hour Law in Sweden. Monthly Labor Review, vol. 12, no. 3, Mar. 1921, pp. 97–98. "Confronted with the unsatisfactory results" of 8-hour law Swedish Government has commissioned Royal Social Board to investigate and report upon advisability of modification of its provisions.

LATHE TOOLS

Turret Lathes. Tooling the Modern Turret Lathe, A. H. Lloyd. Can Machy., vol. 25, no. 12, Mar. 24, 1921, pp. 33–36, 9 figs. Tools for machining magneto cam case, gun-metal bush and motorcycle flywheel.

LATHES

Bench. Tools and Methods for Manufacturing Precision Bench Lathes—II. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 751–754, 9 figs. Practice of S. A. Potter Tool & Machine Works, New York City, in manufacture of bench lathes.

German Automatic. German Automatic Lathes (Der deutsche Automatenbau), Ph. Kelle. Der praktische Maschinen-Konstrukteur, vol. 54, no. 6, Feb. 10, 1921, pp. 17–32, 47 figs. Details of various types of lathes for the machining of screws and similar parts. It is pointed out that whereas most German automatic lathes are copied from American systems, the described screw lathe is a purely German system constructed exclusively in Germany.

Railway Wheel. A new 5-ft. Railway Wheel Lathe. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 771–773, 3 figs. Manufactured by W. G. Armstrong, Whitworth & Co., Manchester, England.

Standards. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 12, Mar. 10, 1921, pp. 159–161, 4 figs. Proposal of the Board of Directors for speed cones. Proposed standards for hand wheels.

Staybolt. A Lathe for Staybolts (Eine Stenbolzen-Drehbank), W. Daevessen. Betrieb, (special no.), vol. 3. no. 11, Mar., 1921, pp. 300–301, 1 fig. Special lathe constructed by the Magdeburger Machine-Tool Factory Corp.

Turret. Large Turret Lathes (Gross-Revolverbänke) Fritz Heilborn. Betrieb (special no.), vol. 3, no. 11, Mar., 1921, pp. 297–299, 3 figs. Type manufactured by Böhringer Bros., Göppingen, Germany, for machining of crankcases. The machining of crankcases of 380 mm. diam. and 200 m. breadth takes about 35 minutes.

LAUNCHING

Tallows for. Some Experiments on Tallows Used for Launching Ships, J. J. King-Salter. Engineering, vol. 111, no. 2883, April 1, 1921, pp. 405–407, 2 figs. Curves of compression strength and hardness factors against temperatures for various natural tallows. Paper read before Instn. Naval Architects.

LIGNITE

Utilization. New Recommendations for the Rational Utilization of Bituminous Wet Lignites (Neue Vorschläge zur rationellen Ausnutzung bituminöser nasser Braunkohle), Gh. Limberg. Braunkohle, vol. 19, no. 46, Feb. 26, 1921, pp. 570–574, 1 fig. Notes on distillation at low temperature for the production of low-temperature coke. (Concluded).

Germany's Brown Coal, Robert G. Skerrett. Sci. Am., vol. 124, no. 16, April 16, 1921, pp. 304 and 315, 2 figs. Industrial utilization of swamp muck.

LOCOMOTIVE BOILERS

Heavy Freight Locomotives. Details of New Santa Fe Locomotive Boilers. Boiler Maker, vol. 21, no. 4, April 1921, pp. 95–100 and 124, 7 figs. Conical design built for working pressure of 195 lb. per sq. in. Outside diameter of course is 88 in., while diameter of rear course is 100 in. Firebox is 132 in. long and 96 in. wide.

LOCOMOTIVES

Bearings. Shop Methods of Casting Locomotive Bearings, J. V. Hunter. Am. Mach., vol. 54, no. 14, April 7, 1921, pp. 590–596, 23 figs. Comparison of methods used in shops of Wabash Railroad, Big Four System and Chicago & Alton Railway.

Belgian. The New "Consolidation" Locomotives of the Belgian State Railways, E. Minsart. Bul. Int. Ry. Assn., vol. 3, no. 3, Mar. 1921, pp. 305–311, 3 figs. Dimensions: Diameter of cylinder, 24 in.; piston stroke, 28 in.; boiler pressure, 199.12 lb.; inside diameter of boiler, 5 ft. 8 in.; heating surface of fire-box, 149.62 sq. ft.; total wheel base of engine, 27 ft. 11 in.

British. 4-6-4 Type Tank Locomotive for the Furness Railway. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 356–357, 6 figs. partly on supp. plate. Characteristics: Cylinders, 19½ in. by 26 in.; wheels, coupled diameter, 5 ft. 8 in.; wheelbase, coupled, 13 ft. 3 in.; heating surface tubes, 1850 sq. ft.; heating surface fire-box, 153 sq. ft.

New Express Locomotives for the Bengal-Nagpur Railway. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 428–429, 3 figs. Characteristics: Type, 4-6-0; cylinders, 21½ in. diameter by 26-in. stroke; diameter of driving wheels, 6 ft. 1½ in.; total evaporative surface, 1259 sq. ft.; superheating surface, 250 sq. ft.; tractive force, 23,554 lb.

Powerful Side Tank "Ghat" Locomotives for the Great Indian Peninsula Railway. Ry. Gaz. vol. 34, no. 12, Mar. 25, 1921, pp. 475, 1 fig. Characteristics: Cylinders, diameter, 22 in.; piston stroke, 26 in.; wheelbase, coupled wheels, 15 ft. 6 in.; weight on coupled wheels, 79 tons 16 cwt.

Coaling Stations. Coaling Station for City Engine Terminal: O. & R. R. Eng. News-Rec., vol. 86, no 16, April 21, 1921, pp. 673–674, 3 figs. Three grades of coal. Operator handles chutes. One hoist service for coal and sand. Large sand drying plant.

Design. Locomotives for Operation on Curves (Bogenläufige Lokomotiven), F. Meineke. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 8 and 9, Feb. 19 and 26, 1921, pp. 191–194 and 217–221, 19 figs. Notes on arrangement of the axles in special frames or in main frames; description of the most important modern locomotive types; the Mallet locomotive; the Krauss truck; the Gölsdorf axle arrangement; the Klien-Lindner axles; American 2C1 and 2D1 locomotives; 1D1 four-cylinder compound locomotives of the Saxon State Railroad. Selection of suitable construction types.

Internal-Combustion. Internal Combustion Locomotives for Railway Service. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 440–443, 4 figs. Light locomotives built by Ruston & Hornsby, England. Two types, one 10 hp. and one 20 hp.

Mine, Internal-Combustion. German Internal-Combustion Locomotives. Gas & Oil Power, 16, no. 187, April 7, 1921, pp. 109–110, 3 figs. Mine locomotive built by Deutz Gas Engine Co.

Reconstruction. Locomotives and Locomotive Terminals. Mech. Eng., vol. 43, no. 4, April 1921, pp. 255–258 and 272. Salient points brought out in discussion of papers on increasing capacity of old locomotives and modernizing locomotive terminals, presented at Am. Soc. Mech.Engrs. 1920 annual meeting.

Stoker-Fired. Operating Economies in Longe Runs, F. M. Nellis. Ry. Rev., vol. 68, no. 14, April 2, 1921, pp. 535–536. Experience of Erie Railroad.

Throttle Valve for. Design of an Improved Locomotive Throttle Valve, W. J. Knox. Ry. Mech. Engr., vol. 95, no. 4, April 1921, pp. 216–218, 10 figs. Type developed by Buffalo, Rochester & Pittsburgh Railroad.

LUBRICANTS

Drilling. Investigation of Lubricants for Drilling (Untersuchung von Bohrölen), Georg Schlesinger and Eugen Simon. Werkstattstechnik, vol. 15, no. 5, Mar. 1, 1921, pp. 140–143, 6 figs. Results of investigation carried out at the experimental bureau for machine tools of the Berlin Technical Academy.

LUBRICATING OILS

Reclamation. The Reclamation of Lubricating Oils (La régénération des huiles de graissage). Bulletin technique du Bureau Veritas, vol. 3, no. 3, Mar. 1921, pp. 64–67, 3 figs. Salaün apparatus for reclamation of lubricating oils.

Separators for. Oil Separator (Oljereningsseparatorer). Teknisk Tidskrift (Mekanik), vol. 51, no. 2, Feb. 9, 1921, pp. 37–40, 2 figs. Description of the Alfa Separator AVO. Advantages of centrifugal separation over older processes are pointed out.

Tests. Tests on Lubricating Oil for Two-Stroker Cycle Semi-Diesel Engines, T. M. Robie. Power, vol. 53, no. 15, April 12, 1921, pp. 588–590, 2 figs. Graphs showing influence of temperature on viscosity of lubricating oils.

LUBRICATION

Cylinders. The Lubrication of Steam Cylinders with Oil Emulsions (Schmierung von Dampfzylindern mit Oelemulsionen), H. Hilliger. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 10, Mar. 5, 1921, pp. 248–249, 5 figs. Describes methods and gives results of tests with oils and emulsions, properties and composition of which are given.

Internal-Combustion Engines. The Lubrication of Internal-Combustion Engines (Zur Schmierung der Verbrennungskraftmaschinen), H. Praetorius. Motorwagen, vol. 24, no. 5, Feb. 20, 1921, pp. 90–93, 4 figs. Lubricating pumps of Natter Apparatus Construction Co., Ltd., Feuerbach.

M

MACHINE SHOPS

England. Machine Tool Works at Broadheath Engr., vol. 131, no. 3405, April 1, 1921, pp. 346–347 and 350, 12 figs. Layout of shops. Details of driving arrangements.

MACHINE TOOLS

Efficiency Tests. Factory Valuation of Machine Tools (Zur betriebstechnischen Wertung der Werkzeugmaschine), Alfred Freund. Betrieb (special no), vol. 3, no. 11, Mar. 1921, pp. 319–322. Description and results of efficiency tests carried out on the shaping machines of the F. C. Nischwitz Machine Tool Factory, Halle.

Hydraulic. Hydraulic Machine Tools. Managing Engr., vol. 7, no. 11, Mar. 1921, pp. 201–203, 5 figs. Forging press, cold plate shears, plate flanger, marine boiler riveter, etc. Paper read before Gloucestershire Eng. Soc.

Leipzig Exhibition. Performances of Standard Machine Tools (Einige Leistungen normaler Werkzeugmaschinen), Heinrich Sauter. Betrieb (special no.), vol. 3, no. 11, Mar. 1921, pp. 285–294, 28 figs. Description of principal exhibits.

Reconstruction. Reconstruction of Old Machine Tools for Special Tasks (Umbau alter Werkzeugmaschinen für Spezialarbeiten), Paul Krieg. Betrieb, vol. 3, no. 10, Feb. 25, 1921, pp. 270–272, 2 figs. It is shown that even in the case of mass production it is not always necessary to procure new and expensive special machines, and that equally good or better results can be obtained through skillful reconstruction of existing machines. Example is given of a lathe for copper locomotive-boiler staybolt.

Standardization. Practical Formulas for Small Construction Parts in the Construction of Machine Tools (Praktische Formeln für kleinere Konstruktionsteile im Werkzeugmaschinenbau), H. Lambrette. Der praktische Maschinen-Konstrukteur, vol. 54, no. 8, Feb. 24, 1921, pp. 33–35. It is suggested that formulas given might be of aid in standardization.

Steels for Parts. Steels for Machine Tool Parts, Robert M. Taylor. Machy. (N. Y.), vol. 27, no. 8, April 1921, pps. 770–771. Table of required properties of steel for machine tool parts. (Abstract.) Paper read before Am. Soc. for Steel Treating.

Stud-Inserting Attachment. A New Type of Stud Inserting Machine (Ein neuartiger Stiftschraubeneinzieher), Christian Weiherer. Der praktische Maschinen-Konstrukteur, vol. 54, no. 7, Feb. 17, 1921, pp. 31–33, 3 figs. Describes patented device, called "Rekord," which has been successfully employed in the M.A.N. works in connection with a radial drill for screwing studs in cylinders.

Testing Laboratory. A Testing Laboratory for Machine Tools (Ein Versuchsfeld fur Werkzeugmaschinen), Willi Mitan. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 11, Mar. 12, 1921, pp. 268–269, 4 figs. The electrically driven testing laboratory of the Fritz Werner Corp., Berlin-Marienfelde, for testing the power requirements and efficiency of machine tools and other necessary tools and auxiliary equipment, is provided with four testing motors and a switchboard with measuring instruments and is fed from a converter installation of 30 kw.

MACHINERY

Production Statistics. Statistics of Production in Machine Construction (Produktionsstatistik im Maschinenbau), H. Rech. Betrieb, vol. 3, no. 9, Feb. 10, 1921, pp. 221–230, 3 figs. 2 on supp. plate.

Deals with organization for collecting statistics of production instituted by Assn. of German Machine Builders in 1907. Compilation of results is given in tables showing extent of employment, importance of export, development of prices, operating efficiency, etc., since 1909.

MAGNETS

Steels for. Steels for Permanent Magnets. Elecn. vol. 86, no. 2235, Mar. 18, 1921, pp. 327, 3 figs. Graphs showing magnetic qualities of hecla M. T. steel, Hadfield Research Laboratory, England.

MALLEABLE CASTINGS

Automotive Industry. Malleable Castings Production as Related to the Automotive Industry. Automotive Industries, vol. 44, no. 13, Mar. 31, 1921, pp. 708–711, 1 fig. Technical and commercial development of malleable castings production.

Influence of Manganese on Strength. Influence of Manganese on the Tensile Strength Properties of Malleable Castings (Einfluss des Mangans auf die Festigkeitseigenschaften des schmiedbaren Gusses), E. Leuenberger. Stahl u. Eisen, vol. 41, no. 9, Mar. 3, 1921, pp. 285–287, 3 figs. Results of tests show that with regard to these properties a higher manganese content than 0.4 per cent is permissible the tensile strength increases with increasing manganese content; up to about 1 per cent, manganese has no influence on expansion; etc.

Steel vs. Malleable Castings vs. Grey Iron and Steel, Enrique Touceda. Can. Foundryman, vol. 12, no. 4, April 1921, pp. 26–28, 4 figs. Ability to stand abuse, static and dynamic strength, ease of machining, smoothness of surface. Properties and limitations of malleable-iron castings.

MALLEABLE IRON

Annealing. Anneals Malleable Iron with Oil Fuel, William F. Hoernke. Foundry, vol. 49, no. 8, April 15, 1921, pp. 323–325, 3 figs. Experience of Stowell Co., Milwaukee. Oil is more expensive fuel but requires less labor in handling and firing.

Properties. American Malleable Cast Iron, H. A. Schwartz. Iron Trade Rev., vol. 68, nos. 13 and 15, Mar. 31 and April 14, 1921, pp. 901–904, 8 figs. and 1039–1042, 5 figs. Series of articles dealing with development of industry, modern methods of manufacture, metallurgical principles involved and properties of American malleable iron. Thermal and electrical properties of malleable iron.

MARINE BOILERS

Standard Construction. Standard Conditions for the Design and Construction of Marine Boilers. Steamship, vol. 32, no. 382, April 1921, pp. 239–242. Regulations issued by British Board of Trade. (To be continued.)

MARINE STEAM TURBINES

Reversing. A Description of a New Reversing Turbine. Mar. Eng., vol. 11, no. 1, Jan. 1921, pp. 40–42, 2 figs. Device to regulate steam supply automatically.

METALS

Calorizing. Protecting Metals Against Heat by Calorizing, Arthur V. Farr. Raw Material, vol. 4, no. 3, Mar. 1921, pp. 86–89, 6 figs. Process of calorizing consists in placing material in retort and heating in reducing atmosphere, retort being filled with mixture containing finely divided aluminum. Homogeneous aluminum alloy is formed for certain depth.

Fatigue of. Tests Support Theory of Fatigue, H. F. Moore. Iron Trade Rev., vol. 68, no. 13, Mar. 31, 1921, pp. 895–897, 3 figs. Experiments conducted on metals which were subjected to alternate and repeated strains showed that failure from fatigue is due largely to growth of minute flaws.

Properties. Physical Properties of Materials. U. S. Dept. of Commerce, Circular of Bur. of Standards, no. 101, Feb. 9, 1921, 52 pp. Strengths and related properties of metals and other engineering materials. Revision of Smithsonian physical tables.

METRIC SYSTEM

Compulsory Adoption in Japan. The Compulsory Adoption of the Metric System in the Japanese Empire (L'adoption obligatoire du système métrique par l'empire du Japan), Ch.-Ed. Guillaume. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 13, Mar. 29, 1921, pp. 795–796. Comment on significance of recent sanction by Japanese parliament of law making compulsory the use of the metric system in the Japanese empire.

MILLING

Gang Milling. Gang Milling. Eng. Production, vol. 2, no. 24, Mar. 17, 1921, pp. 342–345, 14 figs. Notes on cutters employed and their arrangement.

MILLING CUTTERS

Teeth, Spacing of. Metal Cutting Tools—VIII, A. L. DeLeeuw. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 635–640, 16 figs. Spacing of teeth of milling cutters.

MILLING MACHINES

Automatic. A New Automatic Miller. Eng. Production, vol. 2, no. 24, Mar. 17, 1921, pp. 340–341, 5 figs. Machines intended for manufacture of duplicating parts in large quantities. Spindle and table are controlled automatically. Manufactured by Buck and Hickman, London.

Continuous. Continuous milling, J. H. Moore. Can. Machy., vol. 25, no. 14, April 7, 1921, pp. 65–68, 9 figs. Rotary and reciprocating types of continuous milling machines.

High-Power. Rockford Milling Machine. Iron Age, vol. 107, no. 16, April 21, 1921, pp. 1039–1040, 2 figs. High-power, all-geared, single-pulley milling machine recently brought out by Rockford Milling Machine Co., Rockford, Ill. Rectangular overarm moved by rack and pinion. Single control for feed and quick return.

Rockford No. 3 "High-Power" Milling Machine, J. V. Hunter. Am. Mach., vol. 54, no. 14, April 7, 1921, pp. 585–587, 5 figs.

MOLYBDENUM

Norway. The Molybdenum Mines of Norway (Norske molybdengruber), Otto Falkenberg. Teknisk Ukeblad, vol. 68, no. 1, Jan. 7, 1921, pp. 6–11, 15 figs. Occurrences and properties of molybdenum, Norway has only specular molybdenum ore. Notes on production and treatment mainly in Elmore apparatus. It is used in chemical industry, but chiefly with alloyed steels. Prospects.

MOTION-PICTURE PHOTOGRAPHY

200,000 Photographs per Minute. Two Hundred Thousand Photographs per Minute, C. H. Claudy. Sci. Am., vol. 124, no. 15, April 9, 1921, pp. 288–297 and 299, 6 figs. High-speed motion-picture projectors and camera which makes use of prisms instead of usual shutter and intermittent movement mechanism.

MOTOR PLOWS

Tests. Factors Influencing the Draft of Plows, E. V. Collins. Agricultural Eng., vol. 2, no. 2, Feb. 1921, pp. 27–29, 7 figs. Records of tests.

MOTOR-TRUCK TRAFFIC

Legislation. How Maryland Enforces Its Motor Vehicle Law. Eng. News-Rec., vol. 86, no. 16, April 21, 1921, pp. 666–668, 3 figs. Truck weights checked by scales and loadometers. Ten tons limit. Excess loads deposited at roadsides.

Refrigerated Transport. Road Traction for Refrigerated Transport, H. M. Dunkerley. Cold Storage & Ice Assn., vol. 17, no. 1, 1920–1921, pp. 25–36 and (discussion) pp. 37–47, 3 figs. on 2 supp. plates. Requirements of vehicles used in transporting refrigerated product.

MOTOR TRUCKS

Maintenance. The Care and Maintenance of Motor Trucks, N. J. Smith. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 331–334. Practice of Consumers Co., which operates 159 motor trucks for delivering coal, ice and other supplies in territory covering city of Chicago and outlying districts.

Trailers. How to Apply Trucks and Trailers Under Given Load and Road Conditions, Marius C. Krarup. Automotive Industries, vol. 44, no. 12, Mar. 24, 1921, pp. 654–658, 5 figs. Table giving drawbar pull obtainable at speeds from 1 to 20 m.p.h. from net horsepower available at rims of driving wheels. Graph of resistances to vehicle movements due to grades and irregular or soft road surfaces.

MOTORSHIPS

Two-Cycle vs. Four-Cycle Engines. Two Versus Four Cycle Diesel Engines. Mar. Eng., vol. 26, no. 4, April 1921, pp. 321–323, 2 figs. Competition between manufacturers of two types in Europe.

N

NICKEL

Electrolytic. Ductile Electrolytic Nickel, Chas. P. Madsen. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 23, pp. 269–276. Experiments confirming writer's discovery that if cathodes in nickel electrolytic bath are periodically lifted out of bath, exposed to air, and reimmersed within certain limiting time, nickel deposit does not laminate but is greatly improved as regards freedom from pitting and mechanical properties.

The Use of Fluorides in Solutions for Nickel Deposition, William Blum. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 21, pp. 227–247, 3 figs. Discusses factors governing deposition of hard deposits of nickel from solutions containing fluorides, with and without boric acid and other salts. General principles of getting good deposits are discussed, showing that low acidity favors good nickel deposition, but high acidity good anode corrosion. Bearing of hydrogen-ion concentration on matter is explained.

NICKEL ALLOYS

Compositions, Properties, Uses. Miscellaneous Alloys of Nickel, Paul D. Merica. Chem. & Metallurgical Eng., vol. 24, no. 15, April 13, 1921, pp. 649–653. Principal data on binary alloy systems with nickel as one constituent. Use of nickel in bronzes and light aluminum alloys. Composition and electrical characteristics of many special resistance alloys. Analyses of complex alloys for various minor uses.

OFFICE BUILDINGS

Reinforced-concrete. Construction Detail of General Motors Office Building, Joseph Matte, Jr. Eng. News-Rec., vol. 36, no. 15, April 14, 1921, pp. 625–630, 12 figs. Fifteen-story structure with thirty-two acres of floor space to house 6000 persons. Heavy girders and columns in steel frame. Reinforced-concrete laborator building.

OIL ENGINES

Densil. A Serviceable Crude-Oil Engine. Steamship, vol. 32, no. 382, April 1921, pp. 251–253. Densil single-cylinder engine of hot-bulb type, with additional water-cooled head distinct from cylinder and bulb.

Marine. Reversing of Marine Oil Engines, Walter Pollock. Trans. Inst. Mar. Engrs., vol. 32, Feb. 1921, pp. 347–380, 10 figs. Classification and description of reversing systems in use.

OIL FIELDS

Argentina. The Petroliferous Region of Cacheuta (La región petrolífera de Cacheuta), Guillermo Hileman. Ingeniería Internacional, vol. 5, no. 5, May 1921, pp. 286–289, 3 figs. Geological description of and account of prospecting operations in Argentina region.

Australia. The Possibility of Oil Discovery on the Mainland of Australia, Wm. Clarkson. Petroleum Times, vol. 5, no. 114, Mar. 12, 1921, pp. 309–311. Conditions essential to occurrence of oil in quantity. Prospecting experiences in Australia.

Borneo. The Crude Oils of Borneo, James Kelway. Petroleum Times, vol. 5, no. 115, Mar. 19, 1921, pp. 33/-339. Geological and chemical notes.

Canada. Oil Possibilities of the Mackenzie—A Warning. Eng. & Min. Jl., vol. 111, no. 13, Mar 26, 1921, pp. 553–554. It is said oil dissipation has taken place and transportation is a serious problem.

OIL FUEL

Burners. Oil Fuel Burners Insuring Complete Preliminary Combustion of Liquid (Brûleur à combustion complete préalable, pour combustibles liquides). Génie Civil, vol. 78, no. 13, Mar. 26, 1921, p. 279, 1 fig. Air and pulverized fuel are thoroughly mixed and ignited in special chamber before passing into furnace proper.

Flue-Gas Analyses with. Records of Flue Gas Analyses with Fuel Oil, L. J. Goodrich. Power Plant Eng., vol. 25, no. 7, April 1, 1921, pp. 366–367, 2 figs. Calculation of fuel losses from flue-gas analyses and moisture contents of fuel and air.

Stowing on Board Ship. Hydraulic System for Stowing and Handling Fuel Oil on Board Ships in Yards or Docks. Mar. Eng., vol. 26, no. 4, April 1921, pp. 304–305, 1 fig. Adaptation of hydraulic system for control of oil fuel of large dredge.

Uses. Fuel Oil, W. A. White. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 37, part 4, Feb. 1921, pp. 209–238, 4 figs. Estimated petroleum deposits of the world. Statistics of production and transport of oil fuel. Typical oil-fuel storage station. Uses of oil fuel.

Uses of Oil Fuel (Emploi des combustibles liquides. M. Pillard. Arts et Métiers, vol. 74, no. 4, Jan. 1921, pp. 3–9, 4 figs. Tests on use of oil fuel in industrial furnaces.

OIL INDUSTRY

Canada. Canada a Vast Storehouse of Oil Resources, Earle W. Gage. Gas Engine, vol. 23, no. 4, April 1921, pp. 85–87. Canada's annual oil production, according to government statistics, amounts to nearly 310,000 bbl. 90 per cent from Ontario fields.

Poland. Petroleum Industry in Poland. Min. & Oil Bul., vol. 7, no. 4, Mar. 1921, pp. 219–221, 4 figs. Output of fields has reached level of about 842,000 barrels a month.

United States. America's Petroleum Problem, J. O. Lewis Jl. Franklin Inst., vol. 191, no. 3, Mar. 1921, pp. 357–379. Probable duration of oil supply in U. S. taking into account continuously increasing rate of consumption of oil. No exhaustion for many generations is apprehended.

OIL SHALES

Colorado. Studies in Colorado Shale Oils, Arthur J. Franks. Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 561–564, 2 figs. Lighter hydrocarbon oil fractions found to be more saturated than heavier fractions. Methods used in obtaining data. Graphical analysis of distillation cuts, showing temperatures, saturation and specific gravities.

Scotland. The Necessity for Research in the Oil-Shale Industry, Martin J. Gavin. Sci. & Industry, vol. 2, no. 12, Dec. 1920, pp. 746–760, 4 figs. Account of shale-oil industry as developed in Scotland. Steam-regulated pyrolytic distillation. Quality and quantity of oil yields.

OPEN-HEARTH FURNACES

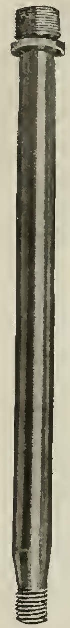
Controlling Valve. New Controlling Valve for Open Hearths, W. H. Wharton. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 253 and 280, 1 fig. Reversing valve combined with air-pressure and volume-controlling mechanism.

Fluorspar Addition. The Use of Fluorspar in Open-Hearth Furnaces (Ueber die Verwendung von Flussspat in Martinöfen), S. Schleicher. Stahl u. Eisen, vol. 41, no. 11, Mar. 17, 1921, pp. 357–361 and (Discussion) pp. 362–364, 2 figs. It is pointed out that if fluorspar is added to an open-hearth slag it decomposes only to a certain extent; fluorspar has a desulphurizing effect in that the sulphur is volatilized from the slag in any desired form so that the slag can re-absorb sulphur from the bath.

OXY-ACETYLENE WELDING

Plate-Steel Roof. Oxy-Acetylene Welding and Cutting at Anaconda, Thomas W. Cunningham. Min. & Sci. Press, vol. 122, no. 13, Mar. 26, 1921, pp. 425–426. Welding of plate-steel roof of metallurgical mill.

The Best Production Methods Are the Most Economical



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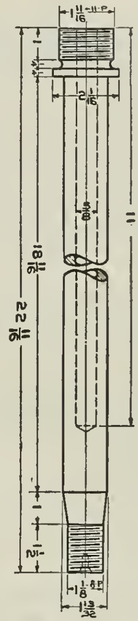

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Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong.

ENGINEERING INDEX (Continued)

Pressure Vessels. Oxy-Acetylene Welding and Cutting, P. E. Willis. Jl. Engrs. Club of St. Louis, vol. 6, no. 1, Jan.-Feb.-Mar. 1921, pp. 13–28. Uses of oxy-acetylene welding torch. Its application to welding of pressure vessels.

P

PAPER MANUFACTURE

Size Standardization. Standardization of Sizes in the Manufacture of Paper. Paper, vol. 27, no. 27, Mar. 16, 1921, pp. 9–10 and 36. List of proposed standards.

PEAT

Minnesota. Experimental Work on Minnesota Peat Soils, F. J. Alway. Jl. Am. Peat Soc., vol. 14, no. 2, April 1921, pp. 40–47, 2 figs.

Utilization. The Manufacture and Utilization of Peat Fuel, Benj. F. Haanel. Jl. Am. Peat Soc., vol. 14, no. 2, April 1921, pp. 1–25, 3 figs. Curve showing effect on calorific power of wet peat by removing different percentages of total moisture content. Investigation on rate at which drying takes place during operating period. Paper read before Am. Inst. Chem. Engrs.

PIERS

Concrete. Oil Protects Concrete Piers from Sea Water Action, Contract Rec., vol. 35, no. 11, Mar. 16, 1921, pp. 268–272, 8 figs. Examination of test specimens immersed since 1909 shows them covered with tar-like coating which prevents corrosion. Rich wet mixes seem least affected by salt water.

PIG IRON

Manufacture. Foundry Pig Iron in Birmingham District, Y. A. Dyer. Iron Age, vol. 107, no. 14, April 7, 1921, pp. 907–909, 3 figs. Trend towards use of machine-cast pig by foundries. Claimed advantages over sand-cast iron include lower melting point.

PILES, CONCRETE

Sea Water, Action of. The Action of Sea Water on Concrete Piles. Contract Rec., vol. 35, no. 12, Mar. 23, 1921, pp. 288–291, 6 figs. Analysis of tests carried out by Aberthaw Construction Co. during past twelve years.

PIPE BENDS

Soft Steel. Pipe Bends (Rohrbogen). Autogene Metallbearbeitung, vol. 14, no. 4, Feb. 15, 1921, pp. 54–59, 26 figs. Describes low-carbon-steel pipe bends manufactured according to a patented process in different curve radii of one-quarter to three-quarter arc and representing finished manufactured articles produced by the Pipe Bend Works, Ltd., Hamburg.

PIPE CONCRETE

Tests. Test Concrete Pressure Pipe With Encased Steel Diaphragm. Eng. News-Rec., vol. 86, no. 15, April 14, 1921, pp. 645–646, 3 figs. Inside of reinforced-concrete shell is 3/16-in. steel pipe which is welded at joints between cast sections.

PIPE, IRON

Strength. Collapsing Strength of Iron Pipes and Tubes, W. F. Schaphorst. Power Plant Eng., vol. 25, no. 8, April 15, 1921, pp. 431. Chart for determining collapsing of iron pipes.

PIPE, STEEL

Spellerized. Spellerized Steel Piping. Power, vol. 53, no. 13, Mar. 29, 1921, pp. 513, 1 fig. Spellerizing process consists of passing heated bloom through rolls and reducing it to proper dimensions for finished product. Spellerizing rolls have regularly shaped projections on their working surface.

PIPE, WROUGHT IRON

Manufacture. Manufacture of Wrought Pipe for High Pressures. Machy. (N. Y.), vol. 27, no. 8, April 1921, pp. 755–756, 5 figs. Practice of National Tube Co., Pittsburgh.

PLANING

Production Systems. Production Planing in Machine Tool Plants. Machy. (Lond.), vol. 17, nos. 442 and 444, Mar. 17 and 31, 1921, pp. 747–752, 8 figs., and 793–797, 7 figs. Methods used in shops of representative planer and engine-lathe builders.

Production Planing in Machine Tool Plants—V. Machy. (Lond.), vol. 17, no. 444, Mar. 31, 1921, pp. 793–797, 7 figs. Methods used in planer-building shops.

PLATES

Stresses in. Contact Pressures and Stresses, E.G. Coker, K. C. Chakko and M. S. Ahmed. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 373–376, 10 figs. Analytical study of stress distribution in plate around point at which concentrated load is applied. Experimental confirmation of analytical results. (To be continued.) Paper read before Instn. Mech. Engrs.

PRESSES

Industrial. Penkala Presses for Compression of Materials and Extraction of Liquids Therefrom (Presses système Penkala, pour l'agglomération des matières et pour l'extraction des liquides qui y sont contenus), M. Biver. Génie Civil, vol. 78, no. 13, Mar. 26, 1921, pp. 265–267, 4 figs. Types of industrial presses, particularly presses used for extraction of juice from cane sugar.

PROPELLERS, SHIP

Design. The Evolution of a New Type of Propeller, H. W. Gill. Mar. Eng., vol. 11, no. 1, Jan. 1921, pp. 17–22, 9 figs. Four-bladed vortex-type propeller protected by outside rim.

Tests. The Screw Propeller—II. Supplément au bulletin technique du Bureau Veritas, Mar. 1921, pp. 9–16, 4 figs. Results of experiments on model propellers with elliptical blades and with wide, deep blades.

Thacher Molding Process. Thacher Molding Process for Propeller Wheels and Blades, Enrique Touceda. Trans. Am. Inst. Min. & Metallurgical Engrs., advance paper, 12 pp. 9 figs. Method developed by Geo. H. Thacher & Co., Albany, N. Y., for rapid manufacture of marine and other gray-iron castings. No subsequent machining is required on blades of propellers.

PROTECTIVE COATINGS

Metal Paints. Metal Protective Paints, Henry A. Gardner. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 11, pp. 85–87. Chemical classification of substances used as paints on metallic structures.

PULVERIZED COAL

Gasification. Gasification of Powdered Coal, A. E. Bourcoud. Chem. & Metallurgical Eng., vol. 24, no. 14, April 6, 1921, pp. 600–604, 4 figs. Consideration of velocity with which reaction takes place between producer gas and suspended carbon, using results for estimating proposal for gasifying powdered coal or oil.

Systems of Burning. Powdered Fuel, Robert James, Proc. So. Wales Inst. Engrs., vol. 37, no. 1, Mar. 10, 1921, pp. 73–110, 18 figs. Systems of burning pulverized coal. Use of pulverized coal in boiler furnaces, locomotives, marine boilers, etc.

Uses. Metallurgical Use of Pulverized Fuel, C. F. Herington. Iron Age, vol. 107, no. 15, April 14, 1921, pp. 965–969, 4 figs. Advances made in utilization of powdered coal as fuel in metallurgical furnaces. List of plants and equipment. There are approximately 2000 metallurgical furnaces using pulverized coal. Plants listed are principally in U. S. and Canada.

PUMPS

Air-Lift. Air-Lift Pumps—Information Required for Design, R. M. Anderson. Stevens Indicator, vol. 37, no. 4, Oct. 1920, pp. 249–269, 10 figs. Formulas, graphs and tables.

PYROMETERS

Platinum-Resistance. Recent Modifications in the Construction of Platinum Resistance Thermometers, T. S. Sligh, Jr., Dept. of Commerce, Sci. Papers, Bur. of Standards, no. 407, Jan. 5, 1921, pp. 49–63, 2 figs. Survey of developments in construction of resistance thermometers as regards heads, leads, terminals and sealing of strain-free type. Elimination of drying head and use of all-metal case with calorimetric type of resistance thermometer.

R

RAILS

Creeping. Rail Creep. Ry. Gaz., vol. 34, no. 11, Mar. 18, 1921, pp. 430–432, 4 figs. Analysis of causes and effects of rail creeping and description of anti-creep anchors.

French Standard. Standard Rails and Splice Bars on French Railways. Eng. News-Rec., vol. 86, no. 11, Mar. 17, 1921, p. 473, 1 fig. Standard rails recommended by commission of engineers appointed at conference between French minister of war and heads of railway systems. Translated from Revue générale des Chemins de Fer.

RAILWAY ELECTRIFICATION

Austria. The Electrification of the Arlberg Railway (Die Elektrifizierung der Arlbergbahn), A. Marschall. Elektrotechnische Rundschau, vol. 38, no. 3, Feb. 7, 1921, pp. 15–16. Notes on the Spuller Lake power station under construction which is the largest railway power station in new Austria and technically one of the most important plants in Europe. Details of equipment and construction.

Economic Advantages. Electrification Reviewed from the Standpoint of Service. C. C. Whittaker. Ry. Rev., vol. 68, no. 13, Mar. 26, 1921, pp. 483–487, 4 figs. Operating advantages resulting from substitution of electricity for steam in railway service. Paper presented before Providence Eng. Soc.

The Economic Aspects of Railway Electrification A. H. Armstrong. Jl. Franklin Inst., vol. 191, no. 4, April 1921, pp. 493–502. Economic advantages of railway electrification, principally from aspect of future growth of transportation system of country and its effect upon national transportation.

France. French Railways Electrification. Elec. Ry. & Tramway Jl., vols. 43 & 44, nos. 1055, 1060, 1064 and 1068, Dec. 10, 1920, Jan. 14, Feb. 11, Mar. 11, 1921, pp. 280–282, 17–19, 61 and 105–107. Official report issued by Ministère des Travaux Publics, containing full details of proceedings of Comité d'Etudes for electrification of systems of great railways as well as various decisions which have been arrived at in respect of lines to be electrified, sources of hydroelectric power, systems of generation and distribution, volatge and frequency, methods of current collection, types of electric locomotives, costs of establishment and operation, and other cognate matters.

India. The Electrification of Indian Railways—III. Ry. Engr., vol. 42, no. 494, Mar. 1921, pp. 92–97, 15 figs. Advantage of using electric locomotives as compared with steam locomotives on heavily graded sections of North Western Ry. of India.

RAILWAY REPAIR SHOPS

Machining Locomotive Parts. Railway Machine Shop Practice—I, Edward K. Hammond. Machy. (N. Y.) vol. 27, no. 8, April 1921, pp. 721–729, 17 figs. Methods employed in railway repair shops for machining locomotive parts.

RAILWAY SHOPS

Sheet-Metal Work. Sheet-Metal Shop Equipment for Railroad Work, J. V. Hunter. Am. Mach., vol. 54, no. 16, April 21, 1921, pp. 683–686, 11 figs. Typical modern power shears, presses and brakes.

RAILWAY SIGNALING

Interlocking. A New Idea in Traffic Locking on the C. & O., H. E. Johnson. Ry. Signal Engr., vol. 14, no. 4, April 1921, pp. 129–131, 7 figs. Traffic-locking scheme developed in order to increase track capacity on congested portions of road.

Non-Interlocking. Non-Interlocking Non-Stop Grade Crossings, L. B. Porter. Ry. Signal Engr., vol. 14, no. 4, April 1921, pp. 144–147, 3 figs. Proposed signal layout to control train movements automatically at intersection points to prevent train stops.

RAILWAY TIES

Steel. Steel Sleepers on the North Eastern Railway. Ry. Gaz., vol. 34, no. 12, Mar. 25, 1921, p. 476, 3 figs. Trial of steel ties under main-line traffic conditions.

RAILWAY TRACK

Buffer Stops. Hydraulic Buffer Stops. Practical Engr., vol. 63, no. 1780, April 7, 1921, pp. 214–216, 4 figs. Buffers suitable for trains weighing up to 500 tons approaching at speed of 10 miles per hour. Stroke of buffer is 8 ft.

RAILWAYS

Light. On the Question of Safety Appliances on Light Railways. Subject XX for Discussion at the Ninth Congress of the International Railway Association, Serge de Kareischa. Bul. Int. Ry. Assn., vol. 3, no. 3, Mar. 1921, pp. 247–304. Report based on answers received from 63 railways in different countries, operating 75 lines.

Pan-American. Intercontinental Pan-American Railway (Fer ocarril International Pan-Americano), Juan A. Briano. Ingenieria, vol. 24, no. 5, Feb. 1, 1920, pp. 99–103. Advocates construction of Peruvian railways with a view to facilitate establishment of Pan-American intercontinental railway. (To be continued.)

REDUCTION GEARS

Double. Mechanical Gears, of Double Reduction, for Merchant Ships, R. J. Walker and S. S. Cook. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 369–370, 3 figs. Graphs showing torque variation at gear wheel end of propeller shaft determined in experiments on S. S. San Fernando. Paper read before Instn. Naval Architects.

REFRIGERATING MACHINES

Ethyl Chloride. The Ethyl Chloride Refrigerating Machine, Charles Bishop. Cold Storage & Ice Assn., vol. 17, no. 1, 1920–1921, pp. 51–63 and (discussion) pp. 64–71, 4 figs. on 4 supp. plates. Installation of Clothel system in Canadian ships.

RESEARCH

Industrial. The Coöperation of Scientific and Industrial Research in the Iron Foundry, Thos. Vickers. Foundry Trade Jl., vol. 23, no. 241, Mar. 31, 1921, pp. 288–290. Economic advantage of coöperation. (To be continued.) Paper read before Instn. British Foundrymen.

Industrial, Belgium. Organization of Scientific and Industrial Research in Belgium (Organisation de la recherche scientifique et industrielle en Belgique), Edgar Forgeur. Revue universelle des Mines, vol. 8, no. 6, Mar. 15, 1921, pp. 501–522, 1 fig. Suggested scheme for national organization under Central Board of Control.

Scientific. Promotion of Scientific Research, William Hoskins and Russell Wiles. Chem. & Metallurgical Eng., vol. 24, no. 16, April 20, 1921, pp. 689–691. Outline of program for forwarding research in chemical and physical sciences at universities. Industries licensed under patentable discoveries to pay reasonable royalties for support of further research.

ROADS

Subgrades. Investigations of Road Subgrades, A. T. Goldbeck. Jl. Soc. Automotive Engrs., vol. 8, no. 4, April 1921, pp. 339–346, 7 figs. Tests being conducted by Bur. of Public Roads.

ROLLING MILLS

Mannesmann Process. Mannesmann Process Rolling Machinery. Carl Gruber. Iron Age, vol. 107, no. 16, April 21, 1921, pp. 1049–1052, 13 figs. Design of rolling mill and its machinery. Details of adjustment devices and guides and of mandrel. (To be continued.) (Abstract.) Translated from Stahl und Eisen.

Sheet Mills. Drive is Feature of Sheet Mill, John D. Knox. Iron Trade Rev., vol. 68, no. 16, April 21, 1921, pp. 1099–1105 and 1111, 20 figs. Roughing rolls driven by friction gears at plant of Superior Sheet Steel Co., Canton, O. High-speed motors with automatic control are provided. Individual squaring shears serve each hot mill.

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ENGINEERING INDEX (Continued)

St. Louis. Scullin Steel Company's New Mills, F. B. Menner. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 260–261. Installation designed to produce wide range of billets, merchant bars and structural shapes.

RUDDERS

Design. The Design of Balanced Rudders of the Spade Type, M. E. Denny. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 370–373, 5 figs. Formulas for determining diameter of stock required to deal with bending and twisting moments and power of steering engine adequate to operate rudder, and determination of longitudinal position of stock relative to rudder area. Paper read before Instn. Naval Architects.

S

SAWS

Circular. A New Cold Circular Saw Machine (Eine neue Kaltkreissägemaschine), Eduard Müller. Betrieb (special no.), vol. 3, no. 11, Mar., 1921, pp. 316–319, 9 figs. "Gnwa" cold circular saw manufactured by the Gustav Wagner Machine Factory, Reutlingen, Germany, which is said to combine increased efficiency with diminished consumption of power; it operates with four cutting speeds and twelve cutting widths.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Automatic. Magazine Feeds for Automatic Screw Machines. Machy. (Lond.), vol. 18, no. 443, Mar. 24, 1921, pp. 757–762, 10 figs. Special equipments developed by Cleveland Automatic Machine Co., for handling second-operation work.

Producing 900 Float Valve Seats Every Hour, J. H. Moore. Can. Machy., vol. 25, no. 15, April 14, 1921, pp. 25–28, 8 figs. Automatic procedure in making spark plug shells, carburetor float valve seats, piston wrist pins, transmission bolts, sewing machine screws, cylinder priming bodies and nuts in quantity.

SCREW THREADS

National Screw Thread Commission. Progress Report of the National Screw Thread Commission. Dept. of Commerce, Bur. of Standards, no. 42, Jan. 4, 1921, 109, pp. 44 figs. National Screw Thread Commission was created by Act of Congress approved July 18, 1918, for the purpose of ascertaining and establishing standards for screw threads for use of the various branches of the Federal Government and for the use of manufacturers. Report recommends certain systems of threads, and gives information, data and specifications pertaining to manufacture of threads recommended.

SEMI-DIESEL ENGINES

Beardmore. The Beardmore Semi-Diesel Oil Engine. Mar. Eng., vol. 11, no. 3, Mar. 1921, pp. 17–20, 16 figs. Four-cylinder unit manufactured by William Beardmore & Co., Glasgow. Ignition is effected by hot bulb.

Tuxham. The Semi-Diesel Engine (Le moteur semi-Diesel). Revue de l'Ingénieur, vol. 28, no. 2, Feb. 1921, pp. 69–77, 4 figs. Description of Tuxham motor built at Delaunay-Belleville works.

SHAFTS

Standardization. Standard Shaft versus Standard Hole (Einheitswelle oder Einheitsbohrung?). Betrieb, vol. 3, no. 13, Mar. 25, 1921, pp. 181–184. Report of sub-committee before the working committee for allowances of the German Industry Committee on Standards (NDI).

Stresses in. Graphical Method of Computing Stresses in Shafts of Electric Machines Rotating Between Three Bearings (Complément aux méthodes graphiques de calcul des flèches arbres des machines électriques à trois paliers), P. Durand. Revue générale de l'Électricité, vol. 9, no. 11, Mar. 12, 1921, pp. 369–370, 7 figs. Formulas for computing stresses in vertical shaft.

Tests. Torsion and Torsion Tests of Shafts, Arthur G. Robson. Practical Engr., vol. 63, no. 1779, Mar. 31, 1921, pp. 196–198, 2 figs. Interpretation of results of tests.

SHEARING MACHINES

Plate. The Modern Methods of Shearing Plates. (Neuzeitliche Blechbearbeitung), H. Graichen. Betrieb, (special no.), vol. 3, no. 11, Mar., 1921, pp. 313–316, 6 figs. Describes a number of plate-shearing machines and summarizes requirements which such machines must fulfill.

Rotary. Rotary Shearing Machines. Engineering, vol. 111, no. 2882, Mar. 25, 1921, p. 353, 4 figs. Machines constructed by Tangent Tool Co., Somerset, England.

SHIP DESIGN

Speed, Depth of Water and. The Influence of the Depth of Water on the Speed of Ships. Engr., vol. 131, nos. 3404 and 3405, Mar. 25, and April 1, 1921, pp. 309–311, 2 figs. and 340–342, 4 figs. Records of experiments conducted by British Admiralty. Survey of literature. Calculations.

SHIP PROPULSION, ELECTRIC

U. S. S. Tennessee. Propelling Machinery of the U. S. S. Tennessee. Mar. Eng., vol. 26, no. 4, April 1921, pp. 269–273, 7 figs. Latest American battleship driven by electricity generated in Westinghouse turbine generators delivering 40,000 hp.

SHIP SALVAGING

Italian Battleship. The Salving of the Italian Battleship Leonardo da Vinci. Engr., vol. 131, no. 3403, Mar. 18, 1921, pp. 281–283, 16 figs. partly on supp. plate. As result of explosion battleship sank in six fathoms of water. Holes in sides were patched and large number of compartments in ship were rendered airtight under water. Battleship has overall length of 650 ft. and displacement of 22,280 tons.

SHIPBUILDING

Manufacturing Methods. Methods in a Shipbuilding Plant, Fred H. Colvin. Am. Mach., vol. 54, no. 16, April 21, 1921, pp. 672–676, 14 figs. Special machines used by Union Iron Works Plant of Bethlehem Shipbuilding Co., together with work-holding fixtures and labor-saving appliances.

Systems of Construction. A Study of the Framing of a Ship, T. B. Abell. Engineering, vol. 111, no. 2882, Mar. 25, 1921, pp. 376–378, 7 figs. Suggested system of construction. Pillars at middle line or two rows of closel spaced pillars. Paper read before Instn. Naval Architects.

SHIPS

Welded. An Entirely Electrically Welded Vessel. Mar. Eng., vol. 26, no. 4, April 1921, p. 277, 1 fig. Vessel was completed at works of Elektriska Svetsnings Aktiebolaget, Gothenburg, Marieholm, Sweden. Dimensions: Length, 52 ft. 6 in.; breadth, 13 ft. 1 in.; depth molded, 7 ft.; draft, 3 ft. 6 in.

SHIPS, CONCRETE

Construction. Lossier System of Constructing Sea-Going Reinforced-Concrete Vessels at Dufour Shipyard, Paris (Les chalands de mer en béton armé système Henry Lossier, construits aux chantiers Dufour, à Harfleur), Robert Sauser. Génie Civil, vol. 78, no. 11, Mar. 12, 1921, pp. 225–230, 15 figs. Characteristics: Length between perpendiculars, 50 meters; width, 10.65 meters; draft, 6.40 meters; displacement, 1000 tons.

SHOP COMMITTEES

Whitley Councils. The Functions of a Work's Council. Eng. & Indus. Management, vol. 5, no. 14, April 7, 1921, pp. 405–408. Scheme in operation at factory of Cadbury Bros., Birmingham, England.

SLIDE RULES

Vector Type. The Vector Slide-Rule, A. F. Zahn. Jl. Franklin Inst., vol. 191, no. 4, April 1921, pp. 525–528, 2 figs. Slide rule for finding magnitude and line resultant when its combination and its moment about a point are given.

SOOT BLOWERS

Tests. Development of Mechanical Soot Blowers, Robert June. Blast Furnace & Steel Plant, vol. 9, no. 4, April 1921, pp. 275–279, 6 figs. Tests of mechanical soot blowers with coal, pulverized fuel and oil.

Tests of Mechanical Soot Blowers, Robert June. Textile World, vol. 59, no. 14, April 2, 1921, pp. 111–115, 4 figs.

SPRINGS

Helical. Charts for the Calculation of Helical Springs (Tafeln zur Berechnung von zylindrischen Schraubenfedern), Adolf Maydell. Dinglers polytechnisches Jl., vol. 336, no. 3, Feb. 12, 1921, pp. 41–42, 2 figs.

Design of Helical Springs, Joseph Kaye Wood. Am. Mach., vol. 54, no. 15, April 14, 1921, pp. 628–632, 4 figs. Alignment chart for determining spring size.

STAMPING

Thin Steel Plates. Stamping Tests of Thin Steel Plates (Essai a l'emboutissage des tôles minces), Ch. Fremont. Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 120, no. 3, Mar. 1921, pp. 241–253, 22 figs. Experimental study of relation between behavior of steel plate in stamping press and mechanical properties. Steel plates were principally tested, also copper, brass and aluminum plates.

STANDARDIZATION

Austria. History and Activity of the Austrian Committee on Standards for Trade and Industry (ÖNIG) (Geschichte und Tätigkeit des österreichischen Normenausschusses fur Industrie und Gewerbe), P. Bretschneider. Zeit. des Oesterr. Ingenieur-u. Architekten-Vereines, vol. 73, no. 13, Apr. 1, 1921, pp. 81–82. (Abstract.)

STAYBOLTS

Standardization of. Standardization of Boiler and Staybolt Taps. Ry. Jl., vol. 27, no. 4, April 1921, pp. 12–17, 7 figs. Suggestions and recommendations made by Committee of Am. Ry. Tool Foremen's Assn.

STEAM-ELECTRIC PLANTS

Chicago. The New Gulbransen-Dickinson Plant. Power Plant Eng., vol. 25, no. 8, April 15, 1921, pp. 401–405, 5 figs. Wood waste utilized as fuel in steam electric isolated plant of Chicago Player Piano Manufacturer.

Newcastle-on-Tyne. A Modern Power Station and Its Development, J. S. Watson. Trans. North-East Coast Instn. Engrs. & Shipbuilders, vol. 36, part 8, Oct. 1920, pp. 496–506 and (discussion) pp. 506–538, 2 figs. on supp. plate. Steam-electric station at Newcastle-on-Tyne with total capacity of 186,540 kw.

STEAM ENGINES

Governors. The "Bee" Governor. Practical Engr., vol. 63, no. 1775, Mar. 3, 1921, pp. 139–142, 5 figs. Patented direct-acting spring-loaded enclosed governor.

The Regulation of Slow-Speed Steam Engines by Means of Slipping Eccentrics (Regeling van een stoomwerktuig met verstelbaar excentriek bij een laag aantal omwentelingen), G. Brouwer. Ingenieur, vol. 36, no. 7, Feb. 12, 1921, pp. 126–131, 8 figs. It is shown that centrifugal governors are not adapatable to slow-speed engines, and an oil-pressure governor without centrifugal action is described which is said to be adaptable for such engines.

Rolling-Mill Drive. A Big Vertical Mill Engine. Engr., vol. 131, no. 3405, April 1, 1921, pp. 354–355, 9 figs. partly on 2 supp. plates. Three-cylinder rolling-mill engine capable of developing maximum of 25,000 hp. at 140 r.p.m. Cylinders are each 45 in. diameter by 42 in. stroke and all take steam at 190 lb. per sq. in., superheated 100 deg. fahr.

STEAM POWER PLANTS

Layout. Fundamental Principles for the Constructional Arrangement and Develpment of Power Plants (Grundzüge fur die bauliche Anordnung und Entwicklung von Kraftwerksanlagen), A. Rüster. Zeit. des Bayerischen Revisions-Vereins, vol. 25, nos. 4 and 5, Feb. 28 and Mar. 15, 1921, pp. 25–28 and 33–35, 8 figs. Deals with plants for generation of heat. Details of steam-boiler installations of modern power plants. (Abstract.)

STEAM TURBINES

Installation. New Turbine Plant of the Hudson Motor Car Co. Power, vol. 53, no. 15, April 12, 1921, pp. 572–575, 8 figs. Turbines of condensing and non-condensing types installed with flexible arrangement to supply varying quantities of exhaust steam.

[See also MARINE STEAM TURBINES]

STEEL

Alloy. See ALLOY STEELS.

Chromium. See CHROMIUM STEEL.

Copper, Influence of. Influence of Copper on Some Physical Properties of Iron and Steel, E. A. Richardson and L. T. Richardson. Chem. & Metallurgical Eng., vol. 24, no. 13, Mar. 30, 1921, pp. 565–567. Number of ferrous alloys were made and physical properties of forging, filing, grinding, chiseling and bending determined. It was found that copper caused iron to be red-short and that manganese or chromium removed this difficulty.

Corrosion-Resisting. Anomalies Encountered in a Study of Immersion Tests of Iron and Steel, Allerton S. Cushman and George W. Coggeshall. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 22, pp. 249–267, 3 figs. Plea for considering all possible factors when comparing corrosion tests of iron and steel, on ground that there are in reality so many and so obscure variables that it is very easy to draw wrong conclusions. Tests in aluminum sulphate solutions, giving curious colloidal gels, are described. Writer denies protective action of copper in steel.

Observations on the Corrosion of Iron and Steel, J. A. Aupperle and D. M. Strickland. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 17, pp. 167–177, 2 figs. Records of tests on pure iron made in open-hearth furnaces, copper iron, plain steel and copper steel, to determine their resistance to sulphuric acid corrosion. Specimen sheets were tested 60 days in each case, either alone or fastened to sheets of pure iron by copper rivets or iron rivets, forming galvanic couples.

The Gap Between Theory and Practice in the Production of Corrosion-Resisting Iron and Steel, William D. Richardson. Thirty-Ninth Gen. Meeting, Am. Electrochemical Soc., April 21–23, 1921, advance paper no. 16, pp. 147–165. Electrolytic theory of corrosion is discussed, also influence of oxygen and role of adhering rust. Accelerated corrosion tests are studied, and their defects pointed out. Behavior of copper-bearing iron, silicon-containing cast-iron, nickel and nickel-chromium steels, nickel-copper steels, chromium steels, and nickel-cobalt-chromium alloys is investigated.

Magnet. See MAGNETS, Steel for.

Metallography. The Metallography of Low Carbon Steel, James Mitchell. Jl. West of Scotland Iron & Steel Inst., vol. 28, part 4, Jan. 1921, pp. 38–45 and (discussion) pp. 45–49, 27 figs. on 4 supp. plates. Interpretation of photomicrographs.

Structural. See STRUCTURAL Steel.

Testing. The Testing of Steel, D. Sillars. Foundry Trade Jl., vol. 23, no. 240, Mar. 24, 1921, pp. 268–270. Comparative value of tests ordinarily applied.

Tests. Experimental Investigations of the Behavior of Wrought Iron and Low-Carbon Steel at Freezing Temperature under Sudden Stress (Versuche über das Verhalten von Schweisseisen und Flusseisen in der Kälte bei plötzlicher Beanspruchung), Ed. Wilh. Kaiser. Stahl u. Eisen, vol. 41, no. 10, Mar. 10, 1921, pp. 333–337, 8 figs. Under sudden stress influence of freezing temperature on both wrought iron and low-carbon steel is considerable. With cooling off to 20 deg. cent., low-carbon steel loses about 85.5 per cent, wrought iron only 42.3 per cent.

STEEL CASTINGS

Centrifugal Process. Tests of Centrifugally Cast Steel, George K. Burgess. Trans. Am. Soc. for Steel Treating, vol. 1, no. 7, April 1921, pp. 370–382, 26 figs. Photomicrographic examination of castings made by Millsbaugh centrifugal processes.

Tests of Centrifugally Cast Steel, George K. Burgess. Iron Age, vol. 107, no. 12, Mar. 24, 1921, pp. 764–766, 5 figs. Results suggested possibility that centrifugally cast steel suitably treated may rival properties of forgings of same chemical composition.

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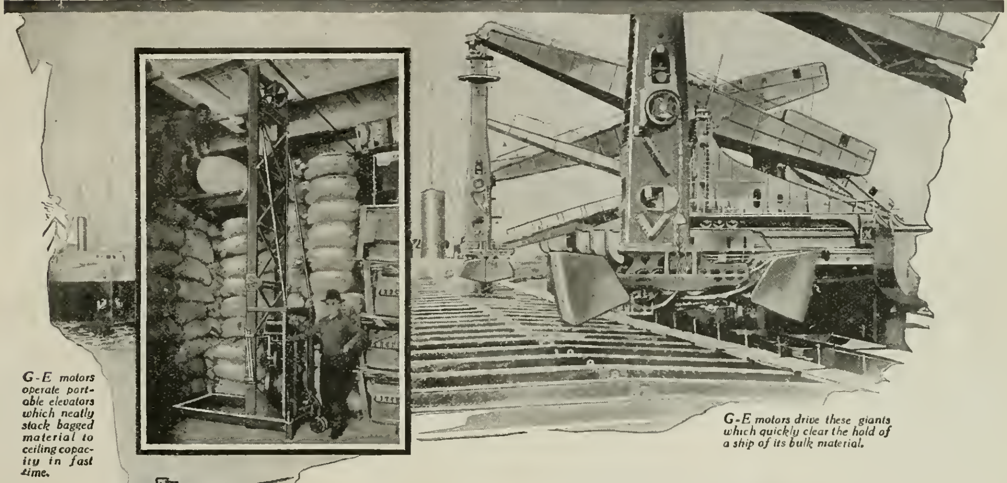

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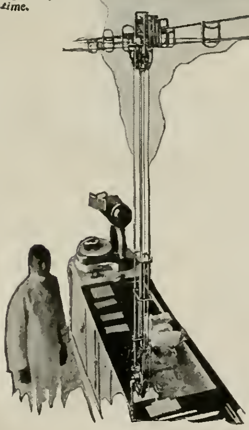

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ENGINEERING INDEX (Continued)

STEEL, HEAT TREATMENT OF

Cooling, Effect of. Effect of the Rate of Cooling on the Magnetic and Other Properties of an Annealed Eutectoid Carbon Steel, C. Nus baum and W. L. Cheney. U. S. Dept. of Commerce, Sci. Papers of Bur. of Standards, no. 408, Jan. 22, 1921, pp. 65–78, 11 figs. Specimens of steel were heated to 800 deg. cent. and allowed to cool at various rates, one in air, one in lime and others in furnace at slower and slower rates. It was found that as cooling rate is diminished there is pronounced increase in value of maximum induction for given small magnetizing force, decided increase in maximum permeability, but decrease in coercive force.

Chrome-Nickel Steel. Notes from the Workshops of a Refined Steel Foundry (Einiges aus der Werkstätte des Edelstahlwerkers), Erdmann Kortny. Stahl u. Eisen, vol. 41, no. 7, Feb. 17, 1921, pp. 213–223, 4 figs. In order to determine the correct heat treatment of chrome-nickel steel which is also used as construction steel for overhung crankshafts, forgings tests were carried out with rolled material at different temperatures, results of which are given in tabular form. Instructions are given for the production of overhung shafts and crankshafts for the different departments of a refined steel works. See same Jl. Jan. 8 and May 20, 1920.

STEEL MANUFACTURE

Direct Process. Direct Process of Manufacture of Iron and Steel from the Ore (La fabrication directe du fer et de l'acier à partir du minerai). Métallurgie, vol. 53, no. 8, Feb. 23, 1921, pp. 385–386. Chaplet-Arnou process. (To be continued.)

STEEL MILLS

See ELECTRIC DRIVE, Steel Mills.

STRESSES

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MECHANICAL ENGINEERING

Volume 43 July, 1921 Number 7

Location and Distribution of the Central-Station Power of the Middle West

By W. L. Abbott,[1] Chicago, Ill.

The location and distribution of the central-station power of the Middle West is a subject which has neither the large commercial possibilities of the proposed superpower system of the North Atlantic states nor the spectacular engineering interest of the hydro developments of the Pacific states. The power development of the low, level, rich prairie country, with its wealth of cheap coal, is peculiar to itself, and the distribution is working out its destiny following its natural instincts.

Fig. 1, taken from a recent issue of the *Electrical World*, is an ingenious redistribution of the area of the country, designed to show up the various states in their true electrical importance. This map, which represents relative kilowatt-hour production, is doubtless a fairly accurate representation of installed kilowatt capacity, the total for the United States being given as 12,600,000, of which about one-third, or 4,000,000 kw., is hydroelectric.

Location of the Water Powers of the Middle West

The various potential power streams of the country and the water powers are generally located where they will do the most good—that is, remote from coal mines—the Middle West, in comparison with the rest of the country, not being particularly favored. The states of Ohio, Indiana and Illinois, which are richest in coal, are poorest in water power. Only 18 per cent, or 776,000 kw., of the water power of the country lies in the middle-western states, and the greater part of this is in the states of Michigan, Wisconsin, and Minnesota. Portions of Ohio rise 500 ft. above the Ohio River and above Lake Erie, but the whole state is credited with only 40,000 kw. installed central-station hydroelectric power.

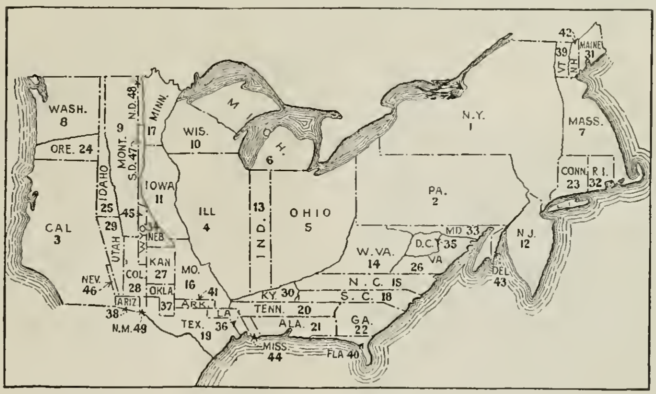

Fig. 1 Relative Sizes of States Based on Their Kilowatt-Hour Production

In Southern Michigan and Northern Indiana is a land elevation of more than 500 ft. above Lake Michigan, giving the St. Joseph River and its tributaries a fall of 10 ft. to the mile over its entire length. The effect of this fall is to dot the map with water powers all along the river's course. A similar elevation near Detroit has its effect on the Huron River, and a hogback up through the center of the southern peninsula makes good mill streams of the Au Sable River, of the Manistee, Grand and Muskegon.

Along the southern shore of Lake Superior the land elevation is, in places, 1000 ft. above the lake, but the territory drained is rather restricted and the rivers are so short that the streams are torrential for a brief interval and almost dry much of the time.

The lower Fox River, between Lake Winnebago and Green Bay, Wis., has a drop of 170 ft. in 28 miles, along which over 40,000 kw. of power was installed long ago and fully occupied by local industries. The level plateau of the watershed of the Fox River and the large pondage of Lake Winnebago make the lower Fox River an ideal one for power. The principal discharge for the rivers of Central Wisconsin is the Mississippi River, which is about 700 ft. above sea level, and as the center of the state abounds in lakes and marshes at elevations of 500 to 1000 ft. above the mouths of the rivers which drain this interior, many important water powers are being developed on these rivers, as at Kilbourn, 6000 kw.; Prairie du Sac, 18,000 kw.; Eau Claire and vicinity, 50,000 kw.; and St. Croix Falls, 18,000 kw.

The principal central-station water power of Minnesota is 50,000 kw. in the vicinity of Duluth. The great water power of the Mississippi River that made Minneapolis famous is principally taken up by flour mills and other local industries. About 33,000 kw. of this power is classified as central-station power.

The territory comprised in this survey includes and extends from Western Pennsylvania to Eastern Kansas, from Southern Kentucky to the Great Lakes and the Canadian border. It comprises an area of 660-000 square miles and a population of 40,000-000. It all lies in the Mississippi Valley and scarcely one per cent can be rated as mountainous, its broad stretches of prairie and forest lands having in general such slight declivity and absorbent soil that the water run-off, excepting that lost in floods, does not exceed one-fifth of the precipitation, and its placid streams for the greater part of their courses flow to the lakes or sea with a slope of half a foot to the mile.

Such a gentle fall of course makes possible relatively little water power, considering the length and breadth of the streams, but as compensation, because these streams have not eroded the soil, the prairie states, with their unrivaled fertility, will some day support a teeming population of hundreds of millions, whose increasing clamor for power must be satisfied principally, as now, by coal drawn from their own great stores.

Water power must be developed at the waterfall, and until long-distance transmission was developed that power had to be used where it was generated; and because much of such power was located in rough, inaccessible country, having no other features of com-

[1] Chief Operating Engineer, Commonwealth Edison Company. Mem. Am.Soc.M.E.

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mercial importance, such rivers were allowed to roll on in solitude "and hear no sound save their own dashing." Now electric transmission has changed all of this, and whereas once factories went to the power, now power goes to the factories, and with a widening effective range of transmission lines and higher cost of coal, more and more of these wild waters are being broken to harness and few of those remaining are escaping serious consideration.

The Question of Power Plants at Mine Mouth

The example of hydroelectric power transmission naturally suggests that coal be burned at the mine to develop steam-electric power for transmission to remote markets, thereby saving the expense and uncertainties of rail shipment. The argument seems plausible, and yet the author is not aware that such a thing is being done anywhere in a large way. Indeed, it is doubtful if in any but the most favorable cases power plants at the mine mouth with a transmission line can successfully compete with power plants located in the remote centers where the power is to be used, the coal necessary for these plants being shipped by rail.

It must be admitted that during the past few years the railroads have done much toward popularizing electric transmission, but rates have not quite reached the point where, even under most favorable conditions in the Middle West, a power company would be warranted in maintaining a power plant at the mine, a stand-by plant in the city, and a transmission line between. Conditions, moreover, are seldom "most favorable," as with us the large quantity of flowing water necessary for condensing in a plant of upward of 50,000 kw. is seldom found at the mines. This renders it necessary to ship the coal to a power house located on a nearby river and to transmit electrically from there to the place where the power is to be used, but right here the railroads that have tried so hard to popularize all-electric transmission have unwittingly intervened with an awkward freight-schedule system, which renders a part rail and part line transmission impossible. This has happened because they did not know there was any system to their schedules, and while the author cannot say that these schedules were prepared according to any rule, he has nevertheless found a key that will fit the average of several taken at random. This key indicates that a coal freight schedule is composed of a basic charge of $1.00 a ton and a hauling charge of four-tenths of a cent per ton-mile. Let us see how this affects a rail and line transmission.

From the Springfield coal district to Chicago is 192 miles. This distance, at 0.4 cent per ton-mile, amounts to 77 cents; adding the basic $1.00 makes $1.77. The actual rate, $1.83, is a little less than 1 cent per ton-mile.

Fig. 2 Central-Station Power Distribution of the Middle-Western States

1—Chicago, Ill.	6—Windsor, W. Va.	11—Indianapolis, Ind.	16—Duluth, Minn.
2—Cleveland, Ohio	7—Keokuk, Iowa	12—Columbus, Ohio	17—Joplin, Mo.
3—St. Louis, Mo.	8—Cincinnati, Ohio	13—Toledo, Ohio	18—Akron, Ohio
4—Detroit, Mich.	9—St. Paul, Minn.	14—Kansas City, Mo.	19—Moline, Ill.
5—Pittsburgh, Pa.	10—Milwaukee, Wis.	15—Louisville, Ky.	20—Cabin Creek Jct., W. Va.

There being no dependable supply of condensing water near Springfield, it has been suggested that the coal destined for Chicago power be shipped to Peoria, where there is water in abundance, used there in power houses, and the electric energy sent to Chicago via a high-tension line.

From Springfield to Peoria is 62 miles, which at 0.4 cent is 25 cents; adding the basic $1.00 gives $1.25. The actual rate is $1.17, —a little less than 2 cents per ton-mile, or about double the ton-mile rate from Springfield to Chicago.

Obviously, the Springfield-Chicago all-rail shipments need have no fear of competition via the Springfield-Peoria-Chicago rail and line route.

Location of Power Stations and Distribution Lines in the Mid-West Territory

Fig. 2 is a map showing the distribution lines of the territory discussed and also showing by dots and circles the centers where the power is generated and used. The smallest circle shown represents 500 kw.; smaller amounts of power are indicated by dots. Central power stations of less than 500 kw. and not connected up to another center do not appear on the map. Broken circles indicate a power station, the greater part of whose output is included in the area of some solid circle. The developed central-station power of the Middle West is 4,500,000 kw., of which all but 18 per cent is from steam power.

The large circle, indicating 500,000 kw. for the central stations of Chicago and vicinity, is the dominating feature; following in order are Cleveland, St. Louis and Detroit, each with a little more than 200,000 kw. The 210,000 kw. of St. Louis is made up in part by its own Ashley Street Station and in part by the 100-000 kw. from the Keokuk dam, shown as circle 7. One significant feature of the important high-voltage transmission lines indicated in the figure is that such lines are used almost entirely to connect water powers with centers where their power is used, the exception to this being in the vicinity of Pittsburgh, where mine-pit cars dump their coal into the hoppers of boiler rooms located on river banks, and in Detroit, where a small amount of power is distributed at 46,000 volts; also a short 66,000-volt line owned by the Doherty interests in Central Ohio.

The line over which the greatest amount of power is transmitted connects the Stone & Webster Keokuk power with St. Louis at 110,000 volts. Probably the system next in importance is that of Hodenpyl & Hardy in Michigan, connecting up water powers on the Au Sable, Manistee and Grand with a line of 140,000 volts—

(Continued on page 458)

The Hardness Testing of Metals[1]

Report of a Committee of the Engineering Division of the National Research Council on Various Methods of Testing the Hardness of Metals

THE Committee on A New Hardness-Testing Machine of the Engineering Division of the National Research Council was formed at the suggestion of Dr. Henry M. Howe to obtain, if possible, more satisfactory methods of measuring the hardness of metals. The following reports were submitted to the committee in the course of its work and are published here as it is believed that they will assist others interested in hardness measurements.

Brinell Tests with Etched Ball[2]

This method, devised by Axel Hultgren, is used on hardened steel in order to obtain indentations which are easier to read than those produced with polished balls. Either 5-mm. or 10-mm. steel balls may be used. The balls are wiped free from grease and thoroughly cleaned in alcohol, and thereafter etched for 2 to 4 minutes under agitation in a solution of 1 per cent nitric acid in alcohol and cleaned again in alcohol. The hardened steel surface to be tested is ground and polished as usual, the higher the polish the better. The load—1000 kg. or 750 kg. for 5-mm. ball, 3000 kg. for 10-mm. ball—is applied as usual in a Brinell testing machine.

In reading the indentation with a Brinell microscope the light should fall at a steep angle. If polishing scratches running in one direction are left on the surface of the specimen, the light should fall in the same direction in order that the best definition of the indentation circle may be obtained. Under the conditions described, the diameter can be read with greater sharpness and more ease than when a polished ball has been used, due to the contrast between the dull indentation surface produced by the etched ball and the surrounding surface.

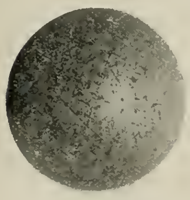

Fig. 1 Appearance of the Brinell Ball after the Polish Has Been Removed by 1 Minute's Immersion in 1 Per Cent Alcoholic Solution of Nitric Acid

The dullness is explained as follows: The ball being made of a hypereutectoid steel, the etched surface presents numerous small cementite grains standing out in relief from the matrix, which is martensite. When this surface is pressed against the surface of the specimen so as to produce an indentation, numerous small holes are formed in the latter by the cementite grains in the former. The dull appearance of the indentation is an effect of these small holes.

In order to show the advantage of using the etched ball in making Brinell hardness determinations, H. S. Rawdon of the Bureau of Standards was requested to illustrate the results photographically. He has done this and given, in addition, the discussion which follows:

To test the method a portion of a file from which the teeth had been entirely removed was used. This was highly polished as for microscopic examination. The balls were 10 mm. in diameter and indentations were obtained with a load of 1000 kg. applied for 30 seconds. The balls were etched in a 1 per cent alcoholic solution of nitric acid for two minutes.

Fig. 1 shows the appearance of one of the balls after etching. The surface pattern revealed, which resembles that of the dendritic structure of steel, may be the result of abrasion markings, caused by the grinding of the balls, which subsequently were hidden but not entirely removed by the polishing of the balls. A microscopic examination of the surface of the ball after etching reveals the structure of the material. The steel consists of innumerable particles of carbide embedded in a matrix which is probably somewhat softer than the carbide. The matrix etches more readily than the carbide so that the tiny particles of carbide stand in relief over

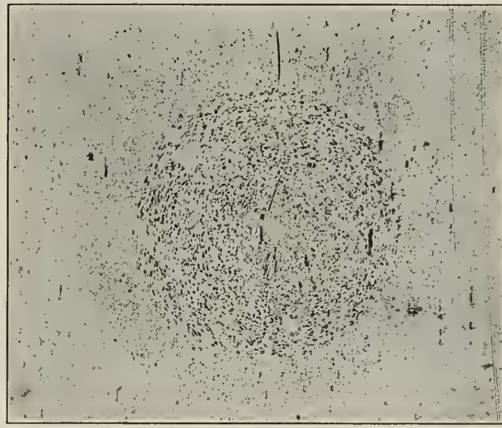

Fig. 2 Character of Brinell Indentations Obtained with Etched Balls. Magnification × 50

Fig. 3 Character of Brinell Indentations Obtained with Etched Balls. Magnification × 100

[1] Slightly condensed from part of the progress report of the Committee on a New Hardness Testing Machine of the Engineering Division of the National Research Council. The personnel of the committee is as follows:
Prof. H. L. Whittemore, Chairman, Bureau of Standards, Washington, D. C.
Major A. E. Bellis, Springfield Armory, Springfield, Mass.
H. C. Boynton, John A. Roebling's Sons Company, Trenton, N. J.
S. L. Cope
Alfred V. de Forest, American Chain Company, Bridgeport, Conn.
Prof. Fred E. Foss, Cooper Union, Astor Place, New York City.
F. P. Gilligan, Henry Souther Engineering Company, 11 Laurel Street, Hartford, Conn.
Prof. S. L. Goodale, 1156 Murray Hill Avenue, Pittsburgh, Pa.
Dr. P. D. Merica, International Nickel Company, Bayonne, N. J.
Prof. H. F. Moore, University of Illinois, Urbana, Ill.
Prof. John H. Nelson, Wyman & Gordon Company, Worcester, Mass.
P. M. Taft, Illinois Watch Company, Springfield, Ill.
The American Society of Mechanical Engineers has donated a bibliography on hardness, copies of which can be obtained from the chairman.

[2] From report prepared by Axel Hultgren, Svenska Kullagerfabriken, Gothenburg, Sweden.

the surface of the ball. The diameter of the ball is not reduced to any appreciable amount, as the specimen is etched only to about the same degree as is the usual practice for revealing the microstructure.

The indentation produced by the etched ball has a "matt" appearance and is readily visible when the specimen is viewed at almost any angle. The impression produced by the unetched ball is almost invisible when the light strikes the surface at certain angles, and particularly is this so when the line of vision is approximately normal to the surface.

Figs. 2 and 3 show the appearance of the spherical surface of

Fig. 4 Brinell Indentation on Hard Steel with Unetched Ball. Magnification × 50

an indentation obtained with the etched ball, viewed with "vertical illumination," that is, normal to the surface. It is readily seen that the matt finish is due to numerous tiny pits, caused undoubtedly by the projecting carbide particles on the surface of the etched ball. The indentation consists of two zones. In the inner one the pits are larger and more numerous than in the outer one and are often slightly elongated and arranged in concentric rings. This is caused by a slight rotary motion of the ball as the pressure is applied. The pits in the outer zone are much smaller, the line of demarcation between the two being very sharp. Fig. 3 shows the difference between the two zones of the indentation more clearly. The micrograph (×100) covers only one quadrant of the impression. Evidently the pressure applied to the ball is not transmitted equally to all parts of the metal covered by the indentation. Fig. 4 shows a view (×50) of an impression obtained with an unetched ball; the dark area is an ink spot which was placed at the center of the indentation in order to locate it. Only very slight traces of the impression can be seen, though a few pits similar to these noted in the other type of indentation may be noted. There is nothing, however, to mark the outer limit of circumference of the indentation.

If desired, an area on the surface of the specimen to be tested may be etched with alcoholic nitric acid before the indentation is made. In this case it is not necessary to etch the ball. The impressions obtained in this way are considerably more conspicuous than those obtained with an unetched ball on a polished specimen, but not quite so conspicuous as those produced by the etched ball on a polished surface.

A further advantage in the use of etched balls may be mentioned. After the indentation has been made, a bright spot remains on that side of the ball which was in contact with the material tested. This renders it an easy matter to turn the ball so that an unused, and therefore a much less distorted, portion of the ball can be employed for a subsequent hardness determination.

Impact Hardness Apparatus

One of the problems of hardness testing has been the determination of the hardness of the large masses of metal which could not be moved readily, and especially the hardness of surfaces which were vertical or in such a position that the use of the scleroscope or Brinell machine was impossible.

Impact Brinell machines in which the impact of a hand hammer is used have been devised. The blow causes a ball between the material to be tested and a material of known hardness to indent both. The hardness desired is computed from the impressions in the two materials. Two instruments of this type, the Morin apparatus and the Brinell meter, have been tested.

Morin Hardness-Testing Apparatus[1]

Description of the Apparatus. The Morin hardness-testing apparatus, Figs. 5 and 6, was tested to ascertain its practical value in determining the hardness of metals. It consists of a cylindrical case in which a steel ball, a standard cube, and a plunger are held firmly in contact in their proper relative positions by a coil spring which surrounds the plunger.

The ball, 10 mm. in diameter, projects slightly from one end of the case so that it may be brought into contact with the specimen. The plunger, projecting about one-half inch from the other end of the case, may be struck by a hammer. The standard cubes are about ½ inch in each dimension. A dozen cubes having different hardnesses are supplied by the maker. The case is so designed that the cubes may be readily put in place, or removed, without having the ball or plunger leave their places.

To make a hardness determination the standard cube is selected that has about the same hardness as the specimen. It is placed in the case, the latter held perpendicularly to the surface of the specimen and the plunger struck with a hammer (see Fig. 5). The ball, held between the standard cube and the surface, indents both of them. The diameter of the impression in the standard cube is measured, as well as that in the specimen. Knowing the two diameters and the Brinell hardness of the cube which has been determined in the usual way, a special circular slide rule provided with the instrument and shown in Fig. 6 is used to determine the hardness of the specimen.

Outline of Tests. For testing the apparatus, carbon steels were used having Brinell hardness numbers ranging from 88 to 302. Standard cubes similar to those supplied with the apparatus were prepared from the same piece of steel. Three series of tests were

Fig. 5 Morin Hardness-Testing Apparatus Ready for Use

made to determine the influence of various factors upon the hardness numeral as given by the instrument: namely,

1 The influence of variations in the energy of impact where the standard cubes and specimen are the same
2 The influence of variations in the hardness of the standard cubes where the hardness of the specimen is constant
3 The influence of variations in the hardness of the material when the hardness of the standard cube is constant.

[1] This report (Bureau of Standards Lab. No. 1118a20) was prepared by H. L. Whittemore, S. N. Petrenko, and L. B. Tuckerman.

In all the tests except Nos. 27 to 35 the blow was given by a 10-lb. sledge hammer. A pin through the handle at a distance of 3 ft. from the hammer head served as an axle. The hammer was raised the required height and then released. When dropped under the influence of gravity the hammer head struck the apparatus resting on the specimen. In tests Nos. 27 to 35 the blow was given by a hand hammer weighing 1 lb.

TABLE 1 TESTS OF MORIN HARDNESS-TESTING APPARATUS

	Standard cube			Material			Morin-
Test No.	No.	Brinell hardness	Scleroscope hardness	No.	Brinell hardness	Scleroscope hardness	Brinell hardness
			Series 1; Energy of Impact, 60 in-lb.				
1-a	A	88	21	A	90	22	94
1-b	B	122	24	B	119	23	113
1-c	C	147	29	C	162	28	143
1-d	D	172	30	D	175	27	168
1-e	E	187	39	E	204	27	173
1-f	F	208	41	F	220	36	208
1-g	G	218	39	G	206	30	210
1-h	H	277	48	H	275	38	262
1-i	I	300	52	I	302	48	302
			Series 1; Energy of Impact, 30 in-lb.				
2-a	A	88	20	A	90	24	88
2-b	B	122	22	B	119	20	143
2-c	C	147	27	C	162	29	173
2-d	D	172	36	D	175	26	158
2-e	E	187	38	E	204	25	172
2-f	F	208	39	F	220	35	208
2-g	G	218	40	G	206	35	216
2-h	H	277	49	H	275	39	268
2-i	I	300	53	I	302	48	280
			Series 2; Energy of Impact, 60 in-lb.				
3	A	88	20	I	302	48	219
4	B	122	23	I	302	48	260
5	C	147	28	I	302	48	254
6	D	172	33	I	302	50	276
7	E	187	39	I	302	50	264
8	F	208	38	I	302	48	299
9	G	218	38	I	302	47	288
10	H	277	49	I	302	47	296
11	I	300	53	I	302	48	284
12	A	88	20	B	119	28	108
13	B	101	22	B	119	26	107
14	C	147	28	B	119	23	119
15	D	172	32	B	119	25	124
16	E	187	39	B	119	24	122
17	F	208	38	B	119	24	134
18	G	218	40	B	119	25	135
19	H	277	49	B	119	23	137
20	I	200	53	B	119	24	138
21	B	101	21	E	204	33	165
22	143	143	26	E	204	32	196
23	150	150	27	E	204	33	197
24	E	185	39	E	204	33	187
25	G	206	38	E	204	28	198
26	I	306	51	E	204	28	206
			Series 2; Energy of Impact, 20-30 in-lb.				
27	143	143	27	E	204	31	210
28	145	145	28	E	204	31	208
29	150	150	29	E	204	30	187
30	210	210	43	E	204	30	204
31	255	255	44	E	204	30	230
			Series 3; Energy of Impact, 20-30 in-lb.				
32	150	150	28	B	119	26	130
33	150	150	29	E	204	30	185
34	150	150	29	F	220	34	190
35	150	150	30	H	275a	40	230

Fig. 6 Parts of the Morin Hardness-Testino Apparatus in Their Proper Relative Positions

Results of Tests. The results of the various series of tests are given in Table 1. In the last column on the table are given Morin-Brinell hardness numerals as determined by means of the slide rule provided with the apparatus. As a check on the Brinell hardness numbers, the scleroscope hardness of the standard cubes and of the specimens is given in the tables. The Brinell hardness was determined by an Alpha Brinell machine, using a 10-mm. ball and a load of 3000 kg.

In the tests of Series 1, two widely different amounts of impact energy were used. The hammer was dropped from the heights of 3 in. and 6 in., the corresponding energies of impact being 30 in-lb. and 60 in-lb., respectively. A comparison of the values in the last column of the table shows that the energy of impact has no apparent influence upon the results.

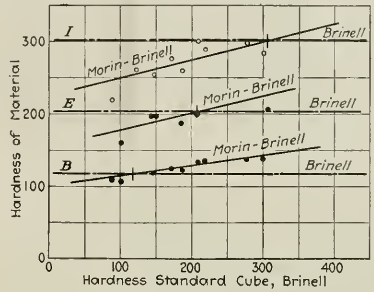

Fig. 7 Graphs of Results of Tests of Series 2; Energy of Impact, 60 in-lb.

In studying these results it should be remembered that the standard cubes and the specimens were of the same material. The slight differences in their Brinell hardnesses is due to variation in hardness of the material and to the usual errors in the determination of the hardness. The results are therefore in this respect obtained under unusually favorable conditions. On the other hand, the hardness of the test pieces was not uniform and the differences in Morin-Brinell hardness and Brinell hardness possibly were partly due to the actual differences of hardness in various parts of the test pieces. The maximum error for the 60 in-lb. impact is 15.2 per cent and the average 5.9 per cent. For the 30 in-lb. impact the maximum error is 20.2 per cent and the average 8.3 per cent.

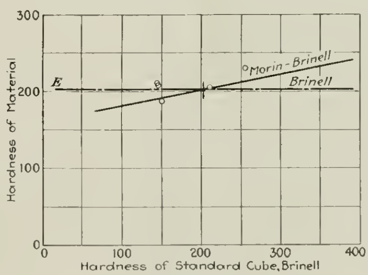

Fig. 8 Graph of Results of Tests of Series 2; Energy of Impact, 20-30 in-lb.

The difference between the Brinell hardness of the material as determined in a Brinell hardness machine and the Morin-Brinell hardness is probably not due to the energy of impact being too great or too small, but to the errors of the apparatus itself and to the variations in the hardness of the test pieces and of the standard cubes. However, it may be said that the 60 in-lb. impact gives the more consistent results. It is also to be noted that the irregularities of the readings increase with increasing hardness, perhaps due in part to the difficulty in accurately measuring the small impression.

In tests Nos. 3 to 20, Series 2, the hardest (Brinell hardness 302) as well as one of the softest (Brinell hardness 119) materials were chosen and tested with standard cubes of various degrees of hardness. The results are shown graphically in Figs. 7 and 8. In these graphs the constant Brinell hardness of the specimen is shown by the horizontal line marked "Brinell." The hardness values of

the specimen as found by the Morin apparatus are plotted as ordinates, using as abscissas the Brinell hardness of the standard cube. If results are desired which are accurate within 10 per cent it is apparent from the graphs that the hardness of the standard cube should not differ from that of the specimen by more than 100 Brinell numbers. Due to the fact that many of the Morin-Brinell values do not lie close to the plotted line among the points, it seems reasonable to reduce this difference one-half, or to 50 Brinell numbers.

In Series 3, tests Nos. 32 to 35, specimens of various hardnesses were tested with standard cubes of constant hardness (150). The results of these tests confirm the deduction from the previous tests as shown in Fig. 9.

Conclusions. From a study of the results obtained in the various series of tests the following conclusions have been arrived at:

1 The hardness obtained with a Morin hardness tester is not affected, to any considerable degree, by the amount of energy of impact. Too light a blow is likely to give more erratic results than a heavy blow, and as the correct measurement of the diameter of a small indentation is difficult, the diameter of the impression should not be smaller than 2.5 mm. or possibly 3 mm.

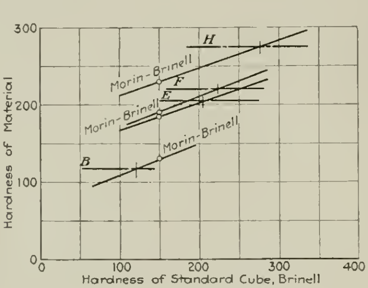

FIG. 9 GRAPH OF RESULTS OF TESTS OF SERIES 3; ENERGY OF IMPACT, 20-30 IN-LB.

2 The hardness of the standard cube should be as near that of the specimen as possible. A difference in hardness amounting to more than 50 Brinell units would be likely to make the error exceed 10 per cent. It is possible that this limitation might be removed by the use of an appropriate correction formula, but this would still further complicate the use of the apparatus.

3 The standard cubes should be uniform in hardness and their Brinell hardness should be determined before they are cut out of a bar, as any error appears in the hardness of the test piece.

4 The size of the standard cubes is too small to obtain their Brinell hardness accurately. They are distorted by the 3000-kg. load more than would be the case with larger blocks.

5 Due to the fact that each block can be used for only six readings, the time and expense required to make additional blocks is a rather serious restriction on the use of the apparatus.

6 The proximity of the hardness of the standard cube to that of the specimen to be tested is numerically of greater importance in the case of hard material than in the case of soft, as shown by the slope of the curve in Fig. 7.

THE BRINELL METER[1]

Description of the Apparatus. The Brinell Meter apparatus consisted of a cylindrical case which held the parts in their proper relative position. At one end was a 10-mm. steel ball, next a standard bar, then a plunger. These were held in contact by a coil spring which surrounded the plunger. A cap which screwed into the end of the cylinder held the parts in place. The steel ball projected from one end of the case so that it could be brought into contact with the specimen whose hardness was desired. The standard bar, approximately, ½ in. square in cross-section by 6 in. long, could be placed in position between the ball and the plunger through holes in the side of the case. The Brinell hardness number was stamped on the bar. Fig. 10 shows the apparatus ready for use and Fig. 11 the parts in approximately their relative positions.

[1] This report, Bureau of Standards Lab. No. 1231a20 (No. 17–203 revised), prepared by H. L. Whittemore and L. B. Tuckerman, includes experimental data on the Brinell Meter obtained by T. L. Sorey.

In order to determine the hardness of a specimen, a standard bar having nearly the same hardness is placed in the apparatus so that the ball rests on an unindented portion. The apparatus, held in the hand, is placed so that the ball rests on the specimen. The plunger is then struck by a 3-lb. hand hammer.

The diameter of the indentation in the standard bar is divided by the diameter of the indentation in the specimen and special tables supplied with the instrument are used to obtain the Brinell Meter hardness of the latter. For measuring the diameters of the indentation, transparent sheet celluloid scales were provided. One of these scales had two lines about 8 cm. long, 5 mm. apart at one end and 3 mm. at the other. The lines were graduated so that one division equaled a change in distance between the lines of 1/20 mm. On the other scale the lines were respectively, 3.5 mm. and 1.5 mm. apart at the ends.

Theory of Brinell Hardness. The Brinell hardness numeral (B. h.n.) was originally defined as the ratio of the load on a sphere, used to indent the specimen, to the area of the spherical indentation produced. The hardness is calculated by the formula—

$$H = \frac{P}{\pi t D}.$$

in which H is the Brinell hardness numeral, P the load on the sphere D the diameter of the sphere and t the depth of the indentation. This depth t was calculated from the observed diameter, d, of the indentation by the formula—

$$t = \frac{D}{2} - \sqrt{\frac{D^2}{4} - \frac{d^2}{4}}$$

Experiment has shown that the B.h.n. so defined varies with the load and diameter of the sphere. This is at least partially due to the elastic deformation of the sphere,[1] and it has therefore become standard practice to define the B.h.n. as the value obtained under a load of 3000 kg. with a ball of 10 mm. diameter. For soft metals a load of 3000 kg. is too great, and therefore 500 kg. has become standard practice.

Theory of the Brinell Meter. The hardness tables furnished with the Brinell Meter are evidently calculated from the formula—

$$\frac{H_1}{H} = \frac{d^2}{d_1^2}$$

in which H is the Brinell hardness of the specimen, H_1 the hardness of the standard bar, and d and d_1 are the diameters of the indentations. This is obtained as an approximation from the Brinell formula $H_1/H = t/t_1$ when the two impressions are obtained from the same load, and its use results in an extreme case in an error of about 2 per cent.

FIG. 10 BRINELL METER READY FOR USE

[1] Technologic Paper, Bureau of Standards, No. 11, entitled Five Methods of Measuring Hardness.

As the accuracy of the results obtained with this apparatus depends directly upon the hardness marked upon the standard bars their hardness was determined in an Alpha Brinell machine. The values are given in Table 2.

Outline of Tests. For convenience it was decided to test the Brinell Meter first under static loads. An Olsen testing machine was used to apply loads to the Brinell Meter resting upon a specimen. In this way the effect of different loads on the accuracy of the static hardness reading can be determined. The diameters of the impressions in both the specimens (d_1) and that in the standard bar (d) were measured with a micrometer microscope such as is supplied with an Alpha Brinell machine. The data are given in Table 3. The hardness of the specimen was calculated by the formula $H_1 = Hd^2/d_1^2$.

Since these results showed that so far as static loads were concerned the Brinell Meter could be relied upon within 2 per cent over a wide range of loads, the apparatus was then tested by hammer blows for which it was designed. The results of these tests are given in Table 4.

TABLE 2 HARDNESS OF STANDARD BARS; DIAMETER OF BALL, 10 MM.

Marked hardness	Load, kg.	Indentation diameter, mm.	Brinell hardness	Average	Error in marked hardness, per cent
430	3,000	2.95	430	429	0.23
430	3,000	2.96	428		
430	3,000	2.95	430		
360	3,000	3.20	364	364	-1.1
360	3,000	3.20	364		
240	3,000	3.93	237	236	1.7
240	3,000	3.96	234		
163	3,000	4.62	168	169	-3.6
163	3,000	4.61	169		
97	500	2.78	81	82	18.0
97	500	2.77	82		
58	500	3.48	51	51	14.0
58	500	3.50	50		
97	1,500	4.39	94	94	3.2
97	1,500	4.41	93		
58	1,000	4.50	60	61	-4.9
58	1,000	4.45	61		

TABLE 3 EFFECT OF LOAD ON BRINELL METER HARDNESS

Load, kg.	Indentation diam., mm. Bar d	Indentation diam., mm. Specimen d_1	Ratio $\frac{d}{d_1}$	Specimen: Brinell meter hardness	Specimen: Hardness by Brinell formulas	Specimen: Variation of Brinell Meter hardness from standard Brinell hardness, per cent
Test 1,	Standard bar (marked 240), 223 Brinell hardness, Specimen, 262 Brinell hardness.					
3000[1]	4.05	3.75	1.08	260	262	-0.76
2800	3.95	3.65	1.082	261	258	1.15
2600	3.76	3.51	1.072	256	260	-1.56
2400	3.60	3.38	1.065	253	259	-2.37
2200	3.46	3.25	1.065	253	257	-1.58
2000	3.32	3.15	1.054	248	250	-0.81
1800	3.15	3.02	1.045	244	247	1.23
1600	2.99	2.85	1.048	245	245	0
1400	2.79	2.64	1.057	249	251	-0.80
1200	2.55	2.42	1.054	248	257	-3.63
1000	2.38	2.26	1.053	247	246	0.40
Test 2,	Standard Bar (marked 360), 354 Brinell hardness Specimen, 259 Brinell hardness					
3000	3.24	3.77	0.859	261	259	0.77
2800	3.13	3.66	0.855	259	257	0.77
2600	3.02	3.49	0.866	265	263	0.77
2400	2.90	3.39	0.856	259	258	0.39
2200	2.76	3.25	0.849	255	257	-0.78
2000	2.64	3.13	0.844	252	253	-0.40
1800	2.53	2.95	0.858	261	258	1.15
1635	2.44	2.85	0.856	259	251	3.09
1400	2.26	2.63	0.860	262	252	3.82
1200	2.09	2.46	0.850	256	249	2.73
1000	1.93	2.29	0.843	252	240	4.77
Test 3,	Standard bar (marked 360), 349 Brinell hardness, Specimen, 268 Brinell hardness.					
3000	3.26	3.71	0.879	269	268	0.37
2000	2.69	3.14	0.857	256	251	1.83
1000	1.96	2.29	0.856	256	240	6.26
500	1.43	1.69	0.846	250	221	11.5
Test 4,	Standard bar (marked 250), 261 Brinell hardness, Specimen, 187 Brinell hardness					
3000	3.76	4.40	0.855	191	187	2.09
2000	3.12	3.66	0.853	190	183	3.68
1000	2.31	2.67	0.865	195	175	10.25
500	1.69	1.99	0.850	189	159	15.90
Test 5,	Standard bar (marked 120), 124.4 Brinell hardness at 2170 kg. Specimen, 63 Brinell hardness at 2170 kg.					
2170[2]	4.58	6.25	0.733	67	62.9	6.12
1500	3.85	5.37	0.717	64	61.5	3.91
1000	3.30	4.67	0.707	62	55.0	11.30
500	2.29	3.36	0.682	58	54.8	5.52

[1] Standard load.
[2] Not standard load.

Conclusions. I The dimensions of the standard bars are so small as to cause error in measuring their hardness in the usual manner. It would seem that a cross-section of at least twice the dimensions would be preferable.

TABLE 4 COMPARISON OF BRINELL METER AND ALPHA BRINELL HARDNESS (HAMMER BLOWS ON BRINELL METER)

Standard bar marked	Indentation diameter, d	Indentation diameter, d_1	Ratio d/d_1	Brinell Meter hardness	Alpha Machine indentation diameter	Brinell hardness	Variations in Brinell Meter hardness	Variation in Brinell Meter hardness from Brinell hardness
	mm.	mm.			mm.		per cent	per cent
430	3 08	2 95	1 044	469	2.78	484	0 4	
	3 05	2.95	1 034	460	2.77	488		
			Average	464.5		486		-4.3
360	3.21	2.89	1 111	445	2 84	464	0 4	
	3 02	2 69	1.122	454	2 84	464		
			Average	449.5		464		-2.7
360	3.21	3.05	1 052	399	2 98	423	0.0	
	3.25	3.05	1.065	408	2.98	423		
			Average	403.5		423		-4 6
240	3 56	3.07	1 16	323	3.25	351	0.4	
	3 81	3.27	1.165	326	3 24	354		
			Average	324 5		352.5		-8 0
240	3.68	3 69	0 998	239	3 86	247	0 0	
	3.81	3 76	1.013	246	3.86	247		
			Average	242.5		247		-1 8

2 A variation in the applied load causes a slight change in the hardness numeral, but Table 3 shows that in most cases for the static load tests the Brinell Meter hardness was practically identical with the Brinell hardness if the standard load of 3000 kg. was used. Both values decrease with decreasing loads, and the decrease in the Brinell hardness emphasizes the necessity for using the standard load of 3000 kg. for hard and a load of 500 kg. for soft metals.

3 The errors in the Brinell Meter hardness due to variations in load are less than for the Brinell hardness.

FIG. 11 PARTS OF THE BRINELL METER IN THEIR PROPER RELATIVE POSITIONS

4 The greatest accuracy is obtained when the diameter of the indentations for the Brinell Meter is approximately that obtained on the same material in a Brinell testing machine under standard load.

5 The celluloid scales should not be used to measure the diameter of the indentations. A micrometer microscope graduated to tenths of a millimeter, which division allows hundredths of a millimeter to be easily estimated, will be found suitable for the purpose.

Efficiency Tests of a 30,000-Kw. Steam Turbine

By HERBERT B. REYNOLDS,[1] NEW YORK, N. Y.

During 1920 three 30,000-kw. General Electric turbines were installed at the 59th Street power station of the Interborough Rapid Transit Company, New York City, complete tests upon one of which form the subject of the present paper.

These turbines are of the straight Curtis impulse type, having 20 pressure stages, each pressure stage consisting of one velocity stage. The normal steam pressure at the throttle is 225 lb. per sq. in., abs., the steam being superheated 150 deg. fahr., and exhausted into a vacuum of 29 in. Hg. The speed is 1500 r.p.m. Novel spring supports were provided for the condenser which are described in the paper.

The highest water rate obtained during the tests while operating under normal conditions was 11.03 lb. per kw-hr., while the highest Rankine-cycle and thermal efficiencies obtained were 75.5 per cent and 25 per cent, respectively. Results of tests on the condensers and auxiliaries are also given in the form of tables.

The results obtained in these tests of a large power-station unit form a welcome addition to the data of tests of turbines of the same capacity installed in 1915 at the 74th Street power station of the company, reported in a paper presented before the Society in 1916, by H. G. Stott and W. S. Finlay, Jr.

In order to provide additional power capacity for the new subways constructed in New York City during the period from 1913 to 1921, and operated by the Interborough Rapid Transit Company, additional turbine units were installed in both the 59th Street and 74th Street Power Stations. The three 30,000-kw. Westinghouse cross-compound turbines which were completed in 1915 were among the new units installed at the 74th Street Power Station. The results of the tests upon these three turbines were presented before the Society by H. G. Stott and W. S. Finlay, Jr., in 1916.[1]

At the 59th Street Power Station, the installation of three 30,000-kw. General Electric turbines has been completed within the past year. Very complete tests have been conducted upon these added units, the results of which are set forth on the following pages.

Reviewing briefly the history of the developments at the 59th Street Power Station, it will be recalled that the original engine-room equipment consisted of nine 7500-kw. maximum-capacity Manhattan type Allis-Chalmers double angle compound engine units, and three Westinghouse 1250-kw. turbines, the latter driving 60-cycle generators which supplied 60-cycle current for subway lighting. The use of this current for lighting was subsequently discontinued and in its place 25-cycle current is now used which is taken from the main units. During 1909 and 1910, five low-pressure 7500-kw. maximum-capacity General Electric turbine units were added, taking exhaust steam from five of the engines at atmospheric pressure. A description of these units and a full report of the tests which were conducted on them are given in a paper presented by H. G. Stott and R. J. S. Pigott before the Society in 1910.[2] The units most recently installed in the 59th Street Power Station are the three 30,000-kw. General Electric turbines mentioned above.

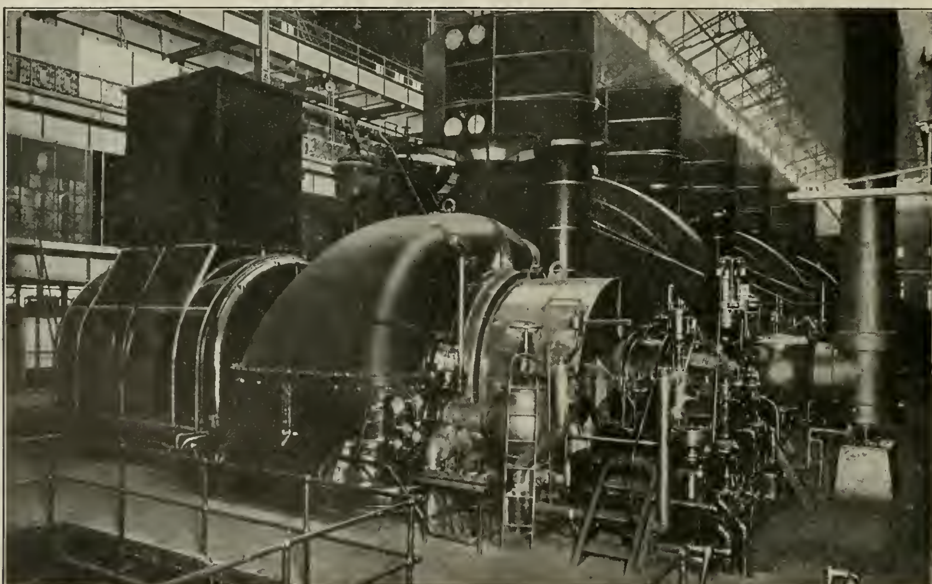

Fig. 1 One of the Three 30,000-Kw. Turbines Installed at the 59th St. Power Station of the Interborough Rapid Transit Co. in 1920

The Turbine Units

Two of the 30,000-kw. units, Nos. 7 and 8, were installed in the space formerly occupied by the three lighting units mentioned in the preceding paragraph, while the third turbine, unit No. 12,

[1] Mechanical Research Engineer, Motive Power Dept., Interborough Rapid Transit Co.

Paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Slightly abriged. All papers are subject to revision.

[1]Trans. Am.Soc.M.E., vol. 38, page 655.
[2]Trans. Am.Soc.M.E., vol. 32, page 69.

see Fig. 1, was installed at the western end of the station. The great concentration of power possible with modern turbines is strikingly shown by the space they require as compared with that for reciprocating engines. The maximum capacity of the engines visible in the figure is but 26,250 kw. while that of the turbine in the foreground is 35,000 kw.

The general arrangement of unit No. 12, upon which the tests were conducted, is shown in Fig. 2. The turbines are of the straight Curtis impulse type, having twenty pressure stages, each pressure stage consisting of one velocity stage. Fig. 1 is a close view of the governor end of the turbine and shows the auxiliary oil pump, etc. driven by a small steam turbine, the speed of which is automatically controlled by the oil pressure. In addition to the cooling effect of the oil, the bearings are further cooled by the circulation of condensate through water jackets.

As all auxiliaries in the station are steam-driven, a connection has been provided in the turbine through which any excess auxiliary steam may be injected. This connection is at the 16th stage of the turbine.

The generators are three-phase, star-connected, generating 25-cycle current at 11,000 volts. Excitation current is furnished at 250 volts. The generators are cooled by a circulation of air

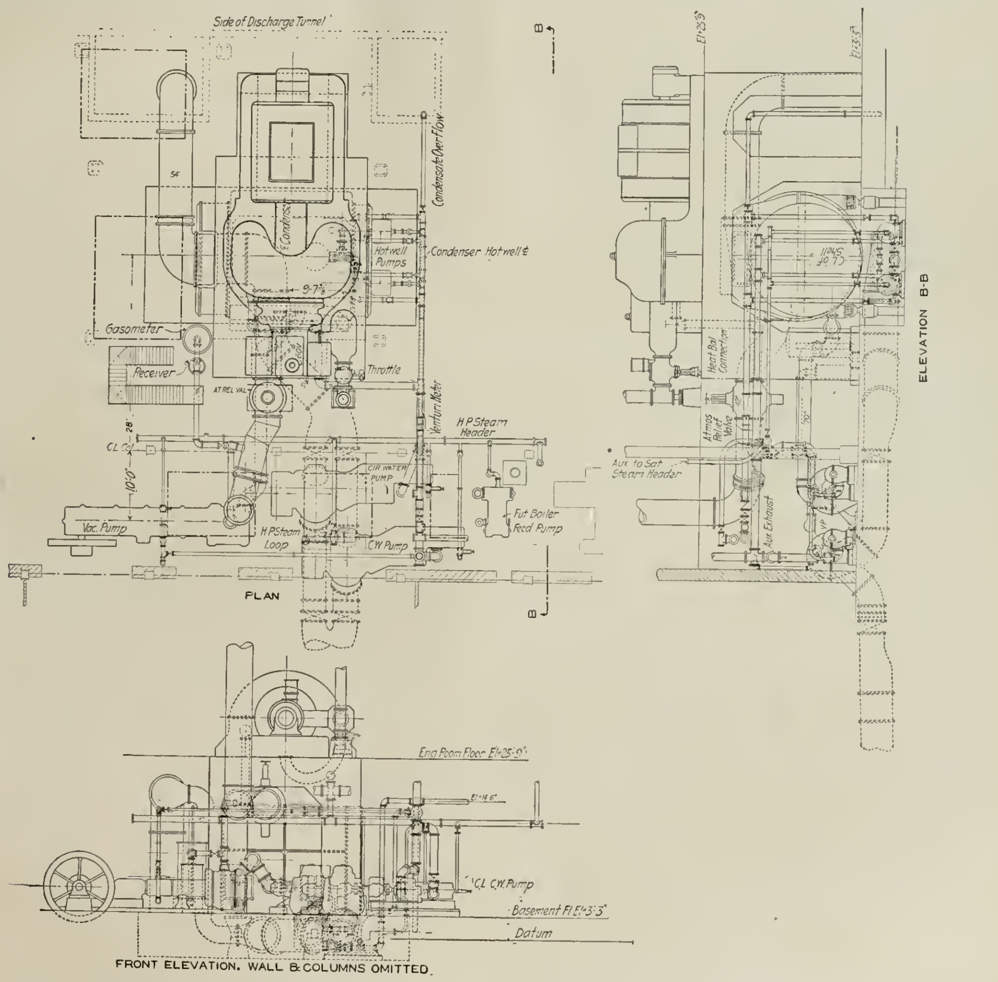

Fig. 2 General Arrangement of Unit No. 2

The normal steam pressure at the throttle is 225 lb. per sq. in. abs., with a superheat of 150 deg. fahr. exhausting into a vacuum of 29 in. Hg referred to a 30-in. barometer at 58.1 deg. fahr. The speed is 1500 r.p.m. In addition to the primary steam inlet, a secondary valve is provided which opens after the load reaches 24,000 kw. and which enables the turbine to carry a load of 35,000 kw. The generator is designed so that this load may be carried continuously.

Water-sealed glands are used which obtain their water supply from the condensate discharge. A self-contained lubricating system is provided. The oil is circulated through the coolers and bearings by means of a pump driven from the turbine shaft. For starting up and emergency purposes a separate pump is provided which is maintained by a fan which forms an integral part of the generator. The air is drawn from the turbine-room basement and discharged from at top of the generator into the turbine-room through a short stack which may be seen in Fig. 1.

Condensers and Auxiliaries

The condensing equipment for each unit consists of one single-shell two-pass Worthington condenser, two Worthington centrifugal circulating pumps each driven through reduction gears by Kerr turbines, two Worthington centrifugal condensate pumps each driven by a General Electric turbine, and one Laidlaw-Dunn-Gordon dry-vacuum pump. The general arrangement of the condensing equipment is shown in Fig. 2.

Each condenser contains 50,000 sq. ft. of tube surface made up of 10,760 tubes 18 ft. long, 1 in. in outside diameter and of No. 18 B. W. G. thickness. The condenser is of the two-pass type, the water entering the bottom and passing out from the top. As the condensers are mounted on springs, rubber expansion joints are inserted in the circulating-water lines.

Each circulating-water pump is capable of delivering 30,000

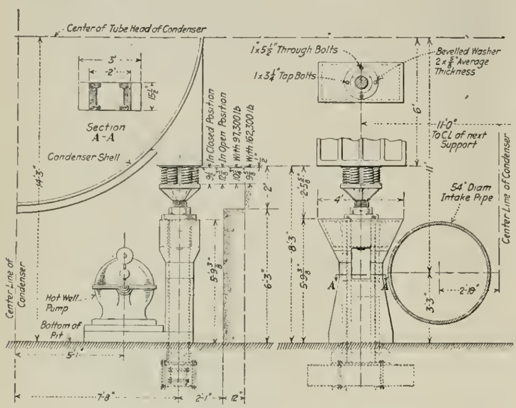

Fig. 3 Spring Supports for Condenser

gal. of water per min. against a total head of 37 ft. The turbines which drive these pumps operate at 3950 r.p.m. This speed is reduced to 395 r.p.m. through Kerr reduction gears. The impellers are made of bronze and are of the enclosed or shrouded design.

Each condensate pump is capable of delivering 950 gal. per min. against a discharge head of 60 ft. The turbine and pump both operate at a speed of 1500 r.p.m.

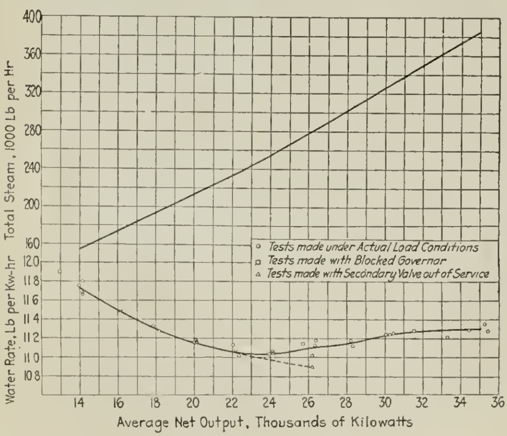

Fig. 4 Water-Rate Curve and Willans Line for 30,000-Kw. Turbine

Steam pressure, 225 lb. abs.; superheat, 150 deg. fahr.; vacuum, 29 in. Hg, referred to a 30-in. barometer; water-rate factor, 0.985. Curve based on tests Nos. 10 to 44, inclusive (excluding special tests with blocked governor and test with secondary valve out of service).

The dry-vacuum pumps are of the single rolling-mill frame two-stage rotative type, with poppet-valve steam cylinder and two-stage water-jacketed vacuum cylinder.

Foundations

Two of the units, Nos. 7 and 8, were installed on the foundations which formerly carried the three 1250-kw. 60-cycle lighting units mentioned earlier. However, it was necessary to alter these foundations to some extent in order to receive the new turbines. The third turbine, unit No. 12, was installed on new structural-steel foundations encased in concrete.

As no expansion joint was provided between the turbine and condenser, it was necessary to mount the condenser on spring supports so as to take care of the expansion and contraction. These spring supports are shown in Fig. 3.

In order to facilitate the setting of these springs and also to provide a means for detecting and adjusting for any fatigue which might occur in them, hydraulic jacks were incorporated in the condenser supports as shown in Fig. 3. As the procedure followed in setting these springs may be of general interest, a brief description will be given. After the erection of the condenser and circulating-water pipe had been completed, with the exception of making the

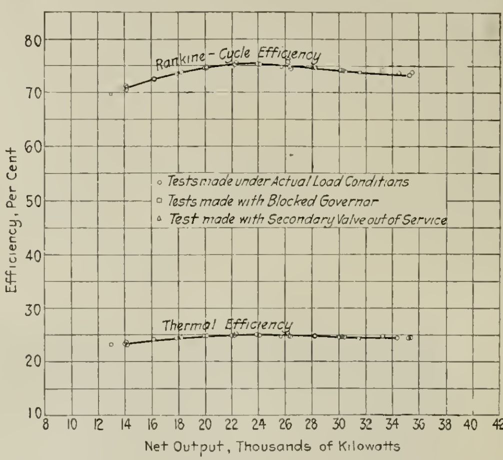

Fig. 5 Rankine-Cycle and Thermal Efficiency Curves for 30,000-Kw. Turbine

Steam pressure, 225 lb. abs.; superheat, 150 deg. fahr.; vacuum, 29 in. Hg, referred to 30-in. barometer. Curves based on tests Nos. 10 to 44, inclusive (excluding special tests with blocked governor and test with secondary valve out of service).

joint between the condenser and turbine, the condenser was raised while empty, by means of the jacks, leaving $^3/_8$ in. clearance

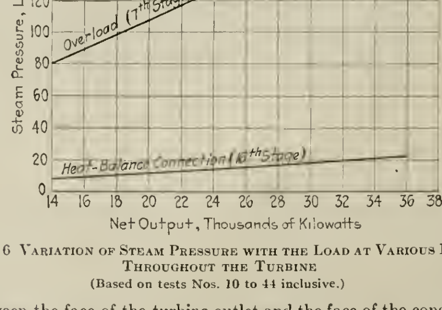

Fig. 6 Variation of Steam Pressure with the Load at Various Points Throughout the Turbine

(Based on tests Nos. 10 to 44 inclusive.)

between the face of the turbine outlet and the face of the condenser inlet. The load on each of the four supports was then determined by noting the oil pressure in the jacks. It was decided that, with the

condenser empty and cold, the downward pull on the turbine should not be less than approximately 17 tons. The distance that the joint between turbine and condenser would have to be pulled in order to give this load was estimated from the modulus of elasticity of the turbine and condenser metal. The condenser was then raised to within the predetermined distance of the turbine outlet, which was found to be 0.231 in., after which the lock nuts on the jacks were screwed home and the condenser bolted to the turbine. The load on the springs was then determined with the condenser still empty by noting the pressure required to just raise the lock nuts. Every few months the load carried by the springs will be determined in this manner and compared with the load which existed when the condenser was first bolted to the turbine. Any fatigue which may develop in the springs will be compensated for by screwing the lock nuts down.

It was found that the minimum condenser load carried by the turbine with the condenser shell empty was approximately 17 tons, which checked with the established minimum. As the water required to fill the condenser amounts to approximately 60 tons, the load on the turbine increases to 77 tons when the circulating-water pumps are started. However, as the result of a slight expansion of the condenser which takes place when it is warmed up, the springs are compressed and a small part of this load is transferred to the supports, reducing the load on the turbine to approximately 70 tons under operating conditions. Immediately after shutting down and while the condenser is still warm but drained, the load on the turbine is reduced to 10 tons. It will thus be seen that the condenser load on the turbine varies from 10 to 77 tons. The total weight of the condenser varies from 180 to 240 tons.

Turbine Tests

The equipment used for conducting the turbine tests consisted of two large water-weighing scales for measuring the steam consumption, three single-phase rotating standard watt-hour meters for measuring the output, and all the necessary thermometers, gages and mercury columns for determining temperatures, pressures and vacua as recorded in this report.

The water-weighing scales had a capacity of about 25,000 lb. each. These scales were very carefully calibrated several times throughout the tests by standard test weights and the total steam consumption corrected accordingly. The rotating standard watt-hour meters which were used for measuring the output were calibrated before and after the tests by the Electrical Testing Laboratories, New York City. It is believed that both the input and output were measured within an accuracy of 0.25 per cent. All thermometers and gages were also calibrated in the usual manner. The specific gravity of the mercury used in the vacuum columns was determined and corrections made accordingly. The readings obtained from the mercury columns were further corrected for me-

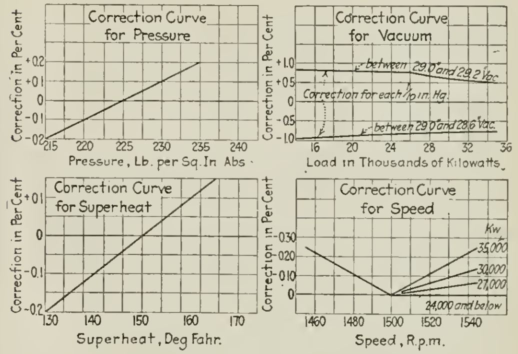

Fig. 7 Curves for Correcting Steam Consumption to the Standard Conditions

TABLE 1 SUMMARY OF TURBINE TEST RESULTS

Test No.	Load Average, net kw.	Duration hr.	Steam Pressures, lb. per sq. in. abs. Throttle	Turbine head	Overload, 7th stage	Heat-balance connection, 16th stage	Exhaust vacuum in. Hg[1]	Steam temp. at throttle, deg. fahr.	Superheat, deg. fahr.	Water, actual total, lb.	Water, corr. total,[2] lb.	Output, gross total, kw-hr.	Excitation,[3] kw-hr.	Output, net total, kw-hr.	Water rate corr.,[2] lb. per kw-hr.	Rankine cycle efficiency,[2] per cent	Thermal efficiency,[2] per cent
36	13,985	3	237	138	82	8.13	29.00	551	155	489,140	492,786	42,118	162	41,956	11.75	70.80	23.46
44	14,146	3	231	142	79	7.60	28.94	537	143	501,560	495,858	42,608	171	42,437	11.68	71.23	23.60
20	14,161	3	231	134	80	7.88	28.99	550	156	498,125	501,233	42,643	161	42,482	11.80	70.51	23.36
33	14,175	3	236	136	81	8.08	28.92	559	163	492,215	495,984	42,686	161	42,525	11.66	71.36	23.64
32	16,165	3	233	150	87	8.78	28.92	548	153	557,730	556,228	48,664	168	48,496	11.47	72.54	24.04
21	16,181	3	229	149	89	8.81	28.97	548	155	555,710	557,438	48,712	169	48,543	11.48	72.47	24.02
10	17,889	3	235	165	95	10.33	28.90	498	103	640,452	607,640	53,845	178	53,667	11.32	73.50	24.38
25	18,243	3	227	166	99	10.25	28.96	546	153	617,170	617,047	54,905	176	54,729	11.28	73.76	24.44
24	20,142	3	229	182	108	11.61	28.96	524	131	688,785	674,156	60,611	185	60,426	11.16	74.55	24.70
11	20,150	3	235	188	114	11.63	28.93	501	105	706,687	673,677	60,636	186	60,450	11.14	74.69	24.74
12	22,065	3	224	196	119	12.87	28.87	513	122	764,761	735,842	66,389	194	66,195	11.12	74.82	24.80
35	22,217	3	232	194	114	12.38	29.00	552	157	731,290	737,485	66,848	196	66,652	11.07	75.16	24.91
23	22,366	3	228	198	117	12.22	28.95	520	127	758,280	738,560	67,293	196	67,097	11.01	75.57	25.04
13	23,945	3	233	207	124	13.75	28.96	518	123	814,978	792,241	72,038	201	71,837	11.03	75.43	25.00
22	24,151	3	227	206	124	13.48	28.99	523	130	815,910	799,598	72,657	203	72,454	11.04	75.36	24.97
42	24,159	3	228	212	119	13.40	29.01	514	121	822,875	800,735	72,681	203	72,478	11.05	75.29	24.95
34	26,206	3	231	216	132	14.92	28.92	540	146	873,350	865,389	78,830	213	78,617	11.01	75.57	25.04
19	26,357	3	224	207	141	15.28	29.01	519	127	898,485	878,714	79,284	213	79,071	11.12	74.82	24.79
14	26,400	3	228	216	139	15.31	28.91	526	133	905,215	884,344	79,425	224	79,201	11 17	74.49	24.68
15	28,244	3	228	216	151	17.02	28.95	523	130	968,485	946,341	84,954	223	84,731	11.17	74.49	24.68
18	28,249	3	225	211	159	18.71	28.84	518	126	979,565	944,796	85,269	221	85,048	11.11	74.89	24.81
30	30,098	3	224	212	161	17.93	29.00	527	136	1,028,595	1,014,193	90,523	228	90,295	11 23	74.09	24.55
43	30,289	3	225	222	161	17 20	28.97	516	124	1,048,920	1,020,053	91,100	233	90,867	11.23	74.09	24.55
17	30,470	3	223	212	165	18.45	29.02	514	123	1,055,025	1,027,989	91,641	231	91.410	11.25	73.96	24.50
41	33,301	3	225	222	177	20.16	28.84	502	110	1,177,895	1,119,672	100,148	245	99,903	11.21	74.22	24.59
40	34,448	3	224	221	186	20.67	28.96	498	106	1,221,695	1,166,630	103,600	255	103,345	11 29	73.63	24.40
37	35,254	3	224	217	191	21.84	29.03	497	105	1,253,160	1,200,517	106,023	260	105,763	11.35	73.30	24 29
31	35,467	3	224	216	193	21.53	28.99	521	130	1,224,235	1,199,055	106,660	258	106,402	11.27	73.82	24.46
26[4]	12,991	2	235	128	75	8.35	28.98	538	142	311,700	309,257	26,085	103	25,982	11.90	69.92	23.17
29[4]	20,073	2	217	178	105	11.42	29.03	528	139	452,960	448,298	42,270	125	40,145	11.17	74.49	24.68
28[4]	25,733	2	226	209	136	13.23	28.97	519	127	587,150	572,718	51,605	140	51,465	11.13	74.75	24 77
16[5]	26,196	3	228	225	133	14.62	28 94	533	140	867,385	855,156	78,798	210	78,588	10.88	76.47	25.34
27[4]	31,568	2	223	212	171	12.13	28 99	521	130	727,290	712,192	63,292	156	63,136	11.28	73.76	24.44
38[6]	No load	0 5	234	23	17		28.15	499	104	8,925			22				
39[7]	No load	0 5	234	23	17		27.93	502	107	8,045							

[1] Referred to 30-in. barometer at 58.1 deg. fahr.

[2] As corrected to 225 lb. per sq. in. abs. pressure, 150 deg. fahr. superheat, 29 in. Hg vacuum ref. to 30-in. barometer at 58.1 deg. fahr.

[3] Including rheostat loss.

[4] Tests Nos. 26, 27, 28 and 29 made with operating governor adjusted to limit maximum loads to the values shown in the second column.

[5] Test No. 16 made with secondary valve out of service.

[6] Test No. 38 made without load on generator, with generator field current adjusted to give normal voltage on open circuit.

[7] Test No. 39 made without load on generator, generator field not excited.

niscus, temperature, and barometer reading. The barometer reading was obtained from the local U. S. Weather Bureau.

Most of the tests were of three hours' duration. With the exception of a few special tests, the turbine was operated under normal conditions in so far as type of load was concerned. The load was controlled from the switchboard through the remote governor-control system provided for that purpose. This method of controlling the load subjected the turbine to the full swings of the railroad load.

Table 1 gives the numerical results of the turbine tests, while the performance is shown graphically in Figs. 4, 5, and 6. Fig. 4 gives the total steam consumption and water rate of the unit, while Fig. 5 gives the thermal and Rankine-cycle efficiencies. From these curves it will be seen that the lowest water rate obtained while operating under normal conditions was 11.03 lb. per kw-hr., while the highest Rankine and thermal efficiencies obtained were 75.5 per cent and 25.0 per cent, respectively. As stated above, all tests with the exception of seven were conducted under operating conditions.

In order to determine the effect of the swinging load on the steam consumption, four tests were conducted with the governor blocked so that the unit operated under a steady load. These tests are shown in Figs. 4 and 5 by the small squares. It will be seen that there is no improvement in the efficiency under the steady load conditions at the loads selected for these tests. When

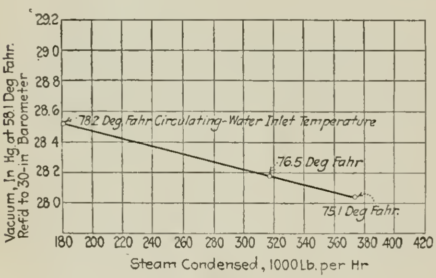

Fig. 8 Curve Showing Vacuum Obtained During Condenser Test

Based on tests Nos. 2, 3 and 4. Circulating-water inlet temperature varied from 5.1 deg. fahr. to 78.2 deg. fahr. Condenser surface, 50,000 sq. ft.

the turbine is operating under normal conditions and carrying loads from 22,000 kw. to 25,000 kw. the secondary valve is continually opening and closing, which no doubt reduces the economy somewhat. If steady load tests had been conducted within this range the points would have probably fallen on the dotted curve. The test shown by the small triangle in Figs. 4 and 5 was run with the secondary or overload valve closed and out of commission, while the load was adjusted so that the primary valve was wide open. As is to be expected, the lowest water rate was obtained while operating in this manner. Since the completion of these tests the governor cams have been modified so that the opening of the secondary valve is delayed. This may improve the economy to some extent near and at the best load point; however, no tests have been conducted to determine just how much improvement has been accomplished.

Test No. 38 was run without any load on the generator, but with the field excited to give normal voltage on open circuit. The actual steam consumption per hour during this test amounted to 17,850 lb. Another no-load test was conducted, but without any excitation, during which the actual steam consumption amounted to 16,090 lb. per hour. No attempt was made to correct the steam consumption during these two no-load tests, due to the vacuum being low and outside the range of the correcting curves.

TABLE 2 SUMMARY OF CONDENSER AND DRY-VACUUM-PUMP TESTS

Number of Test	2	3	4
Condenser Tests			
Average load, lb. steam per hour	180,666	317,000	373,666
Duration of test, hours	3	3	3
Barometer, at 58.1 deg. fahr.	29.93	29.93	30.07
Superheat at turbine throttle, deg. fahr.	41	44	50
Steam pressure at turbine throttle, lb. per sq. in. abs.	230	225	225
Vacuum, in. Hg. at 58.1 deg. fahr. referred to 30-in. barometer	28.51	28.17	28.04
Temperature corresponding to vacuum, deg. fahr.	91.6	98.3	100.6
Temperature of circulating water in, deg. fahr.	78.2	76.5	75.1
Temperature of circulating water out, deg. fahr.	83.0	86.3	86.4
Rise in temperature of circulating water, deg. fahr.	4.8	9.8	11.3
Temperature of condensate water, deg. fahr.	87.0	91.3	91.5
Circulating water (two pumps running), gal. per min.	72,500	61,500	63,800
Heat transferred per hour, B.t.u.	174,144,000	301,277,000	360,662,000
Heat transferred per hour per sq. ft. surface, B.t.u.	3483	6025	7213
Mean temperature difference (log.), deg. fahr.	10.8	16.36	19.4
Heat transferred per sq. ft. surface per hour per deg. mean temperature difference	322	368	372
Dry-Vacuum-Pump Tests			
Vacuum at pump, in. Hg. at 58.1 deg. fahr. referred to 30 in. barometer	28.58	28.55	28.56
Temperature of air and vapor entering pump, deg. fahr.	82	82	82
Temperature of air and vapor leaving pump, deg. fahr.	185	167	160
Temperature of jacket water entering pump, deg. fahr.	68	63	63
Temperature of jacket water leaving pump, deg. fahr.	89	73	71
Speed of pump, r.p.m.	48	47	48
Steam pressure at throttle, lb. per sq. in. abs.	209	207	208
Superheat at throttle, deg. fahr.	11	17	20
Steam pressure at exhaust, lb. per sq. in. abs.	15.8	15.9	15.6
Steam consumption, lb. per hr. corrected to 225 lb. abs. steam pres., 150 deg. fahr. superheat, 16 lb. abs. exhaust pressure	1088	1029	964
Air discharged, cu. ft. per min. at 60 deg. fahr.	9.94	9.47	6.50

TABLE 3 SUMMARY OF CIRCULATING-WATER-PUMP TESTS

Economy Test[1]	
Duration of test, hours	2
Barometer, at 58.1 deg. fahr.	29.78
Steam pressure at throttle, lb. per sq. in. abs.	221
Superheat at throttle, deg. fahr.	21
Steam pressure at exhaust, lb. per sq. in. abs.	15.1
Speed of pump, r. p. m.	386
Pump discharge, gal. per min.	33,300
Total head on pump, ft.	37.63
Steam consumption, lb. per hour corrected to 150 deg. fahr. superheat	10,860
Capacity Test[2]	
Speed of pump, r. p. m.	382
Pump discharge, gal. per min.	51,800
Total head on pump, ft.	20.60

[1] Test made with discharge valve adjusted to give approximately normal operating head.
[2] Test made with discharge valve wide open.

TABLE 4 SUMMARY OF CONDENSATE-PUMP TEST

Duration of test, hours	1
Barometer, at 58.1 deg. fahr.	29.70
Steam pressure at throttle, lb. per sq. in. abs.	216
Superheat at throttle, deg. fahr.	28
Steam pressure at exhaust, lb. per sq. in. abs.	15.2
Speed of pump, r. p. m.	1495
Pump discharge, lb. per hour	475,000
Suction head, in. Hg	26.2
Discharge head, ft.	60.9
Total head on pump, ft.	90.64
Steam consumption, lb. per hour corrected to 150 deg. fahr. superheat	1840

Fig. 6 shows the variation of steam pressure with the load at various points throughout the turbine. In order to correct the steam consumption to the standard conditions, the curves given in Fig. 7 were used.

Water-Rate Factor

In order to make an absolute and numerical comparison of the flatness of water-rate curves for different turbines, an expression has been used which is termed the "water-rate factor." Expressed mathematically,

(Continued on page 460)

The Necessity for Improvement in the Design and Operation of Present-Day Locomotives

By H. W. Snyder,[1] Lima, Ohio

In view of the demands of constantly growing passenger and freight traffic, the most urgent problems confronting locomotive designers and operating officials are, in the opinion of the author, those of increasing the capacity and efficiency of the present-day locomotives. As the limit of size of cylinders and of boilers due to road clearances has practically been reached, it is evident that any increase in the hauling capacity of a locomotive without increasing its size must come about through the employment of special devices. The superheater, brick arch, and mechanical stoker have all shown their desirability in this respect. Two other devices yet to be adopted in this country are the feedwater heater and the variable exhaust, both of which have given satisfaction in Europe.

After a brief discussion of engine problems, the paper proceeds to the consideration of the design of main and side rods and crankpins to withstand the tremendous piston thrust to which they are subjected in large engines; the difficult problem of counterbalancing; frame design and cross-bracing; driving-box brasses; means for temporarily increasing tractive power on critical grades and for starting heavy loads; ash-pan design; and lubrication.

In conclusion, it is stated that the present need is to apply the many labor-saving and capacity-increasing devices which have already been worked out and are giving satisfactory service, and at the same time look forward to the possibilities of applying other devices which have already proved that they are well worth consideration and are of sufficient importance to warrant their adoption.

No one, it is believed, will dispute the fact that present-day operation of high-power locomotives is one of the most vital questions with which our railroads are concerned. The demands of constantly increasing passenger and freight traffic have brought about a constant increase in size and power of our locomotives.

It has not been so many years since an engine of 25,000 or 35,000 lb. tractive power was sufficient to take care of all requirements. Twenty years ago cylinders 22 or 23 in. in diameter were considered as about the limit in size. Constantly increasing demands on motive power since that time have brought us to the huge Mallet engines with tractive powers of from approximately 150,000 to 175-000 lb. Our simple engines have increased from 20-in. or 21-in. diameter cylinders up to 31-in. cylinders, with a tractive power ranging from around 35,000 lb. to 83,000 lb. In view of the rapid strides that have taken place in increasing the size and power of locomotives within the last few years, it seems rather out of place to predict that the maximum has been reached. It is also true that the use of improved devices has made possible the satisfactory operation of the large locomotives of today. Everything seems to indicate that we have not reached the maximum capacity of the locomotive even within the present limits of clearance and rail load, and we may expect to see these same engines made far more powerful and economical by the application of devices which are now available or which are already being given serious attention.

In view of the foregoing, the most vital matter which confronts locomotive designers and operating officials is that of increasing the capacity as well as the efficiency of the locomotives which we have today, and in the following paragraphs an attempt will be made to draw attention to some of the problems involved and upon the proper solution of which depends their success.

Combustion and Steam Generation

In order that large engines may operate properly, it is of course necessary that a sufficient supply of steam be furnished to cylinders so that they can be made to produce their maximum horsepower. It is not enough to provide a given number of square feet of heating surface in the firebox and the tubes—it is necessary that we take into account proper construction of the boiler, necessary firebox volume to produce the best possible combustion of fuel, and the design of grates so that fuel will be economically burned to such an extent only as required by the maximum evaporation of the boiler.

In producing heavy motive power it has been necessary on account of prohibitive axle loads to apply a sufficient number of axles under the engine to reduce the individual axle load to within reasonable limitations. This has lengthened out the engine to such an extent that boiler design and maintenance have become a serious problem. In the first place it is necessary to design a boiler that will properly function with the other vital parts of a locomotive. At the same time the length has become such that the use of combustion chambers is a necessity to avoid a prohibitive length of tube. Large engines have been constructed with a tube length of 25 ft. and it seems that no definite rule has been established as to what the limit of length of tube of a given size should be. Tubes 2 or $2^1/_4$ in. in diameter in excess of 20 ft. in length however, are questionable, and this feature should be looked into carefully before a decision is reached.

The application of a long combustion chamber requires a large number of additional staybolts, and it would naturally be expected that a boiler of this kind would require more staybolt attention. Complete as well as partial installation of flexible staybolts has met with varying degrees of success on many railroads, but the consensus of opinion seems to be that their application goes a long way toward overcoming staybolt trouble. It has been proved by experiment that if flexible stays are properly applied to the boiler when built, while they may make a slight movement during the firing up of the locomotive, after the boiler has become completely heated and steam pressure raised these stays assume their original position. Although long combustion chambers require more attention in maintenance, this will be offset by the increased firebox volume and the resulting better combustion.

On account of height limitations, the height of the dome as well as the steam space in the boiler has been reduced to such an extent that difficulties are being encountered with the proper life and maintenance of superheater equipment, because too much water is drawn over through the throttle into the superheater. This is a question requiring experiment to determine as nearly as possible the minimum steam space which should be provided for boilers working on various grades. The height of the dome has a great deal to do with obtaining dry steam, and in the opinion of the author consideration should also be given to the height of the throttle above the water line as well as to the steam space in the boiler. Considerable development on this subject is now well under way and we can confidently expect results of value in the near future.

We have about reached the limit of size of cylinders and size of boiler due to road clearances, and to undertake to provide additional road clearance on practically all of the main lines today would mean a total expenditure of money entirely out of proportion to the benefits that would accrue.

On account of the apparent limitations of piston thrust and road clearances, the greatest problem we have with our large locomotives today is to increase their capacity without exceeding greatly our present sizes. Anything to increase the hauling capacity of the locomotive without increasing the height and width limitations under which the locomotive must work might be called an essential capacity-increasing device. A few of these with which we are most familiar and which have proved beyond doubt their desirability are the superheater, the brick arch and the mechanical stoker. There are possibilities of still further increasing the efficiency of the superheater without increasing the size of the boiler in which it must operate. There are also possibilities and constant improvements in the design of brick arches which lend to higher evaporation and better combustion of fuel. It has been stated that when a locomotive requires as much as 6000 lb. of coal per

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[1]Mechanical Engineer, Lima Locomotive Works, Mem. Am.Soc.M.E.

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hour it has gone beyond the limits of the ordinary fireman. Automatic stokers have been in use so long that their dependability for heavy power is no longer in question. Many men are studying this particular feature of locomotive design and operation, and we may confidently expect in the future a gradual increase in the efficiency of these mechanisms.

It has been proved without a doubt in foreign countries that the feedwater heater is an essential capacity-increasing device as well as an economical addition to the locomotive. In Germany they apparently do not now consider producing large locomotives without this device. In this respect, then, it would seem that we are somewhat behind the Europeans, and there is no doubt that in the near future when the economies that can be effected by its use are realized it will become almost as general as the superheater today.

Another small item which has received only passing attention in this country is the variable exhaust. As is well known, a variable exhaust that can be properly operated and which will not require much maintenance attention will have a great tendency to relieve high back pressure at high speeds, and its operation will also provide the necessary draft at slow speeds. European locomotives in a great many cases are equipped with such a device which seems to give satisfaction.

The Engine Proper

There have been no radical changes in the general design of cylinders. The use of outside steam pipes has resulted in advantages both from a casting and maintenance standpoint. It would seem well worth while to consider a design of cylinder by means of which the weight could be reduced to a great extent, permitting of additional weight of other parts and thereby increasing the capacity of the locomotive.

The design of valve gears has received a great amount of attention and many accepted types are now available. In all of these every effort has been to better the steam distribution. In maintenance we are far ahead of engines used twenty years ago. There is yet, however, much to be desired in steam distribution, and this subject will bear as careful study in the future as it has in the past.

Power Transmission

When we consider that as much as 150,000 lb. piston thrust is being transferred through a single main rod and from this into the driving wheels of a locomotive, it is not difficult to understand why troubles are experienced with main crankpins and particularly side-rod bearings at the main pin. In order to provide the proper strength to take care of this tremendous thrust, it has been necessary to design extremely heavy main and side rods. Further, the inertia forces, particularly in drifting, at times reach figures that are even greater than the piston thrust. Practically all of this must be taken care of through the main crankpin and the necessary connections to the side rods at this point.

All are familiar with the efforts made to produce a steel that would give a higher elastic limit than the ordinary high-carbon open-hearth steel successfully used until engines reached their present proportions. The employment of such steel for side rods, main rods and piston rods has been principally confined to heat-treated and quenched forgings, which are considerably lighter in section than when the ordinary open-hearth annealed forgings were used. Steel has also been produced which gives a high elastic limit and which can be successfully used with ordinary annealing. The use of such a steel does away with quenched forgings and permits of rods being heated for closing in straps and similar work without destroying the quality of the material as is the case with quenched forgings.

Main and side rods have been produced and have been in successful operation for the past few years in which the piston thrust is carried directly from the main rods to the side rods back of the main wheel. This does not in any way reduce the piston thrust that must necessarily come on the main rods. At the same time, however, it does reduce very considerably the piston thrust that must be transferred through the main crankpin into the side rods, thereby alleviating to a very great extent the troubles that have been experienced with large side-rod connections at the main pin. Such a design does not increase the total weight of the rods to an extent likely to cause any appreciable increase in difficulties from a counterbalance standpoint.

It is impossible to take into account all the stresses produced in rods when a locomotive is in operation, and for this reason the allowable fiber stresses in tension, compression and bending must be small in comparison with the elastic limit ordinarily obtained in such forgings.

Rod design is a study in itself and presents a subject the details of which cannot be covered in a paper of this nature. Hollow-bored piston rods, light designs of crosshead and piston, the use of high-tension steel for side and main rods, as well as the use of hollow-bored crankpins, are familiar to all. More careful attention should be paid to the quality and upkeep of rod bearings, and every endeavor should be made to provide bearings of such quality and design that renewals will be reduced to a minimum.

Before the advent of our present-day large locomotives with their tremendous piston thrust it was not a particularly difficult matter to design a suitable main crankpin. In order for it to be of sufficient size to withstand heavier piston thrust and still maintain the fiber stress within workable limits, it was found necessary to increase the diameter proportionately. This brought up the question of rubbing speed. It is a well-known fact that if the rubbing speed is too high, bearings will heat and wear very rapidly regardless of the bearing pressure. A main pin designed properly for heavy piston thrust must therefore be so proportioned that the length will bear a certain relation to the diameter within very close limits. On account of the necessity for keeping cylinder centers as close together as possible because of road clearances, if a proper length of main pin is obtained, its proper size presents a difficult proposition. This is one of the great difficulties which the author is confident will be overcome in the future by the proper application of a design previously mentioned, wherein a large part of the piston thrust is transmitted directly from the main rod into the side rod, thus reducing the force that previously has been taken through the comparatively short and large-diameter main side pin.

Counterbalance

There is a great diversity of opinion in regard to the proper amount of counterbalance which should be applied to locomotives. We ordinarily think of a locomotive being counterbalanced properly when it will ride satisfactorily and without excessive vibration, and it seems that this is the rule by which counterbalance is judged. There are in operation heavy Santa Fe type locomotives which have between 35 and 40 per cent of the reciprocating weights counterbalanced, and they are said by traveling engineers to ride easy. The author believes that with our present heavy engines with long wheelbase it is not necessary to balance as much as 50 or 55 per cent of the reciprocating weight. In fact, it is quite possible that we may be able to counterbalance a smaller percentage of reciprocating weight than has heretofore been attempted, especially for long, heavy engines, provided the revolving weights at the main pin can be properly taken care of. Every effort, however, should be made to balance all of the revolving weights on the main pin. If, for example, we lack 400 lb. of balancing the revolving weight on the main pin, the effect on the track is exactly the same as if we had 400 lb. of counterweight on any of the other wheels to balance reciprocating parts.

On account of the extremely heavy weight required at the main pin in order to have the proper strength of parts, particularly for large freight locomotives, it is a difficult matter to balance very much—if any—more than the revolving weights at this point. This being the case, if as much as 50 or 55 per cent of the reciprocating weights is to be balanced, it is easily seen that all of the counterweight for reciprocating parts must be added to the counterweight in the wheels other than the main. Thus, in order to balance a high percentage of reciprocating weights on engines of this class, it is necessary to add counterweight to the wheels other than the main to such an extent that track stresses and riding of the locomotive at comparatively high speeds become a very serious question.

The author is of the opinion that no definite set rule can be established in this regard, but that each particular design is a study in itself, and wherever revolving weights at the main pin are encountered such that they cannot be properly counterbalanced,

steps should be taken to provide the best means possible of reducing revolving weights at this point as well as providing reciprocating parts as light as possible consistent with strength. This of course has been accomplished in the past by hollow-boring the main pins and piston rods and by using a light design of piston head, which indicates that a steel having a high elastic limit with the proper elongation and reduction of area should be employed.

The Running Gear

On account of the large increase in the size of cylinders of present-day heavy locomotives over those used several years ago, the cylinder centers have been spread until they have reached practically the clearance limitations of the railroads; and the necessity for larger journals to carry properly the increased axle loads has caused the frame centers to be brought nearer together.

This condition increases very materially the distance from the center of the cylinder to the center of the frame, which of itself produces greater strain in the frame and at the same time increased pressures on the driving-box bearings as well as on shoes and wedges. In addition to the above, piston thrusts have increased from approximately 65,000 lb. to approximately 150,000 lb., and means must be provided to properly take care of the increased piston thrust along with the increased overhang.

Fig. 1, it is believed, shows very clearly the increased forces that a frame must stand in order to properly take care of the tremen-

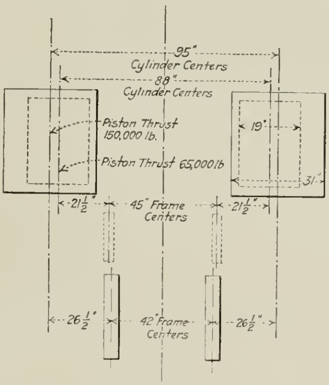

Fig. 1 Diagram Showing Increase of Overhang of Cylinders in Present-Day Locomotives

dous increases in piston thrust as well as the increased leverage caused by the very considerable lengthening of the distance between the cylinder centers and the frame centers.

Substantial and sufficient cross-braces should be applied between the frames and rigidly bolted thereto to form a rugged structure which will not rattle to pieces. Sufficient bearing for bolts and adequate bolting flanges are a very important feature. At the same time it must be borne in mind that there is a possibility of tying up the frame so rigidly that there will be a tendency for failures ahead of the front pedestal and just back of the cylinder fit at a point where it is practically impossible to obtain sufficient reinforcement.

It seems as though the design of driving boxes and driving-box brasses had not successfully kept pace with the rapid increase in piston thrust. It is very evident that we shall have trouble in taking care of driving-box brasses until a suitable design is produced—one in which the brass will cover much more of the front and back projected area of the journal than is now the case. Many experiments have been tried, and in many cases they have gone beyond the experimental stage and have proved to be very satisfactory. Among these are driving-box brasses cast into the driving box. Many boxes are in use today where the brasses are keyed into the box, making them readily removable for replacement. However, the author feels that none of these has approached the solution to the problem, which lies in producing a design that will surround the journal with a bearing as completely as possible and still lend itself to comparatively easy maintenance and reasonable cost of application.

Guiding and Trailing Trucks in Connection with Long Wheelbase

Santa Fe type engines with 22-ft. rigid wheelbase are not uncommon. Engines of this type and of this size will weigh in the neighborhood of 400,000 to 420,000 lb. When we stop to think that to move this tremendous mass of material around a 16- or 18-deg. curve a force of many thousands of pounds is required, is it any wonder that we obtain rapid flange wear and the necessity for returning tires before the proper amount of mileage has been obtained? In the majority of cases, it is believed, the force necessary to properly curve an engine of this kind has been applied at the front truck and the first driver. In most cases types of leading trucks have been used which produce a very small resistance on curves of small degree. In order to prevent rapid flange wear as well as to overcome the development of lateral play unnecessarily, designs have been produced which will give a high initial resistance of the front truck and provide a lateral motion for the front driver with adequate resistance so that some of the guiding force is transferred back to the second pair of drivers.

Since locomotives operate the greater part of the time on tangent track, it is necessary to have a high initial guiding resistance which will not be increased when curving. In other words, a flexible wheelbase is produced which has all the requisites of the ordinary rigid wheelbase, but at the same time will overcome many of the difficulties now encountered in an attempt to operate engines of this size and length. Many designs of trailing trucks have been produced with the idea in mind of helping to remedy the conditions which have been noted above. These of course have met in a way the conditions which it was necessary to overcome. What is needed is a positive centering device whose resistance will be adequate initially, can be always depended upon, and which will not mount up to prohibitive figures under the maximum swing of the trailing truck.

In addition to the foregoing, some work has been done in the way of producing a design by means of which the lateral play in locomotive driving wheels can be taken up without removing the wheels from under the engine or taking the boxes off from the axles.

The advent some years ago of the power reverse gear overcame one of the great objections that engineers had too large locomotives. It is a fact that it is almost impossible for one man to reverse one of our large locomotives equipped with the ordinary hand reverse lever. Power reverse has come to be an essential part of engine equipment and has been found to be economical even though it may be used on a locomotive which could be comparatively easily reversed by hand.

Probably no one thing contributes more to the failure of side rods than the improper adjustment of shoes and wedges. If these are allowed to run loose, stresses in the side rods will amount to a very high figure, and if they are improperly set up, the driving wheels are very likely to be out of tram. This in itself brings undue stresses on the rods, which in time will unquestionably produce failures. The author feels that there are many cases where in attempting to overcome the failure of side rods we have deliberately increased their sections without giving due consideration to the cause of failure. Consideration of the foregoing brings us to the point of providing an adequate automatic adjustment of the wedge so that the difficulties mentioned will not be encountered.

Means for Increasing Nominal Tractive Power

All railroads have points on certain divisions where there is a critical grade or the necessity of starting a heavy load under adverse conditions. At such places increased tractive power is required which is not needed elsewhere. We are therefore confronted with the problem of producing a device which can be set to work to increase the tractive power of a locomotive in such cases, thus enabling the engine to take its full tonnage over the entire division. This device should be so made that it can be applied when necessary and thrown out when the additional tractive power is not required. Designs have already been produced wherein an additional tractive power of 8,000 or 10,000 lb. has been applied to the trailing trucks of large locomotives. There is also a possibility of applying such a device to the tender truck, thus availing

ourselves of the adhesive weight of the tender to help boost the engine over the critical points in a division. There is always present a possible potential boiler capacity which can be brought out by the use of a variable exhaust or other device sufficient to obtain rapid combustion at slow speeds.

The Ash Pan

The question of ash pans is also one needing serious consideration. There are in use a number of rules stating what the proper air opening in the ash pan should be, and while many of these rules have in a way proved satisfactory, it would nevertheless seem that to get at the question logically we should determine the amount of coal that can be burned economically per square foot of grate and then on this basis provide an ash-pan air opening that will give the required amount of air to burn satisfactorily the maximum amount of coal which is expected to be consumed. The amount of air that will flow through a given opening in the ash pan, it is believed, can be very closely approximated from the vacuum produced in the smokebox. This of course is only a suggestion, and it may be that when the question is looked into more carefully a more desirable and accurate method of determining the required ash-pan air opening may present itself.

Lubrication

With our present high superheat the proper introduction of oil into the cylinders and valves of a locomotive is worth serious consideration. In many cases oil has been provided to both the cylinder barrel and the steam chest of superheater locomotive, and in other cases it has been provided to the steam chest alone. Both methods have given apparent satisfaction, but it is a difficult matter to state which is the better.

It is common practice in European countries to provide a force-feed lubricator located very close to the cylinder, with a pipe to each end of the piston-valve steam chest. This oil supply opens directly over each end of the valve when it is in central position. In addition an oil pipe is supplied to the cylinder at its center. It is reported that by this method there is less carbonization of the oil than when it is fed into the steam pipes or into the center of the piston-valve steam chest.

In order to increase the tonnage which a locomotive can haul it is just as vital to decrease the resistance as to increase the power. Now it is not an impossibility to provide roller bearings for passenger cars, and there seems to be no reason why they cannot be used on freight cars. The reduction of rolling resistance and the better facilities for lubrication which would be provided would be sufficient in time to overcome the necessary expense.

This question of lubrication may as well apply to other parts of the locomotive. The proper grooving of side-rod and main-rod brasses, or the use of babbitt inserts, are questions that should be taken up in connection with lubrication of these parts.

Conclusion

In summing up the situation, it may be said that the use of the superheater alone has increased the capacity of locomotives when compared with saturated engines of the same design to such an extent that no one would think of building a large locomotive for up-to-date railroad service without the application of superheat. We must not content ourselves, however, with what has been done with this one device. What we need to do now is to avail ourselves of the opportunities offered in the application of many of the labor-saving and capacity-increasing devices which have already been worked out and are giving satisfactory service, and at the same time look forward to the possibilities of applying other devices which are yet in their infancy, but which have proved beyond doubt that they are well worth our consideration and are of sufficient importance to warrant their adoption. Without the capacity-increasing devices which have been mentioned the large locomotive of today would be impossible—it could not be operated satisfactorily. Our large engines are an absolute justification of these improvements. Further developments are ready at hand and in their use lie the possibilities of still more powerful and economical transportation units built to operate within our present limitations of clearance and permissible rail loads.

MID-WEST CENTRAL-STATION POWER

(*Continued from page 444*)

the highest tension in the Middle West—with some distribution at 70,000 volts.

In Wisconsin the important hydroelectric developments on the lower Wisconsin River at Kilbourn and at Prairie du Sac are connected by 66,000-volt lines to Milwaukee and to important manufacturing centers to the south, which are included in the Middle West system. The water powers of the Chippewa River and its tributaries have been developed largely by the Brewer interests. Much of this power goes to St. Paul and Minneapolis over a 120-000-volt line, and to other Mississippi River cities farther south. The distribution to the south and west from St. Paul and Minneapolis is over 66,000-volt lines and 110,000-volt lines owned by the Byllesby Company.

A study of the five principal states of the group represented in Fig. 2 indicates that when power is to be generated by steam it can best be done by central stations in the locality where it is to be used. For example, Chicago, with its large and efficient power houses, is surrounded by power houses of the Public Service Company of Northern Illinois and by those of the Middle West Utilities Company, with all of which it exchanges power, but which nevertheless generally supply the power needed in their immediate respective vicinities. Chicago is connected with Keokuk and Keokuk with Indianapolis and New Albany, and yet the power sent over these lines from its large power houses is small in comparison with that generated and distributed locally along the lines.

Formerly each small country town requiring 50 kw. or more had its own central station, using 20 lb. of coal per kw-hr. As there was no money in that, there came about consolidations of these isolated central stations into small groups, all supplied from the best-located plant of the group. It was found that with an improved load factor and larger units the coal consumption was by this means reduced to 15 lb. per kw-hr. The next step was to connect these groups into larger ones of 5000 kw. capacity, favorably located as regards condensing water and rail connections, having condensing turbines and capable of delivering a unit of energy for 4 lb. of coal. A plant of this size can reach out its arms and gather in all of the power within a radius of thirty miles or so. This is about the most efficient combination of station power and transmission lines, unless it happens that the power demands of the city in which the plant is located are such that the use of generating units up to 15,000 kw. is practicable, in which case a further material improvement in efficiency is secured and warranting the construction of longer lines to reach more remote groups of power, these large plants being interconnected over lines of sufficient capacity to permit them to be mutually helpful.

Such is the plan which is naturally developing, and although its progress must be as slow as the process of consolidation of the properties, it appears that the problem of cheaper power production is working out its own solution along conservative lines and that in time the present systems will merge into larger ones, with one general scheme for generation and distribution, so that areas equal to a state in extent and overlapping state lines shall be under one management.

What, then, about home rule? Many years ago, when "tariff" was the football of national politics, a candidate for the presidency, upon being asked to declare his position on this burning issue, replied that the tariff was a local question and had no place in a presidential campaign. It is by such reasoning that the interests of a utility, stretching for hundreds of miles across the country and supplying power to hundreds of scattered or contiguous communities and to thousands of industries, becomes a local question and properly subject to local regulation as a foreign monopoly by each of the various cities, towns and villages in which it renders service.

Fortunately it is becoming generally recognized that a state-wide industry of this character requires state-wide regulation andt hat for the state to abdicate its jurisdiction, cut it up into sections and parcel out the pieces to the police powers of the various localities in which the utility operates, subjecting it to the vicissitudes of local politics, cannot help that utility to develop and to most economically and efficiently serve those same communities.

Advantages of Large Freight Locomotives, Particularly the 2-10-2 Type

By ALBERT F. STUEBING,[1] NEW YORK, N. Y.

In this paper the author points out the more important considerations involved in a study of the economic value of various types of motive power and demonstrates the complexity of the problem. Probably, he holds, no absolutely correct analysis is possible, and surely no' practicable. The choice of motive power is of extreme importance because the characteristics of the power affect the earnings more than any other single factor and determine the efficiency of operation usually throughout the life of the engine. For this reason the choice of the locomotive should be made with extreme care. The final decision should be based on a definite knowledge of the economies that can be realized, not on unsupported opinion. Engineering methods are essential in working out the solution, and the study of the problem offers a field for constructive coöperative work by the members of the engineering societies.

PROBABLY the briefest presentation of the advantages of large locomotives is that made by James J. Hill: "Receipts are by the ton- and passenger-mile; expenses are by the train-mile." It is not to be expected that such a general statement will hold good in all particulars, nevertheless it is true that a large proportion of operating expenses decrease as the train load increases, although not in the same proportion as the decrease in train-miles. Under the operating conditions existing on most of the main-line mileage of this country, the greatest possibilities for economy are probably still to be found in the adoption of locomotives of high capacity.

The large locomotive, designed merely for high rated tractive effort, is not a panacea for operating troubles. The first requisite is a design suited to the conditions of the operating territory, the traffic, and the service. The relative advantages of specific designs are a problem in the economics of operation that must be solved by the application of engineering principles. It is a question of adapting the design to the operating and economic conditions and then coördinating the motive power with other facilities.

The adoption of improved power should be only one part of a coördinated program. Every appropriation for larger engines should carry with it, as an integral part, provision for facilities to insure the maximum utilization of the power. Engine terminals, shops, yards, the rolling stock and the track structure itself should be prepared to assist in obtaining the proper operating results. The coördination of facilities deserves careful study. Much better results will be obtained by the use of locomotives adapted to existing conditions where the related facilities cannot be adapted to the locomotive.

The choice of motive power is of extreme importance because the characteristics of the power affect the earnings more than any other single factor and determine the efficiency of operation usually throughout the life of the engine. The problem of introducing new locomotives is similar to the problem of reducing grades and should be studied as thoroughly. The interrelation between the various factors affected affords large opportunities for savings and also for losses. Many investigations have been held up during the past few years and the rapid changes in prices have made earlier data inapplicable. It would seem, therefore, that there is a large field for research in the economic problems of operation when normal conditions are restored.

Most of the available reports on the economic value of heavy locomotives consider comparatively few of the items affected. The comparative costs of wages of train crews, of fuel and water, and of repairs to locomotives are often the only items considered. In some few cases the comparative mileage and fixed charges on the investment in motive power have been computed. This is not sufficient to determine conclusively the relative merits of various types of power. The locomotive has a direct or indirect influence on many items of expense in the maintenance of way, maintenance of equipment, and transportation accounts. The real problem in determining the value of a locomotive is to find the effect that its operation will have on the sum total of these accounts, and the results of a thorough study should more than justify the labor involved.

It is the purpose of the following paragraphs to point out some aspects of the problem that apparently are deserving of attention. A search through the literature on this subject has failed to disclose fundamental data on these questions that are applicable to present conditions.

The Effect of Motive Power of Maintenance-of-Way Expenses

Some roads have reached adverse decisions on the adoption of 2-10-2 type locomotives on the ground that the increased cost of roadway maintenance resulting from their use would more than offset the savings in wages. Maintenance-of-way expenses make up about 17 per cent of the total operating expenses, but the greater part of the expenditures are independent of the character of the power. Much of the work of track maintenance is made necessary by the action of the elements, or by the necessity of maintaining the permanent way in suitable condition for fast passenger traffic. The expense which is most directly affected by heavy locomotives with long, rigid wheelbases is rail renewals. Other accounts that are affected to a lesser degree are ties, track laying and surfacing, roadway maintenance, and superintendence.

There is little or no information available as to the comparative effect of four and five pairs of coupled wheels on rail wear and the other accounts affected. The actual effect will vary according to the wheelbase, the curvature of the road, and whether the locomotive has one or more pairs of drivers equipped with lateral-motion devices.

The sum of the maintenance-of-way expenses which may be increased by heavy motive power is about 10 per cent of the total operating expenses, and if the effect is to increase these items considerably the saving will be difficult to make up in other accounts. However, if the wear and tear on the track is merely proportional to the weight of the engine, as is sometimes assumed, light and heavy engines would be on a par as regards these items. The difference of opinion on this question suggests the necessity for a careful investigation.

Maintenance of Equipment

The percentage of the total operating expenses falling in this classification has shown a fairly consistent increase over a considerable period. Locomotive repairs and renewals, which in 1898 amounted to 5.9 per cent, in 1918 had increased to 11.7 per cent. So many factors may influence this ratio that no definite conclusions can be drawn, but it is significant nevertheless.

The principal difficulties in maintaining large locomotives are due to the short life of driving-wheel tires, driving boxes and main-pin bearings. With the proper facilities and proper construction the work of caring for these parts becomes merely a matter of routine running repairs, but where the lack or inadequacy of terminal facilities hampers repairs, the loss of service due to these minor items may become serious.

While the foregoing remarks are confined to some of the more important items of roundhouse maintenance, they are equally applicable to the work of classified repairs. If the shops and shop machinery are not adequate for new power, repair charges will be high and the time out of service will be increased. The cost of these facilities should be considered when estimating the saving that may be effected by new power.

Wide differences of opinion appear to exist regarding the relative cost of maintenance and mileage of 2-10-2 type and Mallet loco-

[1]Associate Editor, *Railway Age*. Jun. Am.Soc.M.E.

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motives. While the field for each is to a certain extent distinct, there are districts where either might be suitable and roads that have sufficient data to permit a fair comparison could perform a service by furnishing information that would clear up this question.

A very serious problem in connection with the use of locomotives of high capacity is the effect on the cost of repairs to freight cars. The total amount spent for repairs and renewals is nearly as great as the repairs and renewals to freight and passenger locomotives combined. When the length of trains is increased beyond a certain point, break-in-twos, shifted loads, and damage to the cars in general may increase at a rapid rate. The effect of increasing the length of the train may be serious where the road cannot control the character of equipment in the trains, where the car load is light, the train long, and the lading is subject to damage or of such a nature that it may shift and damage the car. It is significant to note that a study made by N. D. Ballantine showed the time delayed due to car failures was more than twice as great with a Mikado engine, which had a tractive effort of 57,000 lb., as with a Consolidation of 39,000 lb. tractive effort.

A study of car failures in long trains may demonstrate that the trouble is largely due to equipment with weak underframes. If wooden underframes are a serious hindrance to the operation of long trains, the remedy can be applied with little difficulty. While the reinforcement of the remaining cars of this type still in service would require fairly heavy expenditures, it would no doubt be justified by the saving in repair costs and improved operation.

Transportation Expenses

Directly or indirectly, the locomotive affects items in the transportation expenses which amount to about 35 per cent of the total operating expenses. Two of the important items which are reduced almost proportionately as the tractive effort increases are wages of train enginemen and trainmen. The economies in these expenses are considerable and they can be predetermined with a fair degree of accuracy.

Enginehouse expenses likewise are affected by the character of the power to an extent depending on local conditions. The reduction in the number of units handled will probably cause a slight decrease in the cost per ton-mile unless the new equipment makes additional facilities necessary.

Several miscellaneous items of operating expenses are also affected to some degree, such as accounts affected by collisions and derailments, loss and damage, damage to live stock, clearing wrecks and injuries to persons. The effect of car failures on loss and damage has already been mentioned. In so far as these expenses are due to collisions and derailments, they are increased by an increase in train density rather than by an increase in the length of the train, and would therefore be reduced by the use of locomotives of high capacity.

Fixed Charges

The fixed charges on the motive power seldom exceed three to four per cent of the operating expenses. The difference between the fixed charges on a thoroughly efficient modern engine and a crude design that might be bought to make an insufficient appropriation cover a given number of locomotives, is negligible. However, the difference in the earning power of these two types is quite appreciable and serves to show what large returns can be derived from the additional capital expended for refinements and accessories that give increased capacity and efficiency.

At first thought it might seem that the additional investment for terminals, shops, and shop machinery would add greatly to the capital expenditure and the fixed charges. Under ordinary conditions, however, the cost of roundhouse space required properly to house a locomotive is a comparatively small proportion of the cost of the power. The cost of the shop buildings and machinery is even less important when the added efficiency and decreased cost of repair operations are considered.

Sometimes the introduction of heavy locomotives necessitates strengthening or replacing bridges or laying heavier rail over certain sections. The expenditures involved are often quite large, but the relatively long life of these structures decreases the fixed charges and the additional cost per ton-mile becomes comparatively small and is seldom an important factor in determining the most economical equipment. When new rail must be laid the additional expenditure is a more serious item and the charge would probably not be justified except on a line with relatively dense traffic.

The preceding discussion pointing out the more important considerations involved in a study of the economic value of various types of motive power demonstrates the complexity of the problem. Probably no absolutely correct analysis is possible; surely, it is not practicable. The question is of extreme importance because the possibilities of economical operation are circumscribed by the motive power. For that reason the choice of the locomotive should be made with extreme care. The final decision should be based on a definite knowledge of the economies that can be realized, not on unsupported opinion. Engineering methods are essential in working out the solution and the study of the problem offers a field for constructive coöperative work by the members of the engineering societies.

EFFICIENCY TESTS OF A 30,000-KW. STEAM TURBINE

(Continued from page 454)

$$F = \frac{MW}{C}$$

in which F = water-rate factor; M = minimum water rate obtained; W = mean load between one-half rated load and maximum load, which is the usual operating range; and C = average total steam consumption per hour covering the range between one-half rated load and maximum load.

Using the curves given in Fig. 4, substitutions may be made as follows:

$$F = \frac{11.03 \times 25{,}000}{280{,}100} = 0.985$$

This factor could be expressed by using the ratio between the minimum water rate and the average water rate over the range selected. However, the factor obtained in this manner would not take into account the fact that it is more desirable to obtain flatness in water-rate curves at the high loads than it is at the low loads. By using the total steam consumption as indicated in the expression given above, a fairer comparison is obtained.

Condenser and Auxiliary Tests

Tests were conducted on the condensers and auxiliaries. A summary of the condenser and dry-vacuum-pump tests, which were run simultaneously, is given in Table 2, while the relation between load and vacuum is shown graphically in Fig. 8. In examining the results of these tests and comparing them with the vacuum obtained during the turbine tests, it should be kept in mind that the temperature of the circulating water during the condenser tests, which were run during the summer, was very high, varying from 75.1 deg. fahr. to 78.2 deg. fahr. The methods used in determining the quantities given in Table 2 need no description, with the possible exception of the measurement of the air discharged from the dry-vacuum pump and the steam consumption. The air was measured by a gasometer connected to the discharge of the pump. The steam consumption was determined by condensing the exhaust steam in a small test condenser, after which it was weighed in the usual manner.

Table 3 gives the results of the tests on the circulating-water pump. It will be seen that two tests were conducted on these pumps, one being an economy test while the other was a maximum-capacity test. Only one of the two pumps was running in either test. During the economy test the discharge valve was adjusted to give the normal operating head which exists when two pumps are running, while in the capacity test it was left wide open. The quantity of water pumped was computed by the heat-balance method, which involved the measurement of the main-turbine condensate, its temperature, the temperature of the circulating water in and out, the steam conditions at the main-turbine throttle, load on main unit, etc. The steam consumption of the turbine driving the pump was determined by means of the small test condenser mentioned above. The results of the condensate pump test are given in Table 4.

Chicago Meeting of A.S.M.E. Sets New Standard

Excellent Technical Program Vies with Attractive Excursions and Delightful Entertainments in Largest Spring Gathering

DRAWN by the strong technical sessions, interesting social events and instructive plant visits listed on the program, 1235 members and guests of The American Society of Mechanical Eng'neers registered for the Spring Meeting at the Congress Hotel, Chicago, May 23 to 26. The attendance exceeded that of any previous Spring Meeting, but the large number was but one of the attributes of a successful meeting. The Chicago General Committee had worked hard in the planning of the event and their labors were rewarded by the pleasure of seeing a smoothly conducted affair. The program was full—fourteen sessions, numerous committee meetings and plant visits—but the schedule was rigidly followed and everything was completed in time.

The opening morning of the meeting was devoted to the Council Meeting and registration—the business session commencing at 2.30 in the afternoon, and the following mornings were devoted to professional sessions, the afternoons being reserved exclusively for plant visits. Tuesday evening was assigned to the session on Training in the Industries.

Entertainments

On Monday evening an informal reception was held in the Gold Room of the Congress Hotel. The Chairman of the Chicago Section and the President of the Western Society of Engineers with the officers of the Society greeted those attending the convention. A large number of Chicago members were on hand to assist in making the guests feel at home. The result was a right enjoyable evening.

On Wednesday evening an informal dance was held. The Gold Room was effectively decorated with flags and lights for an affair that was thoroughly appreciated from the first crash of an exceedingly competent jazz band. The floor was crowded and remained so during the evening, except for some few of the elders who drifted out into the corridors for a good chat.

Special attention was accorded the ladies at the Spring Meeting. Tours to the Marshall Field store and the Field Museum were conducted, and on Wednesday, following an automobile ride through the lake-front residential section of Chicago, they were guests at a charming reception at the home of Mrs. Robert W. Hunt.

Plant Visits

Chicago and its remarkable industrial surroundings furnished a fine opportunity for interesting plant visits. The Chicago Committee chose outstanding plants for these excursions and planned the details carefully, with the result that every one of them was faultlessly conducted. A definite number of visitors were assigned to each excursion and in every case the allotment was more than taken up. The plants visited included the Fisk Street Station of the Commonwealth Edison Company; Sears, Roebuck & Company; Illinois Steel Company; Pennsylvania Terminal; Crane Company; Mandel Brothers; Chicago Mill and Lumber Company; Western Electric Company; Pullman Company; Chicago Underwriters Laboratory, and the Yellow Cab Mfg. Company. The following plants were thrown open for inspection and many members availed themselves of this opportunity: Clementsen Company; Green Engineering Company; Hanna Engineering Works; Ilg Electric Ventilating Company; W. A. Jones Foundry & Machine Company; Link Belt Company, and the Joseph T. Ryerson & Sons Company. On Friday morning about seventy-five members visited the pulverized-fuel installation at the Lakeside plant of the Milwaukee Electric Railway and Light Company.

The Local Committee

The entire arrangement of the meeting was under the jurisdiction of the General Chicago Committee, made up of Robert W. Hunt, Honorary Chairman; Herbert S. Philbrick, Chairman; James D. Cunningham, Secretary; Melville S. Flinn, Treasurer; David Lofts, P. Albert Poppenhusen, Arthur L. Rice and Edward P. Rich. The enthusiastic and efficient work of this committee was responsible for a most successfully conducted meeting.

Proceedings of the Business Meeting

PRESIDENT Carman occupied the chair at this session. To promote discussion of a new Constitution, the first item scheduled at the Business Meeting was a paper by Morris Llewellyn Cooke entitled On the Organization of an Engineering Society. This paper was published in full in the May issue of Mechanical Engineering. By previous arrangement the discussion of the paper was placed in the Management Session the following day.

Members of the Chicago Local Committees Whose Enthusiastic Coöperation Contributed so Greatly to the Success of the Largest Spring Meeting yet Held

General Committee

Robert W. Hunt
Hon. Chairman
Herbert S. Philbrick
Chairman
James D. Cunningham
Secretary
Melville S. Flinn
Treasurer
David Lofts
P. Albert Poppenhusen
Arthur L. Rice
Edward P. Rich

Professional Events Committee

Herbert S. Philbrick
Chairman
John Calder
R. B. Hall
T. A. Marsh
Glenn D. Mitchell
H. M. Montgomery
Alexander W. Moseley
J. M. Spitzglass
Ralph W. Yardley
Coöperating in Plans for Chicago Session (Appointed by Western Society of Engineers):
J. R. Bibbins
F. K. Copeland
E. S. Nethercut
E. J. Noonan
A. L. Rice

Plant Visitation Committee

David Lofts
Chairman
William L. Abbott
George R. Brandon
Bert A. Gayman
Norman Lawrence
Warren C. MacFarlane
George E. Pfisterer
Nathaniel G. Symonds

Social Events Committee

P. Albert Poppenhusen
Chairman
Clayton O. Billow
Adolph G. Carlson
Horace Carpenter
Heinrich J. Freyn
George F. Gebhardt
J. J. Merrill
S. T. Nelson
Herbert S. Philbrick
Howard E. Troutman
Fred L. Webster
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Edward P. Rich
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Oscar E. Andersen
Clayton O. Billow
Scott Bourne
R. T. Crane, Jr.
Courtney C. Douglas
Philip N. Engel
Philetus W. Gates
Arnold H. Goelz
Lorne A. Griffin
George M. Illges
Harold C. Jones
Daniel Lewy
James C. Matchett
P. Albert Poppenhusen
James V. Stannard
Frank F. Vater
J. D. Wallace

Program and Publicity Committee

Arthur L. Rice, *Chairman*
Frank G. Bolles
Robert I. Clegg
Edward C. DeWolfe
DeWitt C. Gross
Harry Himelblau
Walter Painter
Edward C. Pohlmann
Leon I. Thomas
Ralph E. Turner
Thomas Wilson

Hotels Committee

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W. K. Abernethy
Horace Carpenter
A. Cole
Loren Hibbard
W. R. Macklind
O. R. McBride
A. H. McDougal
T. S. MacEwan
William J. Mohr
R. A. Widdicombe

Ladies Social Committee

Mrs. Robert W. Hunt
Hon. Chairman
Mrs. P. Albert Poppenhusen
Chairman
Mrs. Horace Carpenter
Mrs. James D. Cunningham
Mrs. David Lofts
Mrs. J. J. Merrill
Mrs. Herbert S. Philbrick
Mrs. Arthur L. Rice
Mrs. Edward P. Rich

Committee on Meetings and Program in General Charge of the Society's Convention

R. V. Wright
Chairman
A. L. DeLeeuw
W. G. Starkweather
J. W. Roe
L. B. McMillan

The President then introduced John L. Harrington, of Kansas City, Mo., Chairman of the Committee on Constitution and By-Laws, who presented the report of his committee.

Those participating in the discussion included Morris L. Cooke, S. N. Castle, Max Toltz, R. B. Wolf, D. S. Jacobus, P. F. Walker, Charles L. Newcomb, L. C. Marburg, R. L. Sackett, Fred Dorner, Roy V. Wright, W. H. Kenerson, D. S. Kimball, R. H. Fernald, George A. Orrok, L. B. McMillan, Messrs. Nelson, Case, and Jackson (Rock Island), L. P. Alford, R. T. Kent, Charles Penrose and Secretary Rice. The synopsis of their discussion will be published in the next issue in parallel with the Articles proposed.

Special Action on Juniors Voting

Morris L. Cooke, who has an amendment to the Constitution already pending to extend the privilege of voting to Junior Members, sought the sentiment of the meeting regarding this provision, and after considerable discussion the matter was put to vote and carried by a majority of one. This means that Mr. Cooke is entitled to again put his amendment at the Business Meeting next December, and the meeting will vote whether or not it should be submitted to letter-ballot of the membership next March.

Reports of Special Committees

The Standing Committee on Technical Nomenclature presented a progress report on Symbols in Heat Engineering. It was voted that this report be received and ordered printed in Mechanical Engineering for discussion.

The Special Committee on Standard Tonnage Basis for Refrigeration presented a report, already published in the January 1921 issue of Mechanical Engineering, defining the standard ton of refrigeration, the standard commercial ton and the rating of a refrigerating machine. The report was adopted.

The Joint Committee on Steel Roller Chains (with the Society of Automotive Engineers) presented standards for roller transmission chains and sprockets, which were adopted.

Fuel Session

Six papers were presented at the Fuel Session on Tuesday morning, namely: Recording Ash-Pit Loss from Chain-Grate Stokers, by E. G. Bailey; Boiler Tests with Pulverized Coal, by Henry Kreisinger and John Blizard; Limitations of Mechanical Stokers Utilizing Mid-West Coals, by E. H. Tenney; Capacity and Efficiency Limitations of Stokers Using Mid-West Coals, by John E. Wilson; Smoke and Its Relation to the General Health of the Community, by Dr. John Dill Robertson; and Latest Requirements of the City of Chicago in Furnace Design, with Special Reference to Hand-Fired Boilers and Limits of Each Design, by Frank Chambers. Joseph Harrington presided over the session.

The papers by Messrs. Kreisinger and Blizard and by Mr. Bailey were respectively printed in the May and June numbers of Mechanical Engineering; those by Messrs. Tenney and Wilson will appear in the August issue.

In the absence of Doctor Robertson, Commissioner of Health of Chicago, his assistant, Dr. Vernon Hill, spoke briefly on the importance of smoke-preventive measures in lowering the death rate from pneumonia and other acute respiratory diseases induced by the inhalation of dust-laden air. While admittedly an engineering problem, it had nevertheless been thought wisest in Chicago to entrust this work to the Department of Health.

Mr. Chambers' paper, which was read by R. H. Kuss, gave particulars of the requirements of the Chicago ordinance as regards fuel-burning equipment, together with data on draft losses through boilers, the rules employed in determining areas of stacks, height of furnace settings, etc.

Mr. Kreisinger supplemented his paper by particulars regarding the new Lakeside Plant of the Milwaukee Electric Railway and Light Company. This plant contains eight boilers, each with 13,060 sq. ft. of heating surface and burning about seven tons of coal per hour when operated at 300 per cent rating. In one 24.5-hr. test recently made at 136 per cent rating, the remarkably high thermal efficiencies of 85.6 and 90.2 per cent were respectively obtained for the boiler alone and for the boiler and economizer combined. In this test the CO_2 at the boiler uptake averaged 16 per cent, and in the gases leaving the economizer, 13.2 per cent. The gas temperatures were 432 deg. leaving the boiler, 392 deg entering the economizer, and 205 deg. leaving the economizer.

Frederick K. Scheffler[1] submitted a written discussion of the paper by Messrs. Kreisinger and Blizard, in which he said that the authors' tests confirmed other previously carried out and made it safe to state that a boiler and furnace efficiency of 80 per cent can be obtained with any kind of coal properly pulverized when burned in a plant designed to suit the operating loads and conditions.

H. G. Barnhurst[2] wrote that he believed the customary limitation of 85 per cent through a 200-mesh screen should be generally followed, but just how any particular coal should be prepared depended to a great extent on the amount of volatile and ash it contained. Granulation would not give really efficient results. Inherent moisture should not be confused with surface moisture, and the latter should be reduced to approximately 3 per cent. Coal should be dried before preparation—primarily to make transporting, storing and feeding easier.

Guildford Greig[3] wrote describing results obtained with a 400-hp. water-tube boiler at the Erie City Iron Works. The equipment was extremely simple, consisting of but a magnetic separator for removing tramp iron from coal before pulverizing, and a combined coal pulverizer and fan. The furnace had a water-cooled refractory lining, making it possible to burn coal with only 5 to 10 per cent of excess air. Neither drying equipment nor extreme fineness of grinding had been found necessary.

G. E. Pfisterer[4] in a written communication said that the tests were in the proper direction, for if the cost of drying and pulverizing could be reduced the field of usefulness of pulverized coal could be greatly extended. Since the heat absorption of the furnace coil mentioned in the paper was very large per square foot, it might be advisable to put it in circulation with the boiler.

Victor J. Azbe[5] said that Mr. Kreisinger had established a record of great economic importance in getting 90 per cent boiler efficiency. Now that this had been shown to be possible, an end should be made of the practice of operating boilers at between 50 and 60 per cent efficiency.

C. C. Trump[6] said that he had obtained an efficiency of 90 per cent with large boilers, underfeed stokers and economizers, and with at least 12 per cent CO_2 and with care in operation these figures might be exceeded. One advantage in burning fuel in suspension was the radiant quality of the flame, and part of the efficiency attained by burning fuel in pulverized form might be accounted for by the efficiency of heat absorption by direct radiation.

R. Sanford Riley[7] said that the results stated by Mr. Kreisinger set a new standard for possibilities in combustion. One limitation to the use of powdered fuel that might be mentioned was the high cost of the equipment as compared with that for stokers.

E. W. Wagenseil[8] called attention to the practically flat efficiency curve obtained in the Lakeside plant tests with pulverized coal for ratings from normal up to around 300 per cent, and said it was worth while noting that this was also possible with modern forced-draft types of stokers with a proper zone system of air control.

John A. Stevens[9] said that abroad the practice now was to preheat the combustion air, resulting in a gain of something like 2 per cent in the overall efficiency. A boiler efficiency of 90 per cent meant a kilowatt-hour on a pound of 14,000 B.t.u. coal, and this high value could be increased still more by preheating with steam drawn from the second or third stage of the turbine.

Mr. Kreisinger, in reply to queries, stated that in the effiicencies he had given no deductions were made for the economizers; and

[1] Designing & Constr. Engr., Fuller Engrg. Co., 50 Church St., New York, N. Y. Mem. Am.Soc.M.E.

[2] Chief Engr., Fuller Engrg. Co., Allentown, Pa. Mem. Am.Soc.M.E.

[3] Gen. Supt., Erie City Iron Works, Erie, Pa. Mem. Am.Soc.M.E.

[4] Green Fuel Economizer Co., 1450 Old Colony Bldg., Chicago, Ill. Jun. Mem. Am.Soc.M.E.

[5] Cons. Engr., 2194 Ry. Exchange Bldg., St. Louis, Mo. Assoc-Mem. Am.Soc.M.E.

[6] Vice Pres., Humphrey Gas Pump Co., 401 S. A. & K. Bldg., Syracuse N. Y. Assoc-Mem. Am.Soc.M.E.

[7] Pres., Stanford Riley Stoker Co., 25 Foster St., Worcester, Mass. Mem. Am.Soc.M.E.

[8] Commercial Stoker Engr., Westinghouse Elec. & Mfg. Co., 111 W. Washington St., Chicago, Ill. Mem. Am.Soc.M.E.

[9] Cons. Engr., Lowell, Mass. Past Vice-Pres. Am.Soc.M.E.

that powdered coal was safe to handle if kept out of the boiler-room atmosphere. Replying to Mr. Stevens, he said that by preheating the atmospheric air fed to the furnace 280 deg. the boiler efficiency could be increased approximately 3 per cent.

Management Session

THE session of the Management Division, presided over by L. P. Alford, Chairman of the Division, was opened by the presentation of a report of the work of the Executive Committee during she first year of the organization of the Management Division. This report defined management as the art and science of preparing, organizing and directing human effort applied to control the forces and to utilize the materials of nature for the benefit of man. From this definition the following statement of the purpose or object of the Management Division was enunciated:

> Inasmuch as the problems of management are of the utmost complexity and difficulty, the Management Division of The American Society of Mechanical Engineers, in seeking to render disinterested service, therefore declares its purpose to be the formulation and declaration of the fundamentals of management, both regulative principles and accepted practice, and the dissemination of management knowledge. In working toward this object the Management Division can thus not only be of service to the other Professional Divisions of the Society, to the individual members of the Society and to all other societies of like aim, but also to all who are in responsible charge of human effort, and therefore through them of benefit to society at large.

The following activities of the Division in project were named: The standardization of management terminology, units of measurement, and methods of expression; the improvement and development of management education; the elimination of management wastes in industry; the elimination of unnecessary fatigue in industry and engineering; and lastly, management research. The report also listed the work of the Division in assisting local sections to conduct meetings during the past year. Two coöperative activities have been entered into, as follows: The joint committee on graphics with the Society of Industrial Engineers, the Taylor Society, and the American Statistical Association; and the joint committee on Management Terminology with the Industrial Relations Association of America, the National Association of Cost Accountants, the Society of Industrial Engineers, the American Institute of Accountants, and the Taylor Society.

Robert Thurston Kent presented a progress report of the Joint Committee of Management Terminology, of which F. E. Town is chairman. The report stated that the duties of the committee are the definition of management, the listing and defining of terms and phrases of management and the extension of the Dewey decimal system of classification to cover management literature. The Committee limited its field to management terminology applied (1) to production of basic materials for manufacture; (2) to manufacture, including products of public utilities; and (3) to construction of all kinds. In carrying out its work the Committee will request the submission of definitions of a tentative list of management terms from a great number of properly qualified persons and 98 colleges and universities. The definitions received will form the basis for the Committee's action in determining standards. Steps have been taken to form an advisory council composed of one representative from each of the large national trade or commercial organizations. In closing, Mr. Kent asked the membership of the several societies to assist by sending the chairman of the committee lists of management terms used in their shops.

A paper by W. C. Marshall, entitled Graphical Methods, was presented before the meeting. This paper will appear in a later issue of Mechanical Engineering. In a discussion of this paper, Morris L. Cooke pointed out that while the engineer is accustomed to the use of charts, drawings, tables, and blueprints, the general public is getting tired of these evidences of the engineer's technique. He stated it to be the duty of the engineers to make charts palatable and thereby greatly increase their effectiveness. L. W. Wallace further emphasized Mr. Cooke's remarks and stated his belief that education in graphics to catch and hold the eye and convey a lesson is a most important step in increasing public understanding of industrial matters.

In his paper on Industrial Waste, L. W. Wallace, Secretary of the American Engineering Council, presented some interesting facts resulting from the work of the Committee on Elimination of Waste in Industry. He pointed out that waste results from lack of planning, inadequate standards, faulty and uneconomic design, changes in style, and unfair practice; and predicted that the disclosures to be made in the report itself, which will be issued about September 1, will be interesting and vitally important. He gave a brief résumé of the work of the Committee from its appointment to the presentation of the report to the American Engineering Council on June 3, listing the problems solved, giving credit to the Committee members for their conscientious work, and outlining the final character of the waste report. He described the astonishment of the Committee upon finding after careful investigation that there was no known means or procedure for analyzing and evaluating waste, and pointed out the great value to management engineering of the method finally determined upon by the Waste Committee, the use and further development of which he commended to the Management Division. The difficulties experienced by the Committee because of the babel of management terms were explained by the speaker, who encouraged the Joint Committee on Management Terminology in their efforts.

In his discussion of Mr. Wallace's address, Morris L. Cooke pointed out the importance of the work done by the Committee in determining upon a method for waste evaluation and stated that the Management Division should utilize this method still further in the study of industry. Mr. Wallace emphasized the need of coöperation with other societies in putting this procedure to work.

Following Mr. Wallace's paper the meeting was turned over to a discussion of Mr. Cooke's paper on the Organization of an Engineering Society, presented at the Business Meeting of the Society on Monday, May 23. This paper, which was printed in the May issue, was prepared at the request of the Management Division and the discussion was held during the Management Session. This discussion will be abstracted in the August issue of Mechanical Engineering, which will also carry the proposed new constitution and by-laws of the Society, and should be given consideration by the membership of the Society in connection therewith.

First General Session

THE papers read at the General Session, Tuesday morning, Past-President D. S. Jacobus presiding, were Capacity Tests of Dry-Vacuum Pumps by the Low-Pressure Nozzle, by Snowden B. Redfield; and Report upon Efficiency Tests of a 30,000-Kw. Steam Turbine, by Herbert B. Reynolds. An abstract of Mr. Redfield's paper was printed in Mechanical Engineering for April; Mr. Reynolds' paper appears elsewhere in this issue. A brief résumé of the discussion follows:

Allen H. Blaisdell,[1] discussing the first paper, wrote that it seemed misleading to run tests on vacuum pumps using dry air rather than a mixture of air and vapor and then consider the results as indicating the actual capacity of the pumps.

Paul Diserens[2] said that the paper pointed out the ease with which a volumetric test of a vacuum pump or compressor might be made and emphasized the high degree of accuracy obtainable by the use of an orifice. He also called attention to the fact that the vacuum which a pump will develop on a closed suction gives a good indication of its volumetric efficiency throughout its entire working range. He then showed how closely calculated results and actual test results agree.

Wm. G. Christy[3] spoke of the length of the orifice beyond the curved mouth which the author had stated as ranging from 1/4 in. to 3/4 in. in length. He was under the impression that this should be as short as possible.

H. Boyd Brydon[4] said that a dry-vacuum pump should be tested under the conditions under which it was to operate, i.e., with moist rather than with dry air.

N. E. Taylor,[5] who presented the paper in the absence of Mr. Redfield, said that undoubtedly the moisture in the air influenced

[1] Instr. of Mech. Engrg., Carnegie Inst. of Technology, Pittsburgh, Pa. Assoc-Mem. Am.Soc.M.E.

[2] Asst. Ch. Engr., Worthington Pump & Machy. Corpn., 115 Broadway, New York, N. Y. Mem. Am.Soc.M.E.

[3] Stillwater, Okla. Mem. Am.Soc.M.E.

[4] Byllesby Engrg. & Management Corp., Chicago, Ill.

[5] Engr., Ingersoll-Rand Co., Chicago, Ill. Jun. Am.Soc.M.E.

the results of the tests. The logical way to make the test, he said, would be to test the pump with dry air and then determine the effect of moisture.

The second paper was presented by H. Boyd Brydon in the absence of the author. The discussion was opened by the reading of the following communications here briefly abstracted.

O. H. Bathgate[6] noted that the water rates reported in the paper corresponded very closely to those obtained on another group of 30,000-kw. turbines reported by Messrs. Stott and Finlay, if proper allowance were made for difference in steam pressure and temperature. From this he concluded that it was hardly reasonable to expect any further increases in turbine efficiency for this size of unit unless obtained from units of radically different design.

W. S. Finlay, Jr.,[7] discussed certain ruling considerations such as the high price of New York real estate and the necessity and desirability of locating the turbines so as to secure their steam supply with proper distribution from the existing boiler plant. He stated the history back of the use of the spring supports for the condenser and many other details. He criticized the report for not being presented in metric as well as in English units.

Oscar F. Junggren[8] discussed the water-rate curve between 22,000 and 26,000 kw., saying that the secondary valve opened sooner than had been intended, resulting in a higher rate at this point.

Mr. Brydon asked a number of questions covering details of the installation and tests, which were answered by Mr. Junggren.

Frank R. Wheeler[9] said that he had used spring supports for condensers and had found them satisfactory. He had also used rubber expansion joints with copper thimbles to protect the rubber, with similar results. He called attention to the fact that about only half of the condenser surface was effective.

George A. Orrok[10] explained that condensers were designed for maximum conditions of steam and water temperatures, with the result that much of the time they were running at about half capacity. He also suggested hanging the condenser from the supports of the turbine so that a connection might be had between them without expansion joints.

T. E. Keating[11] mentioned the danger of overspeeding due to the admission of auxiliary exhaust steam unless the flow is under governor control. He asked for an explanation of the manner of determining the speed-curve corrections and the method of determining the heat transferred per hour in the condenser. He offered a tabulation of the heat-transfer coefficients as calculated from three of the tests and gave his assumptions in making the calculations.

Session on Education and Training

For the first time in the history of the Society a session was devoted to the subject of training for the industries at the Spring Meeting in Chicago. Dr. Ira N. Hollis, President of Worcester Polytechnic Institute and Past-President of the Society, called the meeting to order and introduced Dean Robert L. Sackett of Pennsylvania State College as presiding officer. In his opening remarks Dr. Hollis called attention to the importance of the problem of training for the industries as the phase of the present industrial crisis to which we have given least attention. The Society as a whole has no share in the establishment of schools and no responsibility for the training of men for the industries. Therefore the interest of the Society applies mainly to the dissemination of information to members and the public as to what is being done in remedying unsatisfactory conditions. Papers were presented by H. C. Smith, chairman of the Committee on Education of the National Metal Trades Association, on What the National Metal Trades Association is Doing and Intends To Do in Industrial Education; by Dugald D. Jackson, professor of electrical engineering, Massachusetts Institute of Technology, and Magnus W. Alexander, National Industrial Conference Board, New York, on The Requirements of Engineering Industries and the Education of Engineers; and by H. E. Miles on General Education and the Engineering Profession. The paper by Professor Jackson and Mr. Alexander appeared in the June issue of Mechanical Engineering. Those by Messrs. Smith and Miles will appear in the August issue.

Chicago Session

The Chicago Spring Meeting was noteworthy because of the policy of close coöperation carried out with the Western Society of Engineers. The session devoted to the consideration of the engineering problems of Chicago was given over to the city's transportation and terminal problems and the Chicago Terminal Committee of the Western Society presented its report at this session. F. K. Copeland, president of the Western Society of Engineers, was introduced as presiding officer by President Carman and the meeting was conducted throughout by that society. A considerable amount of valuable information was presented about the terminal problem in Chicago. The papers with their discussion will appear in the August issue of Mechanical Engineering.

Second General Session

Three papers were presented at the General Session, Wednesday morning, Manager C. Russ Richards presiding, namely: An Investigation of Oxy-Acetylene Welding and Cutting Blowpipes, by R. S. Johnston; Interpretation of Boiler-Water Analysis, by J. R. McDermet; and The Hydraucone Regainer, Its Development and Applications in Hydroelectric Power Plants, by W. M. White. Abstracts of the papers by Messrs. Johnson and McDermet appeared in Mechanical Engineering for May; Mr. White's paper was published in abridged form in the June issue. A very brief account of the discussion of these papers follows:

H. G. Knox[1] discusses some tests made on blowpipes at the Norfolk Navy Yard about a year ago. In these tests more attention was paid to the mechanical features and serviceability of the various blowpipes, and the interest was not so much in the theoretical gas consumption as in the general economics of field service. The blowpipes were examined from three viewpoints: design, performance and upkeep. Subdivisions under these headings were rated on a decimal basis, the weighted average representing the final merit of the blowpipe.

James W. Owens,[2] writing also on the above-mentioned tests, stated that the oxy-acetylene cutting tools were tested on metal up to 8 in. in thickness, this being considered the practical limit. Above 8 in. oxy-hydrogen should be used. In addition to the tests outlined by H. G. Knox, a six-month's service test was also made.

Alfred S. Kinsey[3] asked if the channel mentioned by the author and used under the welding specimens was for the purpose of preheating in order to increase the strength of the weld. The author replied that the channel was primarily used for convenience in bracing, but that it was noticeable in Table 6 that the second plate, which was subjected to greater preheating, was, in most cases, of higher tensile strength, which might indicate that preheating was valuable under certain conditions.

J. I. Banash[4] thought that the paper presented oxy-acetylene welding in too unfavorable a light. He brought out the importance of considering the personal element, and said that some of the criticisms were unjustified.

S. V. James[5] said that the safety of torches depended upon features of mechanical construction of far more importance than flashback, and thought that the author had overstressed this danger, which had never been of serious consequence in the industry.

[6] Works Power Engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Mem. Am.Soc.M.E.

[7] Vice Pres., Am. Water Works & Elec. Co., 50 Broad St., New York, N. Y. Mem. Am.Soc.M.E.

[8] Engr., Turbine Dept., Genl. Elec. Co., Schenectady, N. Y. Mem. Am. Soc.M.E.

[9] District Mgr., C. H. Wheeler Mfg. Co., 1523 Marquette Bldg., Chicago, Ill. Mem. Am.Soc.M.E.

[10] Cons. Engr., 124 East 15 St., New York, N. Y., Mem. Am.Soc.M.E.

[11] Genl. Engr., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa. Assoc-Mem. Am.Soc.M.E.

[1] Production Mgr., Winchester Repeating Arms Co., New Haven, Conn.

[2] Welding Aid, Asst. Shop Supt., U. S. Navy Yard, Norfolk, Va.

[3] Supvg. Instr., Shop Practice, Stevens Inst. of Technology, Hoboken, N. J. Mem. Am.Soc.M.E.

[4] Cons. Engr., 3642 Jasper Pl., Chicago, Ill. Mem. Am.Soc.M.E.

[5] M. E., Underwriter's Laboratories, 207 E. Ohio St., Chicago, Ill. Mem. Am.Soc.M.E.

Stuart Plumley[5a] thought the paper a serious indictment of the welding and cutting industry, and that the conclusions must have been based on a limited experience. The limit of depth of cut as set by the author was too low, while the tensile strengths reported were lower than those daily obtained in industry.

E. Wanamaker[5b] spoke of three primary features, economy of gas, quality of weld, and serviceability of the welding tool.

S. W. Miller[6] presented a written discussion of the paper in which he said that he considered the investigation of great value because it would do much to clear up erroneous and even foolish statements which had been made in the past. He pointed out that a tensile test on a non-uniform or non-homogeneous specimen must be interpreted with caution. It was too frequently assumed that the weld in a steel plate was of the same character as the plate itself. The weld, he pointed out, was a casting, of necessity more or less overoxidized, and metal in this condition had very different physical qualities from the original plate. These differences in quality he then discussed, and considered also the strengths of welds in general.

Mr. Johnston, in his closure, repeated the fact that the welders used in the tests were above the average and that none of the manufacturers of the blowpipes tested had complained of their skill. He hoped that the paper would not be considered as an indictment of the industry as it had been made as a scientific investigation to point out improvements which might be made.

D. S. Jacobus,[7] discussing the paper on The Interpretation of Boiler Water Analyses, spoke of the oxygen content of the water as affecting corrosion. Air can be removed from feedwater, he said, to the necessary extent by heating it in an open heater under atmospheric pressure at about 210 deg. fahr. Considerable economizer effect is thus lost due to the reduction of the temperature difference in the economizer, $1^1/_2$ per cent additional overall efficiency being secured, on an average, by allowing feedwater to enter the economizer at the lowest practical temperature rather than at 210 deg. fahr. aside from that which results through eliminating losses at the heater.

The author has not brought out the fact that he had been working on the development of the Elliott apparatus for the removal of air at ordinary feedwater temperatures so as to obtain the additional gain of $1^1/_2$ per cent in efficiency. Dr. Jacobus described the essential features of the apparatus.

Another reason for removing air from the feedwater was in order to increase the vacuum in the main condenser. This action may be obscured through leakage at the condenser.

G. E. Pfisterer[8] said that while the corrosion of cast-iron economizers due to oxygen was almost negligible, it was serious in economizers of steel. It was his impression that considerable experience might be gained from various installations of steel and cast-iron economizers now in use as regards the corrosive effects of oxygen and carbon dioxide. Comparisons would be difficult until figures regarding maintenance of steel economizers were available.

Discussion of Mr. White's Paper on the Hydraucone Regainer

The discussion of the paper on The Hydraucone Regainer was very voluminous and consumed so much time that an adjourned meeting was necessary in order to dispose of it. On account of limited space, it is possible to give only the briefest abstract of the discussion.

Geo. R. Shepard[9] surveyed the history of the tests which were made of draft tubes proposed by competing companies when the then Hydraulic Power Company was required by the Government in 1917 to proceed with the rapid development of additional power at Niagara Falls. The Hydraulic Power Company constructed a temporary laboratory with testing equipment substantially the same as shown in Fig. 19 of the author's paper and there were tested model draft tubes submitted by the competing companies. Some of the forms in addition to the hydraucone were (*a*) a straight draft tube as long as possible in the space available; (*b*) another form similar to this but flared partly at the end and fitted with a cone in the center; and (*c*) a curved draft tube very much flattened along the horizontal portion in an attempt to conform to the natural shape of the flow lines of the water. Finally an alternate design, Model "M," designed by Lewis F. Moody and of the symmetrically flared radial-discharge type was also adopted, and the hydraucone regainer used in the Allis-Chalmers units and the Model "M" in the others. The models were of 4 in. diameter of intake.

Tests of the models showed that Model "M" with the cone in the center, while not giving as high an efficiency as the model without the cone, seemed to have more uniform efficiency at greater or less velocities.

In addition to its efficiency, there is a practical advantage in the radial-discharge type of tube due to saving in excavation which is below tailrace water elevation and in most cases difficult and expensive.

Lewis F. Moody[10] denied the implication of the author that the draft tubes of Station No. 3 of the Niagara Falls Power Co., units 17 and 18, employ the hydraucone principle. These tubes, he said, were of the spreading-draft-tube type developed by him and were conceived along diametrically opposite lines to the tubes of the author. In this form of tube the water is received between two concentric surfaces of revolution in a direction tangent to both surfaces, and is guided along and not against the confining walls, being turned along curves having as large radii of curvature as can be conveniently adopted within the space restrictions of a plant, and deceleration of the flow is gradual and continuous at every part of the passage. The deceleration of the whirl components of velocity is made gradual and continuous by guiding all parts of the flow away from the axis along the central surface, and the deceleration of the meridian components is definitely controlled by the progressive enlargement of the annular cross-sectional area between the two surfaces according to a simple rule.

H. Birchard Taylor[11] wrote that the author confirmed his conclusions that in turbines of high specific speed, poor conditions of flow will exist in any form of draft tube which is not symmetrical with the axis of the turbine. In addition to this, he further stated that for best results in draft tubes the area through which the water flows from the runner to the tailrace should be enclosed between surfaces of revolution about the axis, and that both the axial and whirl components of velocity should be gradually and continuously decelerated. The author's tube did not meet this last requirement. The Moody tube, he pointed out, satisfied all three of the requirements.

Referring to Table 2 of the author's paper, the writer said that as an important consideration affecting the efficiency had been omitted, the assumptions given in columns 8 and 10 were extremely questionable and the results in column 12 incorrect.

In conclusion the writer stated that a free jet impinging on a flat plate or any other kind of plate involving in the jet pure streamline flow is a difficult condition to secure. It is a product of a laboratory and cannot be secured even there, except under ideal conditions, from a smooth orifice or nozzle attached to a reservoir. Although the author had demonstrated that by the use of a draft tube satisfying the conditions of symmetry it was possible to secure better results than in any form of draft tube which seriously violated these conditions, it must be clearly borne in mind that it is possible to design various types of draft tubes which satisfy these conditions without properly regaining all components of entering velocity. It was in the means for decelerating the velocity that the author and Mr. Moody were fundamentally apart.

F. Nagler[12] wrote that to his mind the remarkable feature of the hydraucone was found in the fact that the water can be turned abruptly at right angles in the conoidal chamber without appre-

[5a] District Mgr., Davis-Bournonville Co., 1108 Tribune Bldg., Chicago, Ill.

[5b] Chicago, Rock Island & Pacific Ry. Co., Chicago Ill.

[6] Rochester Welding Wks., 249 Orchard St., Rochester, N. Y.

[7] Advis. Engr., The Babcock & Wilcox Co , 85 Liberty St., New York, N. Y. Past-Pres. Am.Soc.M.E.

[8] The Green Fuel Economizer Co., 1450 Old Colony Bldg., Chicago, Ill. Jun. Am.Soc.M.E

[9] Asst. Chief Engr., Niagara Falls Power Co., Niagara Falls, N. Y. Mem. Am. S c. M E.

[10] Asst. to Vice-Pres., Wm. Cramp & Sons Ship & Eng. Bldg. Co., Philadelphia, Pa. Mem. Am.Soc.M.E.

[11] Vice-Pres., Wm. Cramp & Sons Ship & Eng. Bldg. Co., Philadelphia, Pa. Mem. Am.Soc.M.E.

[12] Hydraulic Engr., Allis-Chalmers Mfg.Co., Milwaukee, Wis. Mem. Am.Soc.M.E.

ciable loss of efficiency. He was impressed by numerous instances of fairly close approach to the hydraucone principle but where the ultimate idea was not applied. Many tubes discharging against a flat plate have undoubtedly been investigated and numerous studies have been made in this country and abroad on the effect of a flat plate adjacent to the bottom of a vertical draft tube. These came under two heads:

a The work in question was done to overcome what was thought to be a positive disadvantage resulting from the proximity of the bottom of a tailrace;

b The work was performed to permit of some mechanical arrangement of cylindrical gate at the discharge of a wheel or in the attempt to apply a radial Boyden diffuser to some form of an axial-flow wheel.

The writer did not completely agree with the concluding paragraph of the paper. It could not be denied, of course, that any disturbance in the water at the exit end of a draft tube represents energy loss, but the extent of the loss was often overestimated.

L. F. Harza[12a] submitted a mathematical analysis of certain features of the author's paper and asked for additional data.

Arthur M. Greene, Jr.,[13] wrote that from Fig. 18 of the paper it seemed to him that the velocities recorded indicated a condition of disturbance, in that the various streams were moving at different velocities and were therefore moving one over the other and possibly permitting cross-flow.

Chester W. Larner[14] called attention to the fact that the author claimed to base his draft-tube design on the shape of a free jet impinging on a plate and that it was necessary to take into consideration the action of this free jet as it struck the plate if maximum recovery of velocity head was to be expected. This treatment was open to criticism for the following reasons:

1 A free jet presupposes straight-line flow, which does not occur in a draft tube;

2 The object of a draft tube is recovery of velocity head and there is no recovery of velocity head in a free jet, and

3 The author does not adhere to the free-jet principle in working out his own designs.

George F. Lovett,[15] who had been in direct charge of ten installations of the hydraucone regainer, wrote that it had been used in order to avoid the excavation of great amounts of ledge. The efficiency of the units had never been determined but their output had exceeded expectations.

Edward W. Burbank[16] wrote that as the design of the hydraucone can be changed as to its radius and as to volume of its conoidal chamber, the latter principally by placing cones of various sizes at the center of the bottom plate, it was not difficult to see that certain recently constructed regainers are in reality a variation of the hydraucone.

Arnold Pfau[17] wrote that the hydraucone regainer accomplished all that it should, namely—

1 Transforming the static suction head into pressure;

2 Transforming the kinetic energy of the discharging water into pressure, and

3 Transforming into actual head such energies as are latent in the disturbances.

Mr. Pfau added orally that he had found when in Europe recently that the turbine manufacturers there had not paid sufficient attention to the draft tube. American engineers, however, had fully realized its importance and had gone into its development far beyond those of other countries.

Joseph J. Ring,[18] writing of the research done on draft tubes and the development of the hydraucone regainer, said that the natural conclusion was that by using the hydraucone regainer with a runner of almost any specific-speed results could be obtained in the commercial power house as good as the best obtained at the Holyoke Testing Flume with the best possible testing equipment, without excessive excavation or prohibitive cost in the power house or in the hydraulic equipment used.

J. R. James[19] pointed out that the reduction of the depth of excavation was an important feature of the hydraucone regainer. He also suggested that the principle might be applied in steam plants in handling the water used in condensing. Water starting from the intake canal, passing up through the pump and through the condenser tubes and then dropping into the tailrace was in reality an inverted siphon. Therefore any method which would change velocity head into pressure head when the water enters the tailrace would help out the circulating pump to just that extent.

In the oral discussion Gardner S. Williams[20] referred to investigations he had made at Detroit and at the Cornell University laboratory regarding the flow of water and losses to pipe curvature. In 1899–1901 he had supervised tests of the hydraulic machinery of the Lake Shore Power Co. then being installed at Sault Ste. Marie and had conducted what was probably the most extensive investigation into the performance of water wheels attempted up to that time. After extended tests on a pair of wheels mounted on a single shaft and discharging horizontally in opposite directions, which was accepted practice in all low-head installations at that time, he decided to test the individual wheels with a vertical setting—something that had not hitherto been done—and the results showed a gain of 2 per cent in efficiency. He therefore felt a pardonable pride in having been the originator of the vertical setting for low-head installations. The curved draft tubes he had employed there were not very different from what had been recognized as standard elbow draft tubes for a number of years back. Along in 1912–1914 he had had an opportunity of designing a two-unit plant—the Argo Plant mentioned by the author—for a head of about 14 ft., and the draft tubes were designed by him following out his earlier investigations of the variation of velocity as water passes around a curve in a closed pipe. He had reason to suppose that the results obtained in testing that plant had made it possible for the author to carry out the experiments that had been described in the paper.

Later, in another plant, he had designed a draft tube in which four steel blades or fins projected about 8 in. beyond the wall of the draft tube, which checked the whirl of the water to a considerable degree. He felt entirely warranted in saying that for moderate heads it was possible to design an elbow draft tube that would give as high an efficiency as had yet been obtained by any other device. He did not wish to be understood, however, as saying that that was the best thing to do, the most economical or the most desirable, because it depended altogether on the conditions of the installation. The hydraucone called for a greater width than was required in the curved type of draft tube, and it was a matter of width of foundation versus depth. Conditions might be such that width would be cheaper. Generally, however, he thought that width would be less expensive, and therefore practical men would probably use the hydraucone or some similar device in the majority of cases.

C. B. Spellman[21] told of work he had done in redesigning a large, noisy centrifugal pump in which he had employed the Lorenz theory, one principal point of which was that in a right-angled bend the inner radius must be larger than the outer, which latter might even be a sharp angle. From the results of his observations in this work he believed that, referring to Fig. 18, the cone could be omitted and a sharp turn employed at the center where the velocity was very low and the pressure high.

The author in closing said that Mr. Taylor's point regarding one of the tables in the paper might be well taken; what he said regarding the whirl was true. Mr. Shepard's presentation was an unbiased statement of the facts. Mr. Moody had undoubtedly thought out and worked out his tube independently, but he had tested an identical one four years before. Fig. 18 of the paper had been developed to disprove a statement in Church's "Me-

[12a] Engr., 115 S. Dearborn St., Chicago, Ill. Mem. Am.Soc.M.E.

[13] Prof. M. E., Rensselaer Poly. Inst., Troy, N. Y. Past Vice-Pres., Am.Soc.M.E.

[14] The Larner-Johnson Valve & Engrg. Co., 1042 Widener Bldg., Philadelphia, Pa. Mem. Am.Soc.M.E.

[15] Brown Co., Berlin, N. H.

[16] Manager, Dallas Dist. Office, Allis-Chalmers Mfg., Co., Dallas, Texas. Mem. Am.Soc.M.E.

[17] Cons. Engr., Hydraulic Dept., Allis-Chalmers Mfg. Co., Milwaukee, Wis. Mem. Am.Soc.M.E.

[18] Hydraulic Engr., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

[19] Engr., The Detroit Edison Co., Detroit, Mich.

[20] Consulting Engr., Cornwell Bldg., Ann Arbor, Mich. Mem. Am. Soc.M.E.

[21] 3348 N. 22nd St., Philadelphia, Pa., Jun. Am.Soc.M.E.

chanics" to the effect that the formula $v^2 = 2gh$ is applicable to the pitot tube. He then showed several slides and concluded by saying that it should be borne in mind that the discussion was not on the relative merits of the hydraucone as compared with other devices. Competitors must and should have something of the kind, and the fact that 93 per cent efficiency had been obtained on the water wheel with the hydraucone and with another device showed that they were substantially the same thing. He would reserve extended comment until he had had sufficient opportunity to consider carefully the various discussions that had been submitted.

Power Test Codes Session

THIS session, held on Wednesday morning, Past Vice-President F. R. Low presiding, was a public hearing called for the purpose of discussing the proposed A.S.M.E. power test codes on General Instructions, Reciprocating Steam Engines, and Evaporating Apparatus. The first two codes were adopted with such slight verbal changes as the Committee might find were necessary to make them consistent with themselves and with other codes. The third code was referred back to the individual committee having it in charge for consideration at a conference to be held later with a similar committee of the American Institute of Chemical Engineers.

Railroad Session

THREE papers were presented and discussed at the Railroad Session on Thursday morning, namely: Advantages of Large Freight Locomotives, Particularly the 2-10-2 Type, by Albert F. Stuebing; The Design of Large Locomotives, by M. H. Haig; and The Necessity for Improvement in Design and Operation of Present-Day Locomotives, by H. W. Snyder. Mr. Haig's paper was printed in the May MECHANICAL ENGINEERING; the papers by Messrs. Stuebing and Snyder appear in this issue. In the absence of W. H. Winterrowd,[1] who had been selected as Chairman, Wm. L. Bean[2] presided.

In discussing Mr. Stuebing's paper, A. W. Bruce[3] wrote that it was practically impossible to compare engine maintenance costs on different roads because of the varying methods of accounting employed. It would be advisable, therefore, to adopt a uniform system which would also include electric installations.

O. C. Cromwell[4] said that in mountainous country the tunnel clearances made it necessary in designing heavy-powered locomotives to use limited bearing areas that contributed to increased cost of maintenance and kept down size of boilers. Probably more coal was burned because of lack of proper lubrication of cylinders than was wasted in any other direction. Further, machining of parts was not given the attention it should and formerly did receive.

P. R. Duffy[5] said that on eastern roads the Mallet and Mikado type engines did not appear to have as large tenders as they should have. Experience on his road for 16-hr. turn-about service had shown that the long, low tender carrying 15,000 gal. of water and 18 tons of coal was the most suitable.

Discussion of Mr. Haig's Paper on the Design of Large Locomotives

Mr. Haig's paper was also discussed by Mr. Bruce, who wrote that locomotives should be designed particularly for the work to be performed and then used for that class of work. Failures too often occurred from faulty pipe connections, fittings, etc. Proper maintenance of shoes and wedges, boxes and rods, etc., would go further toward keeping engines in service than anything else. Floating bearings if properly lubricated would give good service on main pins for main and side rods. Fireboxes should have crown and sides in one piece where possible. It might be well to consider cutting away the front part of the cab on large engines where no front door is obtainable to provide accessibility to the firebox staybolts.

Referring to the same paper, R. W. Brown[6] wrote that the New York Central had experienced more difficulty with cracks in spokes between the crankpin hub and the rim than between the hub and counterbalance. This difficulty was one for the steel foundries to remedy. There was a question whether the union link connected to the crosshead pin was as satisfactory as the long combination lever. Records of his road showed many breakages of piston rods just outside of the crosshead fit, as well as through the metal of the keyway. Rods should not have sharp corners or shoulders at the crosshead end. Cored pockets should be provided in braces where they bear against frames or other parts, so that when bolted together a full bearing area will be provided. To avoid cracking the shell, the New York Central uses a wearing plate around the boiler upon which the boiler brace angles can rest without rivets or other fastenings.

W. E. Symons[7] wrote that defects in steel castings for crossheads and other parts, shrinkage cracks, etc., could be detected by first immersing the part in benzine or kerosene, and then, after thoroughly wiping it, applying a coat of white paint or whitewash, following which the defects would be made apparent. Crosshead keys should not be driven home until given a preliminary test drive by a foreman and certified to over his signature. Forced feed for lubrication of cylinders and valves should be considered in view of the long life of packing rings in superheated-engine cylinders so equipped. It might be well to undertake an investigation to determine the relative values of grease and oil as locomotive lubricants.

C. J. Mellin[8] wrote that the Laird crosshead was suitable for slow-speed engines, but it had been almost entirely superseded by the alligator type. The introduction of the Walschaerts gear had made it possible to satisfactorily brace frames, but the design in Mr. Haig's paper seemed to him somewhat lacking in tram bracing for so large an engine.

J. G. Blunt,[9] in a written discussion, suggested that axles, boxes and bearings be standardized for the engine truck as they have been for the tender. Draw-pin bearings, center plates, side bearings and other working parts would respond surprisingly if supplied with lubricant, thus increasing hauling capacity and reducing maintenance. A frame to best resist combined stresses should follow as closely as possible the lines of a tube. It would be well to consider making the water column of steel tubing and placing all live steam pipes outside the cab.

J. E. Muhlfeld[10] wrote it was of the utmost importance to reduce weights of all reciprocating parts and that exceedingly large freight locomotives should be designed so that piston thrusts and stresses and the reciprocating weights will be distributed rather than centralized in order that excessive total rail pressures will not be produced by any pair of drivers. Locomotives should be able to double their present daily mileages. Certain means and methods that would increase locomotive starting power and hauling capacity and promote fuel economies without any considerable outlay were: Reduction of abnormal factors of adhesion by increasing working steam pressures from 5 to 20 lb.; increase in superheat; application of arched tubes in fireboxes; revision of locomotive ratings in order to utilize the increased capacity provided by the foregoing changes; distribution of locomotives over divisions and districts so as to insure maximum percentage of gross ton-miles hauled to locomotive rating ton-miles; purchase of most suitable materials for renewals and repairs; first-class enginehouse maintenance, packings, boilers, superheater, draft appliances, arches, etc.; establishment of adequate and effective central and field supervision.

[1] Chief M. E., Canadian Pacific Ry., Montreal, Canada. Mem. Am. Soc.M.E.

[2] Ast. Gen. Mech. Supt., N.Y. N.H. & H.R.R., New Haven, Conn. Mem. Am.Soc.M.E.

[3] Am.Locomotive Co., 30 Church St., New York, N. Y. Mem. Am. Soc.M.E.

[4] M. E., B. & O. R.R. Co., 702 B. & O. Bldg., Baltimore, Md. Mem. Am. Soc.M.E.

[5] Supervisor Power Plants, Western Maryland R.R., Hagerstown, Md. Assoc-Mem. Am.Soc.M.E.

[6] New York Central R.R., Grand Central Terminal, New York, N. Y.

[7] Cons. Engr., 900 Postal Telegraph Bldg., Chicago, Ill. Mem. Am.Soc. M.E.

[8] Cons. Engr., Am. Locomotive Co., Schenectady, N.Y. Mem. Am.Soc. M.E.

[9] M. E., Am. Locomotive Co., Schenectady, N.Y. Mem. Am.Soc.M.E.

[10] V. P., Railway and Industrial Engrs., Inc., 25 Broad St., New York, N. Y. Mem. Am.Soc.M.E.

F. E. Cardullo[11], who opened the oral discussion, said he felt that the developments in other lines of engineering had been such as to seriously raise the question of whether the design of locomotives ought not to be radically changed. The matter of condensation should be considered, for the arguments of 15 or 20 years ago no longer held. Radical designs should be put under way and tested to see if further advantages could not be had through rearrangement of some of the most important parts, counterbalancing, etc.

C. C. Trump[12] asked what the objections were to water-tube boilers and increasing the number of cylinders, and whether they were sufficient to offset the advantages they would give; and whether the advantages due to longer divisions and runs were sufficient to justify the use of superheaters, economizers, heaters, condensers and new methods of firing fuel.

H. Wade Hibbard[13] advocated the greatest possible rigidity in the frame, which he thought should be of box section throughout and all one steel casting. Castings of similar shape were now being successfully made.

O. C. Cromwell[4] said that if the steel castings used in locomotives were properly heat-treated their strength and durability would be increased and internal stresses largely eliminated, resulting in considerably lower maintenance charges. The location of cross-braces and brake rigging and the spring arrangement made it difficult to design a box-section frame. Broken frames could be largely reduced in number if the pedestal binders were kept tight and in place. The feet of the cross-braces should extend even further along the length of the frame than proposed by Mr. Haig in order to get more bolting in the frame to secure the casting.

E. B. Katte[14] said that he understood frames could be cast in steel integrally—the two sides cast with cross-transoms—and that in new locomotives constructed for the Paris-Orleans Railway of France these will be supplied.

Mr. Haig, in closing the discussion, said that the objection to additional cylinders was that they increased the cost of maintenance. The fire-tube type of boiler had been continued in locomotive service because it had been found to meet the conditions in a most practicable manner. With water-tube boilers wash plugs would be required at each end of each tube, the removing and replacing of which would add to the expense and would make it more difficult to clean the tubes. One-piece box-section frames had already been cast, but he did not know of any such frame actually having been applied to a locomotive. The leading objection to their use was the lack of facilities in the repair shops to care for them. The reinforcing features mentioned in the paper in connection with cylinders were intended to prevent their breaking when the heads were knocked out.

Discussion of Mr. Snyder's Paper on the Necessity for Improvement in Design and Operation of Present-Day Locomotives

A. W. Bruce[3] submitted a written discussion in which he said that the so-called floating bushing had been used on heavy-power engines on the main pin for both main and side rods, and when properly lubricated this loose bushing gave good satisfaction. The use of special steel for light parts, while desirable, was questionable until assurance could be had that the same steel would be carried in stock and used for replace parts.

H. B. Oatley[15] wrote that probably less attention had been paid to the more economic production of front-end draft than to any other detail connected with locomotive design; and that intensive work along this line was eminently desirable. There seemed to be no reason why 2 $^1/_4$-in. boiler tubes should be the upper limit in practical use. Long, small-diameter tubes unduly increased the resistance to flow of gases and would nullify to some extent the evaporative capacity unless the front-end draft was greatly increased. He had for several years advocated using 2-in. tubes when the length was from 15 to 17 ft. and up to 2$^3/_4$-in. for 30 to 33-ft. lengths, the shorter lengths being for soft coal and the longer for anthracite, oil and pulverized fuel. Domes had been gradually growing smaller and smaller. The absence of a dome however did not mean that practically dry steam could not be delivered to the superheater proper, but that the throttle, superheater (if any), dry pipe, etc., must be so arranged as to take care of the conditions. With long boilers on grades the rolling and surging would often cause slugs of water to splash up into the dome and pass to the superheater where they would deposit scale and produce deterioration.

C. J. Mellin[8] wrote that in regard to the matter of counterbalancing, the best method available appeared to be to use three cylinders and a single internal crank on the driving axle, which was a simple construction and provided room for parts of ample strength and bearings of ample size. While not giving as good a balancing effect as four cylinders, the method had the greater advantage of affording a better turning effect than any other means that might be suggested.

J. E. Muhlfeld[10] wrote that practically all of the 65,000 locomotives in the United States today were primarily improved enlargements and rearrangements of Stephenson's pioneer "Rocket," built in 1829. To improve their performance and efficiencies one of the simplest and most expedient means was to increase the boiler pressure and thus reduce the factor of adhesion. Superheaters, brick arches, feed heaters, etc., would increase sustained horsepower and promote fuel economy, but they did not materially affect the true capacity value of the locomotive, which was its starting power. With existing driving-wheel load limitations there was no reason for the factor of adhesion in freight locomotives to exceed 4 or 4.1 as a maximum when the limiting friction for dry sanded rail would allow a factor of 3 and for dry rail 4. Due to improper gas-area ratios, too few elements, or location of the superheater element rear return bends too far from the firebox flue sheet, many locomotives were being run with 50 to 100 deg. less superheat then would otherwise be obtainable. The use of 350 lb. steam pressure and 300 deg. superheat together with a more efficient boiler, improved combustion, better steam distribution and utilization of waste heat, would put the steam locomotive in a class by itself as the most effective and economical self-contained mobile power plant for the movement of fast and heavy rail tonnage.

Max Toltz[16] said that the water-tube boiler had been used by the French since 1903, particularly in Algeria They were now used on ships where in heavy seas the foundations similarly lacked rigidity. The simple engine was to be preferred to the compound, but steam pressures should be increased and superheaters employed.

W. E. Woodward[17] said that 20 years ago 70 hp. developed per five tons of locomotive weight was good practice. Now, however, 100 hp. for the same weight was common. The 3500-hp. engine at present used to pull fast, heavy trains weighed about 350,000 lb. If designed according to practice in 1900 to 1905 it would weigh at least 500,000 lb , could not be run on railroads, and would have a boiler so large that it could not be fired properly.

C. T. Ripley[18] thought that in future development work on the locomotive, the manufacturers, railroads, members of the mechanical societies and the universities with their faculties and equipment should be brought together, for their coöperative work would surely produce results quickly and at much lower costs.

In closing the discussion Mr. Snyder said that from his viewpoint the most economical railroad operation consisted in hauling the largest load possible. Capacity should be increased as it had been in marine practice, where no one would care to go back to the caravels of Columbus from the huge ocean liners of the present day.

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[11] Chief Engr., The G. A. Gray Co., Cincinnati, Ohio. Mem Am.Soc. M.E.

[12] V P., Humphrey Gas Pump Co., 401 S. A. & K. Bldg., Syracuse, N. Y. Assoc.-Mem.Am.Soc.M.E

[13] Prof. M. E., Uni . of Missouri, Columbia, Mo. Mem. Am.Soc.M.E.

[14] Chief Engr., Elec. Traction, New York Central R R. Co., 466 Lexington Ave., New York, N. Y. Past Vice-Pres. Am.Soc.M.E.

[15] Chief Engr., Locomotive Superheater Co., 30 Church St., New York, N. Y. Mem. Am.Soc.M.E.

[16] M. E., Toltz, King & Day, Inc., 1410 Pioneer Bldg., St. Paul, Minn. Past Vice-Pres. Am.Soc.M.E.

[17] Lima Locomotive Works, 30 Church St., New York, N. Y. Mem. Am. Soc.M.E.

[18] 918 Railway Exchange, Chicago, Ill.

Materials Handling Session

THE importance of machinery and its intelligent use in the building of roads furnished the topic for the first meeting session to be arranged and conducted by the Materials Handling Division. The subject was treated in the following papers which appeared in the June issue of MECHANICAL ENGINEERING: Planning and Organizing a Road Job for Mechanical Handling of Material, by C. D. Curtis; Road-Construction Plants, by B. H. Piepmeier; and Mechanical Needs in Highway Construction Methods, by R. C. Marshall, Jr. A lively discussion elicited from members and road-building contractors resulted in a successful session which laid the foundation for future coöperative gatherings between contractors and engineers.

In the written discussion William Ord[1] presented an analysis of the savings in investment and reduced overhead expenses when using one high-capacity plant instead of several smaller plants of the same total capacity as the large plant. He pointed out that with six months for actual mixing and six months for preparation twenty miles of 18-ft. road per year is a reasonable task for one plant if general conditions, such as labor, transportation and material supply, can be satisfactorily maintained.

William P. Blair[2] combatted the idea that standardization of road-improvement equipment is practical to a great degree in road-building machinery. He stated three elements of importance leading to the use of mechanical equipment, namely: reduced cost; elimination of rehandling; and proper scheduling so that no step will hinder the performance of any other portion of the organization or machinery.

In the oral discussion, E. H. Lichtenberg[3] emphasized the importance of standardization of equipment and methods of road building. He also spoke of the need for mechanical engineers to study carefully machine parts so that breakage might be eliminated as far as possible. Dean R. L. Sackett[4] compared the large road-building plant with the smaller plant, pointing out the ease of keeping up the supply of parts when a number of small similar machines were used. He also emphasized the need for protecting from grit bearings subjected to severe wear. Attention to such details of design should result in road machinery with a longer average life than four years.

Zenas Carter[5] quoted road builders of standing to the effect that proper drainage is by far the most important requirement for successful road building. Second, however, is the question of personnel, upon which he dwelt at some length. He also emphasized the need for awarding contracts to contractors who could do the work properly rather than to men who submitted the lowest bids. He stated the procedure in London, where the contractor who lays the road must keep it in condition for 15 or 20 years. Mr. Carter also advocated experimental highways in the building of which new mechanical devices might be tried out. O. B. Zimmerman[6] gave the results of his experience in the use of manufacturers' ratings in purchasing road-building equipment for the Government, where lack of a sound basis led to confusion and dissatisfaction. He suggested that the Materials Handling Division take up the standardization of ratings and parts for road-building equipment.

The afternoon was spent in the showing of moving pictures, the titles of the films being as follows: Modern Concrete Road Construction, with explanatory remarks by E. H. Lichtenberg; Methods and Machinery Used in Constructing and Maintaining Earth, Gravel, Macadam and Rigid-Surface Roads, with explanatory remarks by William Ord.

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[1] Manager Road Department, Lakewood Engineering, Co. Cleveland, Ohio.

[2] Secy. National Paving Brick Manufacturing Association, Cleveland, Ohio.

[3] Chief Engineer, Koehring Machine Co., Milwaukee, Wis. Mem. Am. Soc.M.E.

[4] Dean of Engineering, Pennsylvania State College, State College, Pa. Mem. Am.Soc.M.E.

[5] Sales Director, Austin Machinery Corpn., Chicago, Ill. Mem. Am. Soc.M.E.

[6] Export Department, International Harvester Co., Chicago, Ill. Mem. Am.Soc.M.E.

Forest Products Session

THE Forest Products Session was arranged by the organizing committee of the newly formed Forest Products Division. Robert B. Wolf, a member of this Committee and Vice-President of the Society, presided.

One paper, on the Paper Industry of America Dependent upon a Permanent Wood Supply, was presented by Hugh P. Baker, executive secretary of the American Paper and Pulp Association and formerly dean of the Forestry School at Syracuse University.

In his paper Dean Baker outlined the history of paper manufacture and showed the increase in the use of wood pulp for paper until today only 2 per cent of paper is made from pure rag stock. He spoke of the old methods of pulp grinding and pointed out that the chemical methods of reducing wood to pulp have been the basis for the rapid growth of the industry and a considerable price reduction.

Dean Baker listed the kinds of woods most desirable in the manufacture of pulp. The conifers are especially profitable because of the fiber length and ease of reduction to pulp. Hard woods have large possibilities in the paper industry.

Having shown how important a permanent wood supply is in the paper industry, Dean Baker stated that at the present time less than two-fifths of the timber in the original forests of 820 million acres is left for our industries and for constructive purposes. The traditional feeling on the part of the early settlers that the forests were a hindrance and a menace to their safety has logically developed the present attitude of indifference or opposition to forest conservation. Various estimates during the past 20 years have been made of the supplies of timber left. There are still fine forests of considerable extent, and with proper protection from fire these forest areas reproduce rapidly. Increased use of forest products makes it absolutely essential that forests be protected from fire and that progress be made in forest renewal.

The paper industry is interested in the stand of timber east of the Mississippi, for that is where the paper mills are. Of the 2215 billion board feet still standing, less than 900 billion are in this region. Of the wood taken out of the forests it is estimated that two to three per cent of the total quantity is used by the paper industry. Twenty-two per cent of the pulp used in the United States paper mills during 1920 was imported from Canada and Europe. Spruce is the most popular wood for pulp, 58 per cent of the total used being of this species.

The discussion of Dean Baker's paper centered around the utilization in the pulp mill of sawdust, shavings, sawings, short lengths, etc. Consensus of opinion seemed to be that because of the dirt always present, such waste, unless cleaned, which is an impossible process in the case of sawdust, is used with difficulty. Moreover sawdust packs, gets soggy, and therefore does not adapt itself to the process of paper making. The presence of knots in wood introduces an added difficulty. Waste wood can be rendered available only by very careful sorting. Furthermore all present were agreed that the economic utilization of wood waste was not so important an item as that of getting waste out of the way. In lumber-using factories it was therefore generally better to burn the waste, even though in some cases it might be necessary to install special apparatus for the purpose. A number of those present told of practices in the more economical use of wood waste which had considerably reduced the fuel bills of their factories. It was stated that sawed blocks of mixed woods, after having been thoroughly cleaned, might be used in the soda process of pulp making. The chairman pointed out that the largest waste in a paper mill is waste in the utilization of the intelligence of the workman, due primarily to lack of proper provisions for showing him the best methods and to lack of records so that intelligent work may be properly rewarded.

A resolution was presented to the meeting in which it was recommended to the Council that the Society go on record as in favor of a systematic forest policy promulgating definite plans by means of which, with the coöperation of public and private agencies, a prompt solution may be found for this extremely important national problem.

At the closing of the meeting the following executive committee of the Division was elected:

Group of A.S.M.E. Members at Rock Island Arsenal

Grant B. Shipley, president, Pittsburgh Wood Preserving Company, Pittsburgh, Pa.

Thomas D. Perry, vice-president and secretary, Grand Rapids Veneer Works, Grand Rapids, Mich.

Sern Madsen, mechanical engineer, Curtis Companies, Inc., Clinton, Iowa

Charles E. Paul, consulting engineer, National Lumber Manufacturers Association, Chicago, Ill.

Carle M. Bigelow, chief industrial engineer, Cooley & Marvin, Boston, Mass.

O. H. L. Wernicke, vice-president, Pensacola Tar & Turpentine Company, Gull Point, Fla.

Power Session

At THE Power Session, Thursday morning, Samuel Insull[1] presiding, two papers were presented: Location and Distribution of Central Station Power in the Middle West, by W. L. Abbott, and Future Power Development in the Middle West, by C. W. Place. Mr. Abbott's paper is printed elsewhere in this issue. Mr. Place's paper, which will appear later in Mechanical Engineering, dealt with certain phases of the question of power production and use. In it he outlined a system in which the fairly efficient steam power plants in the 100 odd cities of over 25,000 population in the 14 central states would be interconnected, not by heavy high-voltage lines, but by lines which would pick up the small town and village load to the point where its next larger neighbor would take its share; hydroelectric plants would be installed on the streams near the towns and villages, each with a small pondage; the steam stations would carry the steady continuous load above the maximum stream flow and the hydroelectric plants would automatically come on to carry the peaks. On the off-peak period the hydroelectric plants would restore the pondage and carry local load. The quickness with which the latter could get on the line (12 to 30 seconds) would enable the steam stations always to work at maximum efficiency. Mr. Place took occasion to urge engineers to use their power of straight thinking to assist the civic, political and financial interests in arriving at right conclusions.

In opening the discussion Chairman Insull pointed out that the great interest developed recently in the subject of the location and distribution of central-station power in the Middle West was undoubtedly due mainly to the taxation of transportation facilities during the war. It took that war to convince the country that concentration of production of energy was in the interests of the whole people. The superpower scheme as presented in the East was very good in itself, but he believed that if engineers would pay more attention to similar projects in their immediate localities they would accomplish more than by considering the matter as a general proposition. It was seldom that there were ample supplies of feed and condensing water where coal was produced economically. A proper location of power stations and economic tying up of existing facilities would relieve the railways of some of their burdens, hasten the day when their power would be furnished more economically than by steam locomotives, and afford an opportunity of supplying electrical energy to every hamlet and farm as cheaply as it was done in large cities.

W. E. Bryan[2] said that the United Railways of St. Louis used about half of the energy generated at the Keokuk hydroelectric plant. In order to insure continuity of supply, however, they felt it necessary to have installed in St. Louis considerably more steam-generating equipment than was needed to care for the loads day in and day out.

Geo. A. Orrok[3] said that the point had not yet been reached where an electric transmission line could be built that was proof against the direct stroke of lightning. It was therefore necessary to have practically a full steam reserve if dependence was to be placed on a long-distance line and where continuity of service was the desideratum.

As to the use of spare hydro power to pump water up to a storage reservoir to be used through a turbine and generator at the time of the peak load, this was practicable if a natural storage pond was available near by, but to build a reservoir of any considerable size would cost more than could be gotten out of it.

John A. Stevens[4] spoke of interconnection of stations in England, where under the rulings of the Electricity Commission it was allowable to draw on the less efficient stations only when their capacity was required. In Italy provision was made by the government for the protection of the investment in those stations in an interconnected system where the cost of producing energy was higher than in the others.

Chairman Inull in closing the discussion told of the development of interconnection in Illinois and neighboring states. Already there was practically a continuous system of distribution extending from Minneapolis southward to St. Louis and Louisville save for gaps totaling about 120 miles. The diversity of demand existing between city and country would go a long way toward providing a load factor that would amount practically to continuous use. No concern should be allowed to generate energy that would cost more than it could be bought for. He had advocated regulation for 25 years and believed that the various state utility commissions should be empowered to regulate the industry much more drastically than formerly along economic lines, for it was just as interstate in character as the railway and the telephone.

Aeronautic Meeting at McCook Field

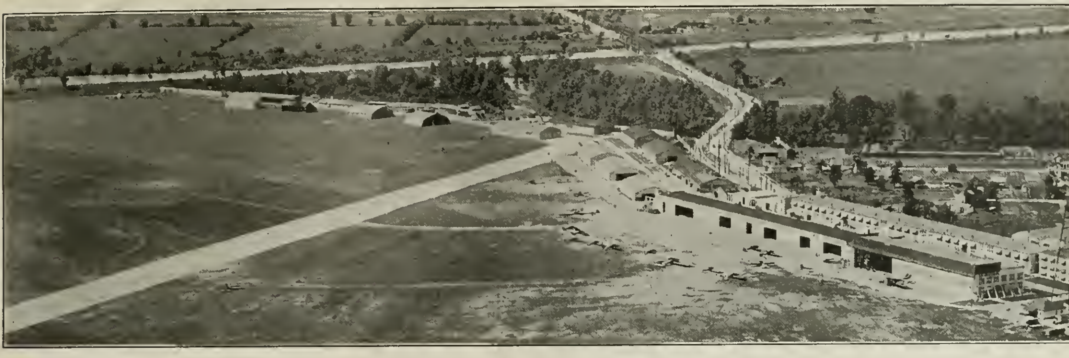
The visit of the Society to the McCook Field Air Service Station on May 21 was something more than a sight-seeing pilgrimage to a point of engineering and patriotic interest. It was a plan instituted by the new Aeronautic Division of the Society to develop the interest of the membership, and the engineering profession in general, in the national aviation policy, both govern-

[1] Pres. Commonwealth Edison Co., 72 W. Adams St., Chicago.

[2] Supt. Power Stations, United Railways Co. of St. Louis. Assoc-Mem. Am.Soc.M.E.

[3] Consulting Engr., New York City. Mem. Am.Soc.M.E.

[4] Consulting Engr., Lowell, Mass. Past Vice-Pres. Am.Soc.M.E.

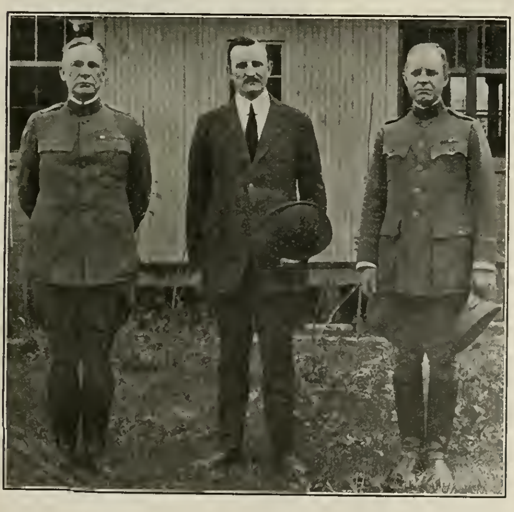


Airplane View of McCook Field

mental, through the Air Service, and commercial, which latter should be of especial concern to all of us.

The Air Service officers at Dayton, as well as their superiors in Washington, were successful in stimulating the engineers who participated in the trip to the realization that progress in the art from now on was to a large extent dependent upon their sympathy and support, and that if the United States wished to develop an efficient defense arm in the air, coöperation between governmental and industrial agencies should be developed as rapidly as possible.

The Society of Automotive Engineers, which has done so much valuable work in this field, participated in the visit. The S. A. E. members were on their way to their own spring convention at West Baden, Indiana, just as ours were to our Chicago convention. The registration at McCook Field was 203; twelve states were represented. There were of course large contingents from Dayton, Cincinnati, and Springfield, Ohio.



From left to right—Col. C. L'H. Ruggles, Chief of Technical Staff; E. S. Carman, President A.S.M.E.; and Lt-Col. Harry B. Jordan, Commanding Officer, Rock Island Arsenal.

The Air Service had prepared an elaborate program, which was carried out to the letter, with the result that ample time was available for all events.

The arrangements at the Field were in charge of Major Thurman H. Bane, Commanding Officer; Major George E. A. Hallett, Mr. Glenn Martin, and Mr. Joseph A. Steinmetz, chairman of the A.S.M.E. Aeronautic Division. The officers at the Field all assisted; of these Lieut. E. E. Aldrin is secretary of the Executive Committee of the Society's Aeronautic Division.

Distinguished visitors were Messrs. F. Handley-Page and Griffith Brewer of England, and Orville Wright and C. F. Kettering.

Promptly at ten in the morning the visitors assembled and Major Bane outlined the program of the day. The forenoon was given over to inspections of the materials laboratory, the shops, and the power-plant laboratory—all splendid examples of engineering practice embodying many features of interest.

A unique feature was the armament-testing laboratory, at which exhibitions of synchronized firing attracted much attention.

Then came an inspection of airplanes on the line—thirty-one machines in all, ranging alphabetically from Caproni to Thomas-Morse, and from bombers and pursuit to honeymoon express in type. Sixteen of these machines were flown.

Following a splendidly served lunch at the Field's cafeteria, there was a professional session in the Auditorium, with papers by E. H. Dix, S. D. Heron, Bayard Johnson, C. F. Taylor, Gerald P. Young, O. E. Marvel, G. W. Stevens, and A. O. Russell, all of the Air Service Station. The respective subjects were Aluminum Cylinder Castings; Air-Cooled Airplane Motors; Airplane Radiators; Carburetor Problem on Aircraft Engines; Color Camouflage; Radio Apparatus, Including Direction Finders; Aerial Photography; and Machine-Gun Synchronizers. These papers will be abstracted in a later issue of Mechanical Engineering. Chairman Steinmetz presided at the professional session.

In the evening the visitors and their ladies enjoyed dinner in the beautiful building of the Dayton Engineers' Club. Messrs. Kettering, Handley-Page, and Steinmetz were the speakers, and the trend of their remarks was the necessity for the development of commercial aviation. Mr. Handley-Page recounted the developments in Europe along this line, while Mr. Kettering urged the production of a reasonably priced commercial machine, without which the public could not be expected to take up flying.

The last event on the program was a military ball given by the officers of the Field and held at the Miami Hotel.

The thanks of the Society are due to all the officers of the Air Service who contributed to the success of the day at McCook, which was acknowledged by everyone as a pleasurable as well as a profitable opportunity to show our interest in the magnificent work the Air Service is doing.

Rock Island Excursion

About forty of those attending at the Chicago meeting went to Rock Island on Thursday night, joining with some sixty engineers from the Tri-Cities Section for the events at Rock Island and Davenport. They started with a trip of inspection through the Rock Island Arsenal where Col. Harry B. Jordan, Commanding Officer, conducted the party through the modern shops in which

(Continued on page 499)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

First Motorship with Double-Acting Two-Stroke-Cycle Engines

By R. DREVES

THE present article is of interest not only as describing an important project in motorship construction but also as illustrating the German method of going about the job of solving technical problems where experiments on models are not feasible.

The years 1909 and 1910 were signalized by a rapid growth of interest in Diesel engines, owing to the expiration of the life of the original Diesel patents. At that time the Augsburg-Nuremberg Engine Co. and the Blohm & Voss Shipbuilding Co. in Hamburg jointly formed a research corporation to develop large oil engines for ship use, and, in particular, for use on warships. It was decided at that time that the Diesel engine best suitable for this purpose would be of the double-acting two-stroke-cycle type.

As the first step in this development it was decided to build comparatively small units so as to keep within bounds the cost of experimentation. At the same time, in order to test the engine not merely on the testing stand but under actual conditions of operation, the Blohm & Voss Co. decided to lay down in its yards for for its own account a double-screw experimental freighter to be equipped with double-acting two-stroke-cycle engines. The actual work started in 1910—the ship to have an overall length of 106 m. (347.6 ft.) and a deadweight of 3083 registered tons.

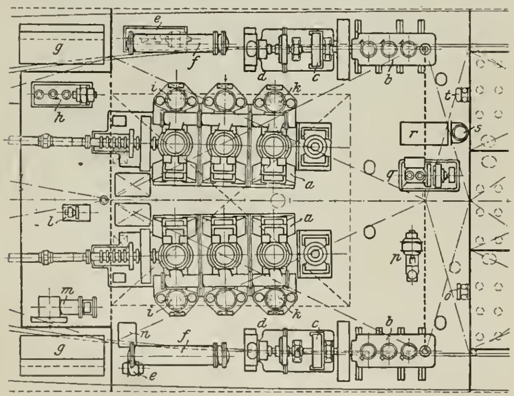


Fig. 1 Engine Room of the Motorship *Fritz*

The first three-cylinder unit could not be put into the ship because while on the test stand cracks appeared in the cylinders. Its engine was, however, used for experimental purposes and as a basis for the design of a new unit. This latter had working cylinders of 480 mm. (18.9 in.) bore by 710 mm. (27.9 in.) stroke, with an output at 120 r.p.m. of 830 s.hp. The fuel-injection compressor built as a three-stage unit was driven by a crank from the extension of the main crankshaft, an arrangement which since has become fairly universal. This compressor has bores of 510, 445 and 115 mm. (20, 17.4 and 4.55 in.) and a stroke of 350 mm. (13.75 in.).

The three scavenging pumps of 650 mm. (25.60 in.) bore and 500 mm. (19.6 in.) stroke were driven from the crossheads of the working cylinders, while the six-cylinder fuel pump of 11 mm. (0.43 in.) bore and 60 mm. (2.36 in.) stroke was driven by an eccentric from the camshaft.

Furthermore, the bilge pumps and fresh-water pumps for the piston cooling were driven by means of a rocking lever from the first and third cylinder.

In designing the engine the question of reliability was made paramount, while weight and cost of construction were secondary and even fuel consumption was treated as being subordinate to reliability. As regards weight, it was decided that the Diesel engine should weigh about as much as a steam engine of similar output. Because of this, not only the bearings but bedplates, foundations and other parts were made of unusually generous size. If it had been desirable to keep down the weight many parts

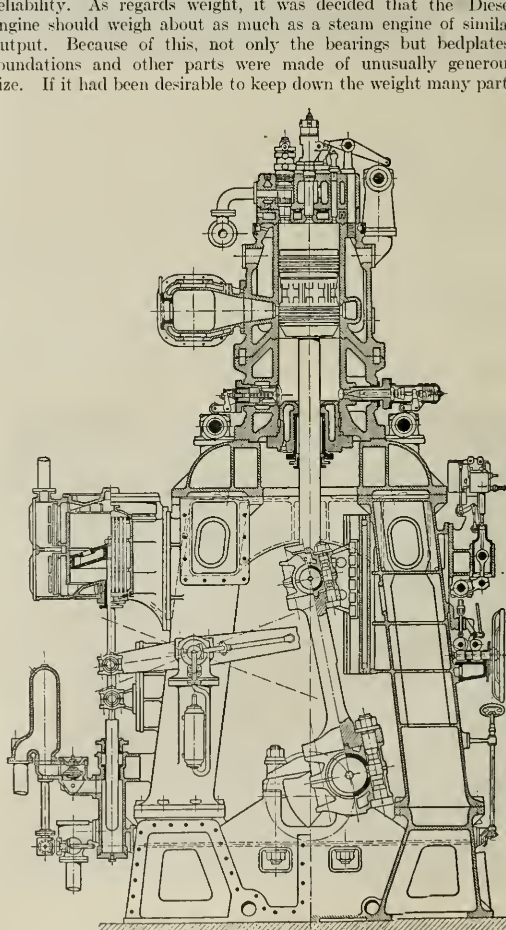


Fig. 2 Cross-Section of Main Double-Acting Two-Stroke-Cycle Diesel Engine

could have been made at least 50 per cent lighter. No effort was made to keep down the length of the engine since this was so small anyway that the size of the engine room was determined not by the dimensions of the engine but by the location of the auxiliary machinery, as may be seen from Fig. 1. This, for example, made it possible to design a crankshaft in the manner usual with marine engines, namely, in three parts with two bearings between each two crankshafts. This tended to make the loads on the bearings extremely light, which was further assisted by the fact that in

double-acting engines the variations of pressure on the bearings are more favorable, giving them a longer life than is the case with single-acting engines. As a result of this, it proved to be possible to operate the bearings just as in steam engines—without forced lubrication, and this, in its turn, permitted making the engines open-type and thoroughly accessible in all their parts, which was particularly desirable as it made it easy to inspect the stuffing boxes on the piston rods. It may be mentioned in this connection that during the entire period of very extensive series of tests these stuffing boxes have never given any trouble. Fig. 2 shows a cross-section of this engine.

The working cylinders are made up of two parts. At the bottom of the cylinder, which constitutes the upper part of the columns and reinforces it crosswise, is located the lower part of the double-acting working cylinder which is closed at the bottom by a special head.

In the upper head the valves are set in the usual manner and comprise one starting valve, one fuel-injection valve, two scavenging valves and one safety valve. In the lower cylinder head there are two fuel-injection valves, two scavenging valves, a starting valve and a safety valve.

The arrangement is such that the valves are easily accessible to the engine personnel and can be withdrawn in a very short time without disturbing any other part of the engine mechanism.

The starting valve is built as a balanced valve and is operated by compressed air. Fig. 3 shows the starting valve for the upper half of the double-acting cylinder. The valve opens with air admission to, and closes through air exhaust from, the air chamber over the distributing piston, the air being governed by means of the starting throttle. Each starting valve is equipped with two starting throttles located in the same housing, one being intended for forward and the other for reverse running of the engine. The needle of the fuel valve opens into the cylinder, but can be adjusted without trouble from the outside.

The working pistons are in two parts. The lower part is attached

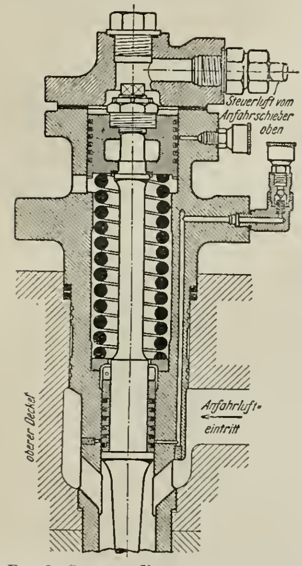


Fig. 3 Starting Valve of the Upper Part of the Cylinder of the Double-Acting Two-Stroke-Cycle Engine

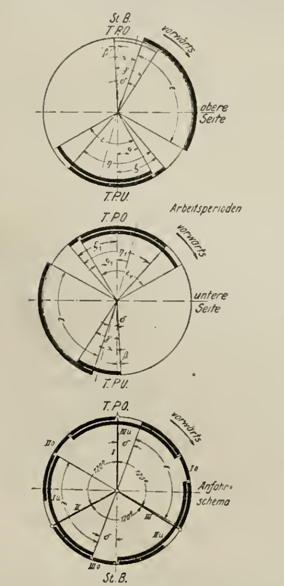


Fig. 4 Valve Diagrams of the Double-Acting Two-Stroke-Cycle Diesel Engine

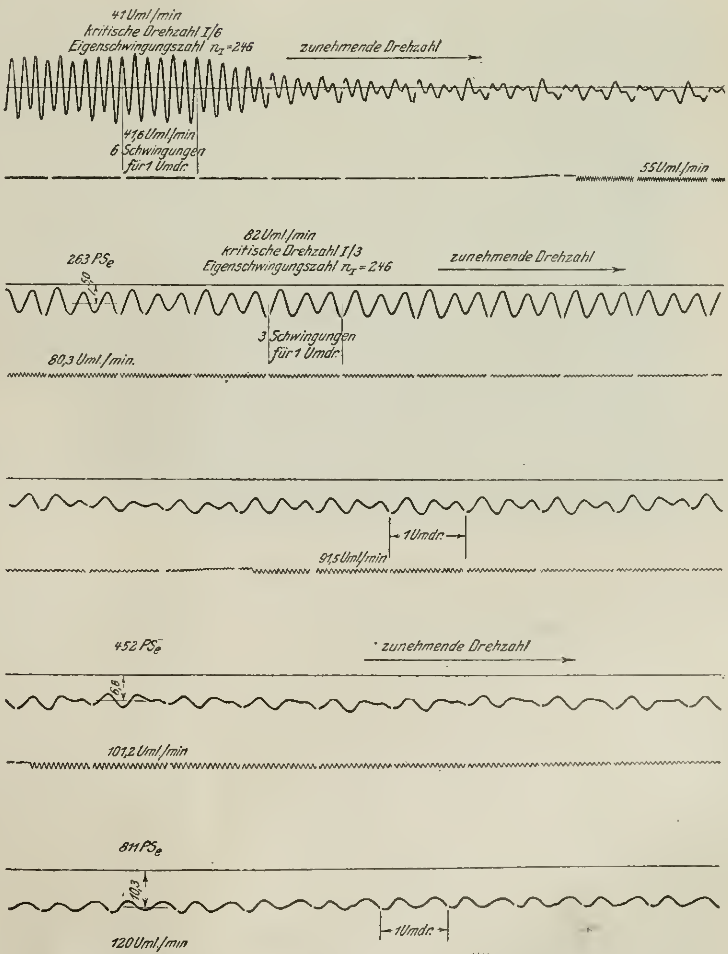


Fig. 5 Torsion Diagrams of the Reconstructed Diesel Engine Taken by Means of a Frahm Torsion Indicator

to the piston rod and carries a cast-iron upper section from which it may be separated by sheet-iron disks, the volume of the combustion space varying with the number used. The piston in each half of the cylinder is equipped with five cast-iron rings held so as to make their rotation impossible.

The valves are operated by cams. The upper valve set is operated by means of a single camshaft, while in the lower set there are two camshafts—one in front and the other back of the cylinders, all three camshafts being driven by gear wheels in the same manner as other Diesel engines built by the company, generally referred to as "MAN," its German name being the Maschinenfabrik Augsburg-Nürnberg.

The engines were very extensively tested both on the testing stand and in the ship. Before the first of the two engines was put into the ship it was subjected to a test equivalent to six days of uninterrupted travel, then 12 hr. of maneuvering, 3 hr. of reverse

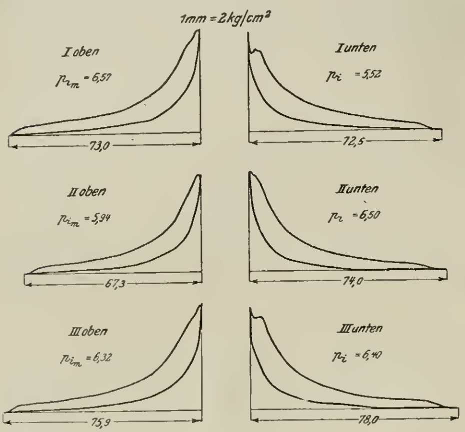


Fig. 6 Indicator Diagrams Taken During the Second Trial Run

running, and 4 hr. of slow-speed travel. The second engine was tested in the same manner. (It is not quite clear, however, how the first engine was tested in this manner *before* it was installed on shipboard.)

The fuel consumption proved to be 225 grams (0.48 lb.) per hp-hr. with an overall efficiency of 72 per cent. The mechanical efficiency, taking into consideration the indicated output of the scavenging pump and compressor, was 89 per cent. It would be difficult to expect anything better from a comparatively small engine. When the engine was tested on shipboard important disturbances appeared through the rise of oscillatory motions with amplitudes which previous experience did not lead one to look forward to. In fact, certain speeds of rotation could not be employed at all without endangering the entire installation and could be obtained only with unusually heavy fuel consumption. The conditions were made still worse through the fact that the cruising speed of 120 r.p.m. happened to be within the critical range of the engine. Important alterations had to be made in order to get away from this situation.

After the engine was rebuilt measurements were made by means of a Frahm torsion indicator developed in the meantime and some of the torsion diagrams are shown in Fig. 5. From these can be seen the uniformity of running at the higher speeds. At 82 r.p.m. and 41 r.p.m. are located the two critical speeds of the third and sixth order. Further measurements were carried out on submarine engines both on the testing stand and on board a submarine, and data collected in this way are now used by Blohm & Voss in the design of their commercial heavy-oil engines. So that while it is still impossible to compute the oscillatory disturbances which may arise at certain higher speeds, sufficient data are available to make it possible to design engines in such a manner as to keep on the safe side.

The first experimental run on the motorship *Fritz* was undertaken on the River Elbe in May 1915, lasted 8 hr. and was free from any trouble. The fuel consumption proved to be 160 grams per i.hp-hr. (0.35 lb.) with an average output of 1093 i.hp.

The next test run could not be undertaken until September 1919. During these test runs the diagrams of Fig. 6 were taken showing the operation of the upper and lower ends of the various double-acting cylinders.

In accordance with the Peace Treaty the motorship was surrendered to England. It is of interest to note that the firm of Blohm & Voss called the attention of the British Government to the fact that the ship was of a merely experimental character and that at least a few more sea trips ought to be undertaken to determine the reliability of the various apparatus. The firm therefore made a proposal to the British Government that a few more runs should be undertaken in the Baltic. The British Government accepted this proposition and in November 1919 an acceptance run was undertaken. The ship encountered very heavy weather but reached England safely.

Since that date the two German concerns working in coöperation have undertaken and executed the construction of marine engines of the type described here, but of very much greater dimensions. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 18, Apr. 30, 1921, pp. 459–462, 18 figs., *dA*)

Centrifugal Casting Processes

HUME CENTRIFUGALLY MADE CONCRETE PIPE

DESCRIPTION of a process for the manufacture of concrete pipe by centrifugal deposition as carried out by a company in South Africa. The pipe is reinforced with steel and the first step in its manufacture is the preparation of the reinforcement. As the plant is located not far from the gold-mining district of the Witwatersrand, it is able to make use of the discarded mine-haulage cables for this purpose.

The cables are delivered at the pipe works in coils and are first degreased, which is necessary as cement will not adhere to any material that has a greasy surface. The grease is burnt out in a wood fire, the wire being somewhat annealed at the same time.

After a coil has cooled down it is unraveled with the help of specially designed machines. This is followed by spooling the wire, the spools being then transferred to the machine on which the reinforcement cylinders are made.

A spool of wire is placed on a spindle, set vertically, and fixed, a few feet from the machine. The end of the wire is drawn forward and threaded through a series of three pulleys on a traveling feeder, these pulleys serving to keep the wire tight. The feeder itself is part of the reinforcement machine, along the base of which it is drawn by chains in a direction parallel with the cage core.

The reinforcement or "cage" is built on a round horizontal core consisting of four radially collapsible sections.

The molds are two-piece cylinders made of galvanized iron and are greased inside to prevent the cement from adhering. The reinforcement is then inserted and the end caps bolted in position. These end caps are broad, flat rings, the inside diameter of which is the inside diameter of the pipe to be made, the desired thickness of the pipe wall being exactly secured by the use of rings or end caps of the proper dimensions.

The pipe-making machines each make six pipes in one operation, the duration of which may be anywhere from 12 to 20 min. according to the size of the pipe.

In making the concrete for low-pressure pipe, Pretoria cement is used with sand and specially selected $^1/_4$ to $^1/_2$-in. grit in the proportion of 2 to 2 to 1; for high-pressure pipes sand and cement are used in the proportion of 2 to 1. The material is prepared in rotary

into the mold. When the molds have received sufficient concrete the speed of the machine is increased. This speed varies with the size of the pipe and, for instance, for a 4-in. pipe is 360 r.p.m., while for a 6-ft. pipe it is 48 r.p.m.

One of the important features about the Hume pipe is the great denseness of the material. The following tests have been made to prove this. An ordinary 12-in. mold without reinforcement was filled with concrete and rammed in by hand as tightly as it would go. In other words, the same process was followed as one might use to make a solid concrete column. The mold was then placed in the machine and rotated for a period at the speed required for the making of an ordinary Hume pipe. The mass was then examined and was found to have developed itself into a pipe with an internal diameter of $3^1/_2$ in., which would mean that the 12-in. column as originally made had a volume of air-filled spaces between particles equivalent to a pipe $3^1/_2$ in. in diameter and that by the centrifugal action this was packed solid.

The pipe has also a rather unusual joint. The end of each pipe is so molded that instead of a flat surface a groove of a peculiar shape is produced, this groove being such that its deepest portion lies toward the inner periphery of the pipe, while it becomes shallower as it reaches the outside periphery. When two pipes are brought together their edges enclose a cone-shaped space, the apex of the cone being toward the outside of the pipe, and this space is filled by the pipe layer with a special plastic compound.

A sleeve of concrete also goes over the joint and its inside diameter is a little larger than the outside diameter of the pipes. The annular space thus formed is filled with a mixture of sand and cement, which is calked or rammed into position exactly as lead is used for jointing iron and steel pipes. The practical effect of this system of jointing is that the greater the pressure of water in the pipes, the more resistant to leakage becomes the joint.

It is claimed that the Hume pipe never bursts and that when the pressure is increased beyond a certain point the pipe merely begins to "weep." If the pressure is further increased sprays of water appear, but there is no burst; moreover, when the water pressure is reduced to normal the pipe is just as efficient as it was before. In other words, the strain does not cause any deterioration. (*The South African Journal of Industries*, vol. 4, no. 3, March-April 1921, pp. 224–235, illustrated, *dA*)

the works of the George C. Clark Metal Products Company, Detroit.

The process appears to be one which requires a high grade of skill and knowledge at practically every stage. Beginning with the handling of the metal, it would appear that positive methods must be employed that will permit the band to be cast at the most desirable temperature, as otherwise the physical properties of the compound will not be right.

The metal is cast in down-draft melting furnaces of 3000 lb. capacity each, and from the furnaces is poured into ladles of a capacity sufficient for three bands. It is hauled to the casting room by means of an overhead trolley system and extra precaution is taken that the metal does not oxidize while on its way there.

The casting machine is shown in Fig. 1. Its principal parts are the die and die holder, the movable spout and the metal-pouring attachment. The holder is made of plain carbon-steel wire; the die or liner is a specially heat-treated forging. A hinged cover plate of the same diameter as the holder and having an opening large enough to accommodate the pouring spout is made to open and close on the side of the die and holder. It is said that the life of a liner is such that about 250 bands may be cast before it is burned out and replaced.

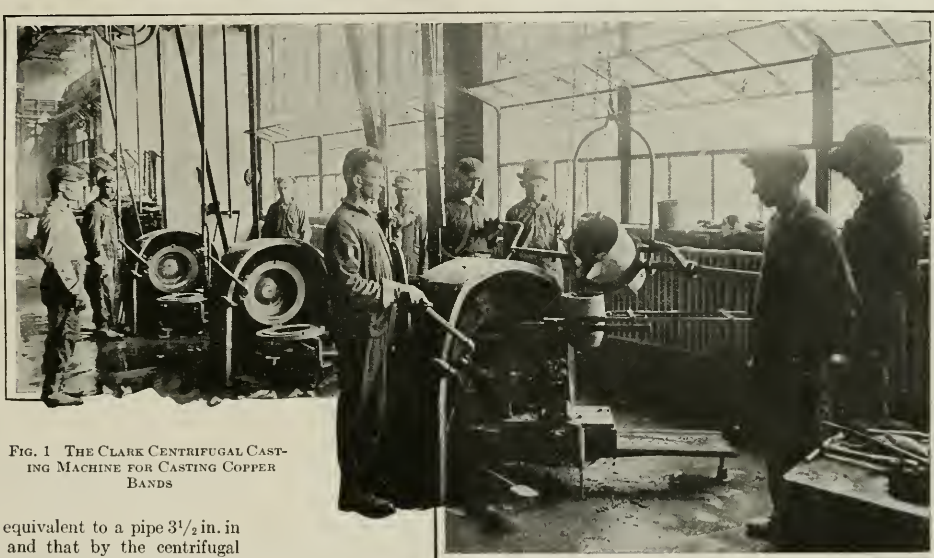


Fig. 1 The Clark Centrifugal Casting Machine for Casting Copper Bands

It is obvious that all revolving parts must be in absolute balance, as otherwise the band will not come out true. The metal is poured through the spout so arranged that it can move in and out of the die. Pouring is done by tilting the small crucible in the machine so that the metal will flow through the spout into the die. While the machine is still in motion the spout and crucible are pulled back out of the way, and when the band shows the desired color for annealing, a stream of water is turned on the band. After the band has sufficiently solidified and has received the proper annealing, the water pipe is taken back out of the way, the cover plate is unscrewed and the band removed from the die. After the band is cast it is necessary to keep the lip of the pouring spout clean as a certain amount of metal clings to its side and has to be removed by hand with a chisel. The bands themselves are then machined.

It is stated that the most successful bands made are of the larger

diameters, 10 in. and up, and that the percentage of rejected castings made by this process is small. (*The Iron Age*, vol. 107, no. 20, May 19, 1921, pp. 1289-1292, 4 figs. *d*)

TESTS OF CENTRIFUGALLY CAST STEEL

By Dr. Geo. K. Burgess

In an abstract on this subject printed on page 334 of Mechanical Engineering for May 1921, a statement was made that the distribution of carbon in the metal is not uniform, but the character of the lack of uniformity was not indicated.

In view of the importance of centrifugal casting as a recent development, Table 1, taken from the more complete publication

TABLE 1 HARDNESS AND CHEMICAL SURVEYS

Casting Number and Wall Thickness,	Zone[1]	Brinell	Scleroscope	Carbon per cent	Manganese per cent	Silicon per cent	Sulphur per cent	Phosphorus per cent	Nickel per cent	Copper per cent	Chromium per cent
No. 1	1	186	25.8	.44	.44	.47	.024	.011	2.33	.084	...
	2	186	24.9	.48	.44	.47	.030	.013	2.35	.089	...
3½ in.	3	187	25.0	.46	.44	.47	.032	.013	2.32	.085	.04
	4	187	25.2	.46	.44	.48	.032	.014	2.36	.094	...
	5	196	25.7	.50	.44	.47	.034	.015	2.39	.089	...
3A	1	160	22.3	.33	.54	.19	.022	.015	2.66	.051	...
	2	164	22.2	.32	.55	.19	.030	.014	2.67	.053	...
3 in.	3	167	22.4	.32	.55	.19	.032	.015	2.70	.051	.04
	4	167	22.6	.34	.57	.19	.034	.016	2.75	.055	...
	5	160	22.3	.34	.57	.20	.030	.017	2.70	.054	...
3I	1	158	21.9	.30	.55	.20	.031	.012	2.66	.062	...
	2	159	22.0	.30	.55	.19	.030	.013	2.67	.062	...
3 in.	3	158	22.0	.30	.55	.20	.030	.015	2.68	.067	.04
	4	156	22.5	.34	.57	.20	.030	.017	2.76	.068	...
	5	184	23.9	.35	.57	.21	.030	.018	2.70	.065	...
4	0	...	....	.16	.47	.27	.054	.045	....	....	...
	1	125	19.7	.16	.50	.29	.045	.033	....	....	...
	2	...	20.4	.16	.51	.28	.045	.033	....	....	...
2¼ in.	3	128	20.6	.17	.50	.28	.049	.037	....	....	...
	4	...	20.0	.18	.50	.29	.053	.038	....	....	...
	5	121	19.2	.21	.52	.29	.060	.043	....	....	...
	6	...	....	.18	.40	.22	.066	.059	....	....	...
5	1	249	63.5	.64	.56	.65	.033	.014	2.94	....	...
	2	...	60.6	.65	.56	.65	.032	.015	2.92	....	...
3¼ in.	3	248	58.0	.63	.55	.64	.029	.015	2.93	....	tr..
	4	...	55.5	.63	.55	.64	.031	.017	2.93	....	...
	5	245	57.0	.72	.60	.68	.033	.017	2.90	....	...
6	1	164	23.4	.32	.56	.19	.034	.015	2.69	.059	...
	2	166	23.4	.33	.56	.19	.035	.015	2.75	.058	...
3½ in.	3	161	23.4	.31	.56	.19	.039	.015	2.72	.059	.04
	4	167	23.8	.33	.57	.19	.032	.015	2.76	.064	...
	5	191	25.2	.35	.57	.19	.033	.016	2.81	.064	...
7	1	...	....	.22	.54	.26	.026	.013	....	....	...
	2	123	....	.21	.53	.25	.026	.014	....	....	...
½ in.	3	...	....	.25	.55	.25	.026	.016	....	....	...

[1] Zones numbered from outside to inside of casting.

of the paper by Dr. Burgess, is of interest, as it shows that throughout the main part of the body of the centrifugally cast tube the distribution of carbon and other alloying elements is very uniform indeed, and it is only in the inner ring, which may be from 1/32 to 1/16 in. thick, that there is an increase of the lighter elements such as carbon or phosphorus, due evidently to the classification produced by centrifugal action. (*Transactions of the American Society for Steel Treating*, vol. 1, no. 7, Apr. 1921, pp. 370–382, *eA*)

CENTRIFUGALLY CAST CAST-IRON PIPE

By Prof. Peter Gillespie

Description of the De Lavaud process of centrifugal casting of cast-iron pipe as carried on commercially in Canada.

The pipe is cast on the inside of a horizontal water-cooled rotating cylinder revolved on its axis by an impulse water wheel integral with itself and flared at one end to give the proper contour to the bell. The mold revolves in a cylindrical stationary casing and is supported at two points in its length by two pairs of friction rollers which are carried on the inside of this casing. In the manufacture of 6-in. water pipe the speed of revolution is about 550 r.p.m.

The molten metal is introduced into the mold by a cantilever spout which receives its supply from a tilting ladle operated by hydraulic pressure. The iron for the bell end is first supplied, immediately following which the casing and mold are moved backward by hydraulic means on horizontal ways away from the ladle and spout, thus enabling the latter to supply the metal continuously from the body of the pipe right out to the spigot end. The mold continues to rotate for perhaps 15 sec. after the last of the necessary iron has been supplied.

As it comes from the mold the iron is chilled and must be annealed. This annealing in a special furnace takes from six to seven minutes, after which the pipes are allowed to cool in still air.

Centrifugally cast pipes are lighter than sand mold pipes of similar bore, and, for example, in 4-in. size the standard C class weighs 23.3 lb. per ft. and the centrifugal pipe 15 lb.

The metal in centrifugally cast piping is of a dense, homogeneous character and the pipes are smooth inside and out. Tests were carried out by the writer at the University of Toronto on pipes and pipe material made by sand casting and spinning and it was found that roughly the tensile strength of the specimens from centrifugally cast pipe was 2.3 times as great as that for specimens cut from sand-mold pipes. In every other test the centrifugal modulus of elasticity was 2.3 times greater for machine-made pipe than for ordinary pipe, and a 6-in. pipe with walls 0.28 in. thick was found capable of sustaining an internal hydrostatic pressure of 1250 lb. per sq. in. without failure.

The pipe is manufactured in Canada by the National Iron Corporation, Ltd., Toronto. (*The Canadian Engineer*, vol. 40, no. 19, May 12, 1921, pp. 454–455, 4 figs., *d*)

STEEL-TUBE CASTING

Description of a process for the centrifugal casting of pipe in which the metal is melted electrically in the same mold in which it is subjected to the spinning process.

The process is carried on in four stages, the first consisting of casting the metal in bars of approximately the same weight and length as the final tube. These bars, together with such additional metal as is necessary, are placed into the mold which consists essentially of an outside steel shell, a refractory lining, and a graphite lining. The molds with the metal inside are closed airtight at both ends and placed in a rack where electric current is supplied to the terminals from a bus bar. They are left on the rack until the metal inside has thoroughly melted, and are then transferred to the spinning machine.

The spinning continues until the metal has solidified, the time varying with the kind of metal and to a certain extent with its external temperature. When the metal in the tube has set, it is allowed to cool until the contraction of the diameter of the tube is sufficient for it to be pulled out of the mold. It is then subjected to such heat treatment as may be necessary.

The advantages claimed for this process are its practically automatic character, permitting the use of unskilled labor; ability to control very strictly the temperature and composition of the metal, and the absence of gases in the mold. (*The Iron Age*, vol. 107, no. 20, May 19, 1921, p. 1300, 1 fig., *d*)

The Failure of Metals Under Internal and Prolonged Stress

At a joint meeting of the Faraday Society, the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institue of Metals, the North-East Coast Institution of Engineers and Shipbuilders, the West of Scotland Iron and Steel Institute, and the Institution of Engineers and Shipbuilders in Scotland, held in London on April 6, the subject of failure of metals under internal and prolonged stress was discussed. Abstracts of several of the papers presented were printed in the June Survey Section. Excerpts from others follow.

The Prevention of Season Cracking in Brass by the Removal of Internal Stress, H. Moore and S. Beckinsale. In a previous paper before the Institute of Metals the writers showed that in 70:30 brass the internal stresses could be reduced sufficiently to prevent season cracking by annealing at low temperatures, and this without sensibly reducing the strength of the material or appreciably softening it. For the experiments whereby those results were obtained the writers used cups spun from fully annealed brass sheets and employed mercurous nitrate solution as the test

for the presence of injurious internal stress. The actual value of the stresses induced in the material by the spinning process could not be determined, and to that extent the experiments were incomplete. In the present paper the writers describe similar experiments conducted with specimens, the stresses in which, before and after annealing, could be calculated. Each specimen took the form of a strip of cold-rolled 70 : 30 brass, 6 in. long, 1 in. wide and either 0.02 in., 0.015 in., or 0.01 in. thick. Such a strip was clamped by its ends to a former block of 7 in. diameter. On the clamps being removed, the strip returned to the straight, showing that the elastic limit of the material had not been exceeded. The tension in the outer skin of the strip, when clamped, could therefore be calculated from the usual bending formula $p = Et/2r$. The strips, clamped to the former, were annealed at various temperatures for various lengths of time, and, on release, were found in all cases to assume a circularly bent form. If the radius assumed were r_1, then the stress in the material, after annealing and before release from the block, would be given by $p_1 = Et\ (r_1 - r)/2r_1r$. In this way the reduction of the initial stress effected by the annealing could be evaluated. Full data giving the results of the experiments are to be found in the original paper. In general the rate of reduction of the stress was found to increase as the annealing temperature rose, but in all cases it showed a marked slowing down after about one-half or two-thirds of the initial stress had been removed. For a brass of given hardness the higher the initial stress the higher was the stress remaining after a given heat treatment, while for a given initial stress and a given treatment the stress remaining after annealing decreased as the initial hardness of the material increased. The reduction in the internal stress is attributed to a slight plastic flow which occurs in the metal and which increases in amount with an increase of the annealing temperature, the duration of the annealing process and the magnitude of the initial stress. It is said that season cracking of brass can be eliminated in all cases by the application of a suitable low-temperature annealing to the manufactured article after the final cold-working operations. (*The Engineer*, vol. 131, no. 3408, Apr. 22, 1921, p. 427, *e*)

Intercrystalline Cracking of Mild Steel in Salt Solutions, A. J. Jones. Experimental study of the action of salt solutions on stressed mild steel. A number of riveted plates were prepared, the rivet holes in some cases being punched and in others drilled. The rivets were heated only to the minimum temperature necessary for the work, in order that comparatively high stresses might be induced. The plates were placed in a solution consisting of four parts of calcium nitrate to one part of water, at a temperature of about 145 deg. cent., and were examined at intervals. No corrosion or cracks could be detected on the outside surface of the plates after 23 days, but in 28 days two of the plates with punched rivet holes and one of the plates with drilled rivet holes showed a large number of distinct cracks. The other plates, including four with $^1/_2$-in. rivets, showed no cracks after 74 days; a number of these were then cut up, but no cracks were found on the inner surfaces. Plates produced in the same way, but normalized after riveting, showed no signs of cracks after 74 days in the calcium nitrate solution. The cracks produced as described above were examined and in every case were found to be intercrystalline. The microstructure of the plates was normal.

A second series of experiments was carried out on strips of mild steel $^1/_4$ in. thick, 1 in. wide and 4 in. long. Bolt holes were formed in pairs near the ends of the specimens, and the strips were tightened up and bent until their ends met. In calcium, sodium and ammonium nitrates and in potassium hydroxide the specimens developed intercrystalline cracks in from two and a half to five and a half days. No cracks were found after a number of days in specimens placed in sodium carbonate, ammonium sulphate, calcium chloride and a fused mixture of sodium and potassium nitrates. Specimens of bent plate identical with the above were annealed for one hour at 200, 300, 400, 600, and 900 deg. cent., respectively, after assembling and previous to placing in calcium nitrate and potassium hydroxide solutions. The plate annealed at 200 deg. cent. cracked in the calcium nitrate solution in 7 days. The specimen which had been immersed in the fused sodium and potassium nitrate mixture at 250 deg. cent. for 29 days cracked in the calcium nitrate solution in $8^1/_2$ days. The plate annealed at 300 deg. cent. cracked after 11 days in the calcium nitrate solution. None of the plates annealed at higher temperatures had cracked after 50 days. Two specimens similar to one another but bent through a smaller angle than the standard form cracked in 8 days and 6 days in calcium nitrate and potassium hydroxide solutions, respectively. (*Engineering*, vol. 111, no. 2885, Apr. 15, 1921, pp. 469–470, 7 figs., *e*)

Action of Internal Stress on Tool Steel, J. Neil Greenwood. Discussion on the failure of metals through the action of internal stresses, with special reference to tool steels. The opinion is advanced that internal stress falls into two main classes, namely, distortion of the equilibrium space lattice by cold-working, and suppression of an allotropic change as a result of rapid cooling. In the case of pure iron the change from the α form to the γ form is accompanied by a volume contraction of about 0.5 per cent. With the introduction of carbon another change takes place due to solution of iron carbide at and above 725 deg. cent., accompanied by transformation of the solvent iron to the γ state. This is associated with a volume change, which increases with the carbon content. The expansion due to solution of the carbide, however, does not equal the contraction due to the formation of γ iron even with 1.5 per cent carbon present. With 0.8 per cent carbon or more the contraction is approximately half of that due to the "α to γ" transformation in pure iron. The compressibility of steel is 0.62×10^{-6} per megabar, or 0.945×10^{-4} per ton per sq. in. In other words, a pressure of one ton per square inch causes a diminution in volume of 0.009 per cent; so that an external pressure of at least 50 to 60 tons per sq. in. would be required to cause a contraction equal to that resulting from the transformation from the α form to the γ form. A contraction of volume also occurs when α cementite is transformed into β cementite at about 200 deg. cent., but this contraction is very slight and only becomes appreciable in comparison with the other changes when there is about 2 per cent carbon present. In the process of hardening carbon steel internal stresses may be caused by the retention of iron in the γ form with a tendency to revert to the α form or by the suppression of the carbide phase change when this compression is accompanied with decrease in volume, or by the completion of the carbide phase change in the interior of the mass. (*Engineering*, vol. 111, no. 2887, Apr. 29, 1921, pp. 535–537, 1 fig., *g*)

Note on Phosphor-Bronze Bars, John Arnott. Examination of properties and behavior of phosphor-bronze hexagonal bars, presumably either cold-rolled or cold-drawn. Tensile tests on one bar gave: Yield point, 36 tons per sq. in.; tensile strength, 37 tons per sq. in.; elongation, 22 per cent on 2 in.; and reduction of area, 67.9 per cent. A similar bar was annealed at 600 deg. cent. for half an hour. Tensile tests on the annealed bar gave: Yield point, 7.2 tons per sq. in.; tensile strength, 21.12 tons per sq. in.; elongation, 81 per cent on 2 in.; and reduction of area, 80 per cent. It was evident that the very high yield point and tensile strength of the material could only have been obtained by excessive cold work. To prove this, pieces of the cars were immersed in mercurous nitrate solution. Cracks began to form in three minutes, and after an hour the bars showed both transverse and longitudinal cracks. The material, as received was apparently quite ductile. (*Engineering*, vol. 111, no. 2885, Apr. 15, 1921, p. 474, 2 figs., *e*)

The Spontaneous Cracking of the Necks of Small-Arm Cartridge Cases, W. C. Hothersall. Experimental study of the cause of cracking of the necks of small-arm cartridge cases during storage. Mercuric chloride and ammonia tests revealed the fact that the bulleting and necking operations, in which the mouth end of the case is swaged down to fit the bullet diameter, are most likely to originate the stresses causing the cracks. Of twenty cases placed in an acidified solution of mercuric chloride sixteen cracked immediately and all within forty-eight hours, while of a similar number suspended in ammonia gas all cracked in twenty-four hours. The cracks were similar to those which have been observed to form spontaneously, that is, mainly longitudinal, beginning at the mouth of the case and extending up the neck toward the shoulder. The presence of circumferential stress in the necks was confirmed by

withdrawing the bullets and measuring the diameter of the case close to the mouth. It was found that the necks were expanded by the withdrawal in some instances and were contracted in others. The former cases did not crack in mercuric chloride, while the latter did. Evidence was also found to the effect that the indenting process, under which the bullet is fixed in position by indenting the neck at three point to the circumferential groove in the bullet, can set up local stresses which will later cause the formation of cracks. The hardness of the neck of the case also influences the cracking, and it is possible that mercury derived from the fulminate of the cap composition acts as an accelerator. (*The Engineer*, vol. 131, no. 3408, Apr. 22, 1921, p. 427, *e*)

Experiences of Season Cracking During the Great War, Owen W. Ellis. Account of investigation undertaken during the war at the Metallurgical Laboratory of the Royal Laboratory Department of the Ordnance Factories, Woolwich, with a view to preventing season cracking of brass rods. After numerous experiments it was found that annealing for two hours at from 200 to 300 deg. cent. was quite sufficient to remove all internal stresses which would be likely to develop cracking. Since, however, the required mechanical properties of the material would not be affected by annealing at 400 deg. cent. and because annealing at 350 deg. cent. for about half an hour proved to result in the same beneficial effect as the annealing for a longer time at the lower temperature, this latter method of annealing was finally adopted as the standard workshop practice. (*Engineering*, vol. 111, no. 2885, Apr. 15, 1921, p. 474, *e*)

Short Abstracts of the Month

AERONAUTICS

Pulsating Wings for Aeroplanes, Harry Harper. An attempt to describe the theory and action of the wing said to have been invented by Prof. Raimund Nimfuhr of Vienna. It is stated that a full-sized load-carrying aeroplane is to be built and that the venture is to be financed by American capital.

In the Nimfuhr method an attempt is made to imitate the pulsating action of an insect's wing and it is stated that the Nimfuhr wing is hollow with air bags inside, the underneath section of the wing taking the form of a flexible membrane. This membrane can be set beating or pulsating by the action of pneumatic pumps which alternately fill or empty the air bags in the wing. These pulsations, extremely rapid, act powerfully on the cushion of compressed air which, in flight, is formed beneath the plane, and it is claimed that they will not only sustain but also propel a machine forward through the air, the air screw being eliminated entirely.

The Nimfuhr wing is also provided with flexible extremities at both ends, which, by pneumatic action, can be made to extend or contract in imitation of the "reefing" of a bird's wing. (*Motor Transport*, vol. 32, no. 843, Apr. 25, 1921, pp. 442–443, *d*)

[It may be mentioned in this connection that an unsuccessful attempt to build an aeroplane with pulsating wings was made in 1908 by a Russian engineer, Tatarinoff, working with the Russian War Dertm ent, in which the pulsations of the wing were to be produced by means of springs.]

AIR MACHINERY (See also Pumps)

Despatching Messages on Warships Pneumatically

Pneumatic Transmission of Messages on Warships. Description of pneumatic-despatch equipment extensively used on British warships.

Fig. 1 shows diagrammatically the layout of a ship installation. There are two electrically driven pumps situated respectively in the fan room and on the lower deck, and controlled from the main and auxiliary wireless-telegraph offices. Each valve has a reversing valve fitted above the silencers, by means of which the message pipes are put into connection either with the suction or pressure sides of the pipe, so that the message carriers may either be drawn from the far end of the tube or propelled in the opposite direction.

On the suction side there is an intake consisting of a simple bell-mouthed casting covered with wire gauze at the open end. The silencers are galvanized steel vessels with the internal baffle plates and are introduced to eliminate the pulsations of the air and deaden the sound of the exhaust.

The pumps in smaller installations have a vertical single-acting cylinder of 6 in. bore by 4 in. stroke running at 500 r.p.m. and driven by a $1^1/_4$-b.hp. motor. In larger installations horizontal pumps of a somewhat different type are used.

The brass tubes in which the condensers or carriers travel are of $1^1/_2$ in. internal diameter and are made in lengths of about 15 ft., the bands being of standard radius of 5 ft. with a minimum radius of $1^1/_2$ ft.

The type of carrier employed has an end pad of hard felt and a body of fiber. A light steel finger spring is fitted inside to prevent the papers being carried from falling out. The felt pad fits the tube and forms a piston against which the air pressure works.

The layout of Fig. 1 shows that a single transmission tube is carried from the installation in the main wireless-telegraphy room to the bridge, and that tubes are carried from the auxiliary wireless-telegraphy room to the main wireless-telegraphy room and

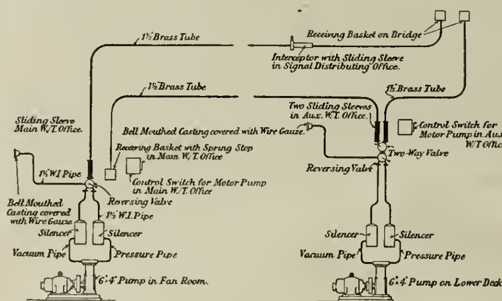


Fig. 1 Pneumatic Transmission of Messaoes on Warships (Diagrammatic Layout)

the bridge. On the tube leading to the bridge there is an interceptor in the signal-distributing office which consists of a sliding sleeve with a celluloid window and a valve or stop worked by a handle so that the carriers may either be stopped or allowed to pass through as desired.

The whole of this pneumatic-dispatch arrangement is simple and there is little or nothing to get out of order. It was very quick in operation and the time of transit on the longest tube on board ship is rarely more than 10 sec. (The speed at which the carriers travel in the tubes is approximately 30 m.p.h.). The original article describes also some of the secondary details of this apparatus. (*Engineering*, vol. 111, no. 2888, May 6, 1921, pp. 548–549, 10 figs., *dA*)

Pressure Losses in Compressed-Air Piping. Data of German experiences with various type of packing for compressed-air piping, taken from an investigation by a commission appointed by the German Board of Trade.

The test was made on a holiday. The piping of a large mine installation about 22 miles long with an average diameter of about 5 in. was kept under a uniform pressure of 6 atmos., all the underground workings being shut off. To maintain this pressure a compressor had to work continuously at 48 r.p.m., delivering roughly 3000 cu. ft. per min., which compensated for the leakage in the line.

As the consumption of the plant during the main shift amounts to 420,000 cu. ft. of free air, the loss due to leakage would be on an average of 30 per cent of the air delivered. A large part of this loss is attributed to the use of substitute packing instead of the standard rubber packing, as has been proved by additional tests. In these the air piping (60 ft. long, 3 in. in diameter, with 15 flange-packed joints) was put under the pressure of 6 atmos. The piping itself was absolutely tight and the pressure conditions in the line were recorded automatically. In these tests paper rings soaked in linseed oil and rubber rings were used for packing joints, with

the result that with an initial pressure in all cases of 6 atmos. the pressure with both plain paper rings and paper rings soaked in linseed oil at the end of 570 min. was 1 atmos., while with rubber rings the pressure from the same level only fell to 1.5 atmos. at the end of 1298 min., at which time the test was discontinued.

This would indicate that in the case of an installation of the size of the one tested the saving effected by using rubber packing rings is very material, indeed, and that the subject of packing rings is worthy of very serious attention. (Translated from the German engineer's report—source not specified. *The Compressed Air Magazine*, vol. 26, no. 5, May 1921, pp. 10092, *ep*)

FORGING

Friction Drop Stamp with Twin Brake Drums for Lifting and Holding Up

Twin-Drum Friction Lifter for Drop Stamps. With all its advantages the ordinary friction drop stamp has to overcome the handicap of considerable consumption of power together with heavy wear of brake linings. The new type built by a British concern is claimed to overcome some of these troubles through having two brake drums, one for lifting and one for holding up. As shown in Fig. 2, the flywheel is connected to the main shaft which runs at a speed from four to five times that of the ordinary lifter shaft. Connected to the same shaft is also a small central pinion of an epicyclic gear, the idlers of which mesh with an internal gear fixed to the rim

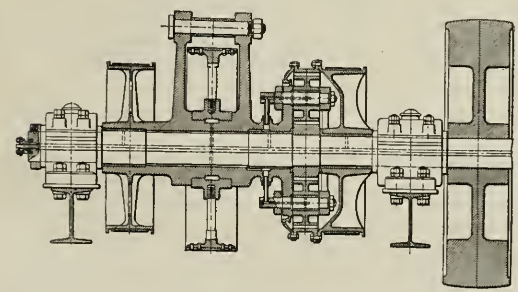


Fig. 2 Twin-Drum Friction Lifter for Drop Stamps

of a band-brake drum. The idlers themselves are mounted on a plate which is integral with the lifter, arms and pulley and also with the second band-brake drum seen on the left.

As regards the action, normally the central pinion revolves and the epicyclic gear causes the band-brake drum for the lifting movement to revolve also freely. If, however, this be arrested by the application of the right-hand brake, the idlers themselves revolve round the main shaft carrying the lifter, arms and pulley. The tup is held up by applying the band brake to the left-hand drum. The arrangement of the device is such that during holding up the only power used is that absorbed in gearing and the friction of the shaft and sleeve, whil no power is absorbed by slipping brake linings.

The design of the brake requires so little power to operate it that hand power can be employed without the introduction of any multiplying gear. The major portion of the braking load is taken on the brake drum attached to the lifting arms, so that the usual severe retarding loads on the gearing and motor are practically eliminated and the fluctuation of the load on the motor is greatly reduced. This is confirmed by data of tests given in the original article.

The brake linings used are pure asbestos and no water cooling is employed. (*Engineering*, vol. 111, no. 2889, May 13, 1921, pp. 584 and 588, 6 figs., *d*)

FUELS AND FIRING

Protection of Pulverized-Coal Plant from Dust Explosions and Fires, L. D. Tracey. Article based largely on data collected by the Bureau of Mines. Only the more important parts can be abstracted here.

The author, who is coal-mining engineer of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, believes that it is practicable to install a vacuum-cleaner system in a coal-pulverizing plant, by means of which all parts of the building in which dust is liable to settle may be reached and cleaned. This has been done in some of the coal-crushing plants in France and Germany, and, in a few instances in our own country. Dust should never be brushed or swept up without first being thoroughly wetted down, and this applies not only to the pulverizing plant but also to the industrial portion of the operation.

The author strongly emphasizes the fact that accumulated dust and clouds of fine coal dust are highly dangerous when in close proximity to an open flame or mass of hot metal.

Excessively high drying temperature may result in explosion; moreover, as the author points out, coal dried at an abnormally high heat contains more moisture than when dried at a temperature of from 100 to 150 deg. fahr.

As regards some of the fires in the coal-conveyor lines between the bins and the furnace, the author believes that they oftentimes are due to spontaneous combustion in the storage bin. The coal in the bin becomes heated almost to the ignition point and the air current conveying it to the furnace supplies enough additional oxygen to bring it to incandescence. Because of this, whenever a plant has been shut down for a few days an examination should be made to ascertain the temperature of the coal in the bins before any pulverized coal is delivered to the transport lines.

Fine coal at a temperature of above 150 deg. fahr. should never be stored in a bin because of its liability to spontaneous combustion, and whenever a plant is to be shut down for a few days all storage bins should be emptied if possible. In the direct system of using pulverized coal the pressure of the distributing air should always be maintained well above that of the air supply for combustion purposes. Other recommendations of a practical nature are given in the original paper. (Paper read before the Engineers' Society of Western Pennsylvania, April 5, 1921, in Pittsburgh. Abstracted through *Coal Age*, vol. 19, no. 17, Apr. 28, 1921, pp. 746–749, *gp*)

INTERNAL-COMBUSTION ENGINEERING (See also Machine Parts)

Large British Gas-Driven Blowing Engine

1300-Hp. Gas-Driven Blowing Engine. Description of an engine to be operated on blast-furnace gas as built by a prominent British concern.

The power cylinders are 41.34 in. in diameter by 47.25 in. stroke and the bore of the air cylinder is 93.3 in., the engine being intended to deliver 30,000 cu. ft. of free air per minute. With the air compressed to 10 lb. per sq. in. normal blast pressure, the full load amounts to 1335 b.hp. The engine is chiefly interesting for the refinements of design which it embodies.

To eliminate casting and expansion stresses the power cylinders are cast in two halves and these are forced by hydraulic pressure over a cylinder liner of special cast iron and then bolted together. The water space is closed by a jacket casing of mild steel plate made in two halves, and a rubber joint between the jacket and the cylinder casting permits of relative motion caused by unequal expansion without stressing the cylinder castings.

The exhaust-valve box and valve seat (Fig. 3) consist of a separate outer casing and inner casing and valve seat, all of which are water cooled. The exhaust-valve seat is in the form of an inverted U-shaped ring of hard cast iron and easily renewable. The joint between the valve seat and the top of the inner casing is in the form of two concentric spigoted circular rings and is made tight by copper joint rings, the whole insuring efficient water cooling and ease of access for inspection.

The arrangement of the joint between the exhaust-valve box and the cylinder is such that any leak of gas at this joint or any leak of water at the joint of the valve seat becomes immediately visible, which is important as a leak in this joint may lead to cracking of a cylinder if allowed to continue.

The valve arrangement is somewhat different from usual, the inlet valve consisting of a main inlet valve and a gas valve flexibly attached to the spindle of the former; this permits both valves to close tightly, even if the seatings are worn unequally.

The pistons are water-cooled and have coned faces stiffened by pairs of internal diagonal ribs. Coned nuts are also provided at each side of the piston to permit of longitudinal adjustment so that the piston rings may work exactly edge and edge with the ends of the liner when running. Both pistons and piston rods are water-cooled, the cooling water being supplied at about 40 lb. pressure. The cooling water (Fig. 4) enters a bracket placed on the foundation below the middle distance piece. From this it passes by two short swiveling pipes into one of two pairs of long pipes, by which it is led up to the intermediate crosshead. Thence it passes by bent pipes, one portion flowing along the annular space between the piston rod and the internal pipe, through the piston and back by the internal pipe to the intermediate crosshead, from which it passes out into the swinging leg on the other side of the engine. The other portion of the water supply passes in a similar way through the second piston and rod.

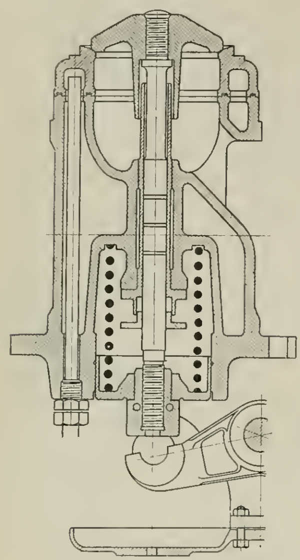


Fig. 3 Exhaust Valve of British 1300-Hp. Gas-Driven Blowing Engine

The cylinder barrels, covers, exhaust boxes and exhaust-valve seats are cooled by low-pressure water, while for the high-pressure piston water there are independent centrifugal pumps. The water from the pistons, cylinder jackets, covers, exhaust boxes and exhaust valve seats is discharged by separate pipes into open tun dishes mounted on the engine, so that the discharge from each part can be independently inspected, and the quantity and temperature individually controlled. (*The Engineer*, vol. 131, no. 3409, Apr. 29, 1921, pp. 451–454, 8 figs. and a 2-page supplement containing two more figures, *d*)

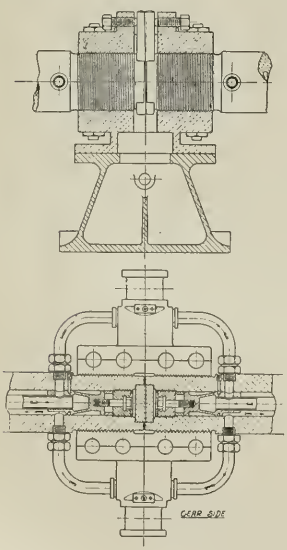


Fig. 4 Cooling-Water Arrangements for 1300-Hp. Gas-Driven Blowing Engine

A Unique Two-Stroke-Cycle Engine

"Silent Record" Internal-Combustion Engine. Description of an engine built by a British concern and working on somewhat unconventional lines. Essentially, the engine is a two-stroke cycle. Fig. 5 shows the arrangement of a two-crank engine. The cranks are at 180 deg. to each other and are connected to the charging-pistons C and D. These large pistons carry above them four working pistons A_1, A_2, B_1 and B_2. As the working pistons are about half the diameter of the charging pistons, the net area of the latter is about equal to that of the former. There is also a piston valve worked by the eccentric E. The action is as follows: On the down stroke the pistons C and D draw in explosive mixtures which are compressed on the up stroke and delivered to the inlet ports at the bottom of one of the working cylinders, the exhaust escaping through exhaust ports at the bottom of the other cylinder. The charging cylinders do not supply the working cylinders directly above them but those above the opposite crank, i.e., C supplies B_1, B_2 and D supplies A_1, A_2.

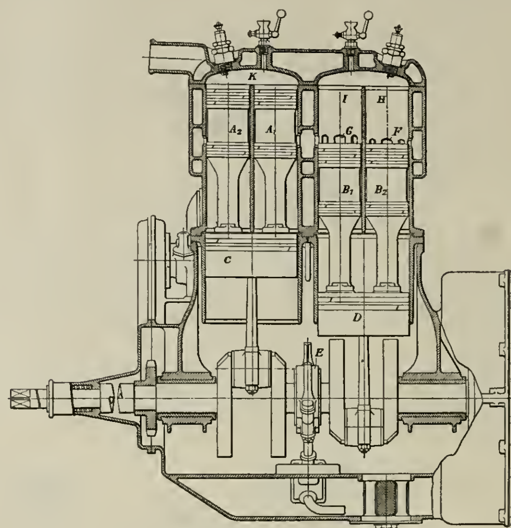


Fig. 5 "Silent Record" Two-Cycle Engine of Unconventional Design

Taking Fig. 5 in the position shown, the pistons A_1, A_2 have compressed the working charge into the combustion chamber K ready for firing. The charging piston C has also drawn in a charge and slightly compressed it in the space between the pistons. The pistons B_1, B_2 have finished their working stroke, and B_1 has fully uncovered the exhaust port G while B_2 slightly later uncovered the inlet port F. The piston valve now allows the charge compressed by the charging piston C to flow through the inlet port F into the cylinder H, from which it flows across the combustion chamber and down the cylinder I, pushing the exhaust out of the port G in front of it.

The charge in the combustion chamber K is now fired, and the pistons A_1, A_2, descend. As they do so the piston valve puts the space above C into communication with the carburetor and allows new mixture to be drawn in, while it puts the space above D into communication with the inlet port uncovered by the piston A_2. The charge in H and I is compressed and fired at the top of the stroke, while the pistons A_1, A_2, uncover exhaust and inlet ports corresponding to F and G, and the cycle recommences.

As compared with the ordinary two-stroke-cycle engine, the advantage of the design described above lies in the fact that crankcase compression is not used and also that positive distribution of the mixture to the charging cylinders is secured. It is also claimed that a more complete stratification is obtained.

The engine shown has four working cylinders equivalent to two cylinders 3 in. by $3^1/_2$ in., and develops 10 b.hp. at 1600 r.p.m. (*Engineering*, vol. 111, no. 2888, May 6, 1921, p. 565, 2 figs., *d*)

MACHINE PARTS

Aluminum Pistons. Frank Jardine and Ferdinand Jehle, Mem. Am.Soc.M.E. Discussion of performance and design of aluminum pistons.

According to the authors the most important function which the piston performs is that of converting heat into mechanical energy. Providing a path for some of the waste heat is a secondary duty, and it is of the utmost importance that the performance of this secondary duty interferes little or none with the performance of the first. Unfortunately, up to the present time there has been interference. The heat passing through the piston causes such undesirable effects as self-ignition of the charge and excessive expansion of the skirt which necessitates a large clearance when the piston is cold. The clearance trouble is aggravated when aluminum is substituted for cast iron, because of the greater expansion of the former.

As regards the design of aluminum pistons, the authors point out that it was Col. E. J. Hall who arranged the piston so as to provide a good path for the flow of heat from the head of the piston to the water jacket, but his design, while successful in aviation motors, did not prove adaptable to automobile engines.

The authors give their own formula for the head thickness of aluminum pistons.

The most interesting part of the paper, which, unfortunately cannot be abstracted owing to lack of space, reports tests in which the actual temperatures in pistons in operation in an engine have been measured at various speeds and horse-power outputs.

From these tests it was found that piston temperatures, especially those of the head, were very susceptible to changes in fuel consumption. Also, it was discovered that changes in cooling-water temperatures brought about a marked difference in the piston temperatures. Much of the heat was found to leave through the rings and the temperature immediately below the rings was found to be several hundred degrees lower than the head temperature. This brings up an interesting discussion of the influence of the temperature of the piston head on the expansion of the skirt, in addition to the thermal expansion due to individual temperature of the skirt. In fact, the authors come to the conclusion that separating the head from the skirt, in so far as this can be done mechanically, would relieve the skirt of mechanical expansion in certain directions and permit using a smaller clearance than would otherwise have been necessary. (*Journal of the Society of Automotive Engineers*, vol. 8, no. 5, May 1921, pp. 397–403, 9 figs., *ge*)

MACHINE TOOLS

Machine for Cutting Double-Helical Gears

Sykes Double-Helical-Gear Generator. Description of a gear generator based on the principle that the cutters take the form of pinions in gearing contact with the wheel being cut, and, with the latter, are rotated during the process of generation. The reciprocating motion given to the cutter is combined with the helical movement in order to secure teeth set at the required angle, in this instance the standard angle of 30 deg.

The reciprocating motion of the cutters across the face of the work is combined with two other movements. The first of these is an oscillating helical movement to make the cutters follow the lead of the gears to be cut, while the second is a continuous revolution to keep the cutters in unison with the revolution of the work blank. In modern types of Sykes generators the first movement is obtained with the bars and guides all to one side, one set having a hollow spindle through which the other is passed so that the guides can be placed close together on the left side of the machine.

The large guides and cast-iron housings with their two guiding faces are shown in Fig. 6. The fixed member is held in each case in a revolving housing and the reciprcoating members work to and fro in the same elements. This design permits of both members being machined in exactly the same way. The fixed part is in two sections, the joint between the two being straight and in line with the axis. This enables wear to be taken up, one section being fixed and the other capable of adjustment longitudinally.

The continuous revolution of the cutter is obtained by large indexing worm wheels driven by worms on vertical spindles. In order to obtain the greatest accuracy of pitch the two indexing worm wheels are made as large as possible.

The cutters have to register correctly together, which is insured by means of two toothed clutches. The work is set up to the cutters until they just mark it and then they are adjusted by the vertical worms, the clutches being afterward secured down so that the driving gears are engaged again.

The following is said to be a typical example of marine turbine gears cut on this machine: Transmitting 2500 hp. with the primary pinion running at 4800 r.p.m., the smallest pinion of the set was of 5 in. diameter, 14 in. face and 5 diametral pitch, while the largest was 50 in. in diameter, 18 in. face and 3 diametral pitch. A 0.5 per cent carbon steel pinion of 14 teeth 5 diametral pitch and 8 in. wide can be cut in 60 min. Wheels of cast iron of 5 diametral pitch, 6 in. wide and 45 in. in diameter, take 7 hr. Cast-steel wheels 50

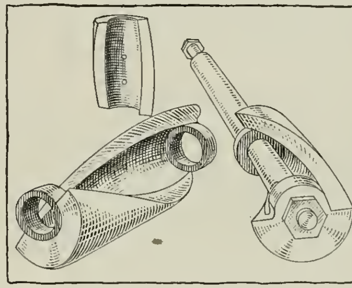


Fig. 6 Helical Guides for Cutter Spindles in the Sykes Double Helical-Gear Generator

in. in diameter, and of 16 in. face and 3 diametral pitch are cut in 14 hr. Rolling-mill pinions integral with 9-in. shaft, of 0.7 Mn and 0.5 per cent carbon steel, 25 teeth of $1^3/_4$ in. pitch, take about 9 hr. each; 48-in. turbine reduction gears with 18 in. face, of a maximum degree of accuracy, take about 24 hr. each. (*Engineering*, vol. 111, no. 2887, Apr. 29, 1921, pp. 520–522, 7 figs., *d*)

PRODUCER GAS

Water-Gas Apparatus and the Use of Central District Coal as Generator Fuel, Wm. W. Odell. Many gas companies are facing considerable financial difficulties as a result of the greatly increased cost of gas oil used to enrich water gas. Reconstruction of plants to manufacture coal gas instead of water gas is difficult, if not economically impossible, under present conditions. One of the economies by which an attempt is being made to meet the situation is the use of cheaper grades of coal to replace anthracite or coke, and the present paper presents certain preliminary studies bearing on the possibility of substituting Indiana and Illinois coal for coke in water-gas generator sets.

Prof. T. S. C. Lowe, of Norristown, Pa., appears to have established the basic principle of water-gas generation some 45 years ago.

Many attempts have been made to use bituminous coal as generator fuel with varying success, and the paper mentions eleven objections which have so far prevented the general use of coal in place of coke fuel. Several designs made to meet these objections are discussed, such as the Loomis, the Fahnehjelm, Rew, K & A, and Smith.

The distribution of heat in a water-gas set is discussed in detail and various heat balances presented. An interesting part of the paper is a list of the main requisites for the efficient production of good water gas in quantities from coke fuel and a discussion of coke and coal as generator fuel. From this latter it appears that successful utilization of central-district coal as a generator fuel seems to require the maintenance of the following conditions:

1 Higher temperatures in the fuel bed
2 Larger body of completely heated fuel
3 Increased production of blue gas per given amount of blast or an increased amount of blast with an auxiliary utilization of the excess combustible blast gas
4 A means of carbonizing the coal in the generator without the

formation of a mat or cake in the upper part of the fuel bed

5 The utilization of an increased air-blast pressure to offset the increased resistance of the coking fuel to the passage of air, or the equivalent by a change in design of the set
6 A means of control of clinker, particularly edgings
7 A means of properly distributing the fuel in the generator.
8 A means of thoroughly atomizing the oil
9 A generator so proportioned that the steam used during the run has ample time of contact with the incandescent fuel for the completion of the blue-gas reaction.

The principles of design of a generator set suited for central-district coal is discussed. It is stated, however, that although clinker difficulties may be partly eliminated by the method suggested, it is doubtful if they can be entirely eliminated in that manner. (Paper prepared under a coöperative agreement with the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois through its Department of Mining Engineering, published as *Technical Paper No. 246, U. S. Bureau of Mines*, Washington, D. C., 1921, *gp*)

PUMPS

Air-Lift Pumping Plant with Remote Control

A Modern Air-Lift Pumping Plant, John Oliphant. Description of an air-lift pumping plant installed by the Philadelphia & Reading Co. at Telford, Pa. In this case the problem was to deliver the water from an artesian well into an elevated tank located at a distance from the well and to control the operation as to starting and stopping from another distant point, and at the same time to control the cooling water supplied to the water-jacketed air cylinder of the compressor, the pumping being at the rate of approximately 100 gal. per min.

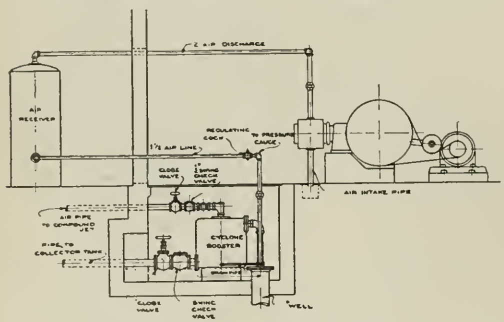


Fig. 7 The Compressor, Air Receiver and Well in the Air-Lift Pumping Plant of the Philadelphia & Reading Co., at Telford, Pa.

The well was equipped with a 3 in. air-lift footpiece having outside air connections and a multiple-orifice mixing tube located centrally in the mixing chamber and discharging the air through a number of small openings into a relatively thin sheet of ascending water. It is claimed that this design secures a complete emulsion of air and water in the footpiece.

In the pit around the well head and connected to the reduction pipe was located a Sullivan cyclone booster 30 in. in diameter by 30 in. high. The combined air and water was discharged into this booster and separator near the top and at one side at a tangent to the periphery under high velocity from the well, causing it to swirl and thus effect a perfect separation of the air and water. The water leaves the separator at the bottom, also at a tangent to the periphery, and the air passes off at the top. The air pressure in the booster is controlled by a valve set to maintain the pressure required by the head against which the booster is discharging, this head being caused by friction in the pipe (536 ft. of horizontal run, a rise of 14 ft. from the booster to the base of the elevated tank, and the elevation of 66 ft.). The arrangement of the compressor, air receiver and well is shown in Fig. 7. In addition to this the original article contains an interesting drawing showing the pipe layout for the air lift.

The regulation as installed is of considerable interest. As it was required to control the plant from a distant point, it became necessary to unload the compressor when it stopped, and in starting to permit the compressor to get up to speed before the load was thrown on. This was accomplished by means of a flyball governor on the compressor that acted as an unloader when it was at rest, and did not admit air to the compressor until the speed had elevated or extended the controlling balls. It was also necessary to shut off the cooling water to the air cylinder when the compressor was stopped, and turn it on again when started. This was accomplished by placing a balanced solenoid valve of the normally closed type in the cooling-water line controlled from the starting control at the switchboard.

A push button, together with a relay, were located at the pumping station. In the railway station, 3600 ft. from the plant, another push button was installed and an electric-connected pressure gage at the base of the elevated tank was connected to a bell at this latter point to give the alarm when the tank was full of water. Provision was then made for starting and stopping the plant either at the pumping station or at the station 3600 ft. away. As the compressor is of the enclosed, splash-lubrication type, and is equipped with a McCord force-feed lubricator, it is safely manipulated from the station, where a push of the button by the station agent starts the pumping and when notified by the ringing of the bell that the tank is full, another push stops it. The air and water lines were laid so as to drain back into the booster, and a small connection with a partly opened valve was made from the bottom of the booster back into the well, so that all connections drain to obviate freezing in cold weather during idle periods.

A record is given of a test run, from which it would appear that with a total head of 149 ft. the theoretical horsepower required was 3.55 hp. while the actual electrical input was 12.5 hp., which would indicate an overall efficiency (wire to water) of 28.5 per cent. (*Railway Maintenance Engineer*, vol. 17, no. 5, May 1921, pp. 172–174, 3 figs., *d*)

Rotary Pump of Novel Design

Exeter Rotary Pump. The Exeter rotary pump built under the Feuerheerd patents is an application to pumps of the principle of the square-hole drilling device, in which a triangular bit functions inside a restraining square former of equal size. The irregular spaces increasing and diminishing in volume as the two rotate together are utilized to admit and eject the fluid.

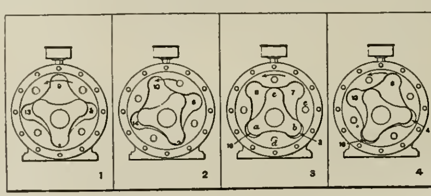


Fig. 8 Cycle of Movement of the Rotors of the Exeter Pump

Fig. 8 shows the cycle of movement of the rotors of the Exeter pump. One of the interesting features is that the pump is self-priming. It has, of course, no valves. As there are no surfaces rubbing against each other, this pump may be used to handle dirty and gritty water. The capacity of the pump per revolution is equal to three times the volume of space 9 in volume 1 of the illustration. (*The Nautical Gazette*, vol. 101, no. 19, May 7, 1921, pp. 597 and 609, 1 fig., *d*)

SHIPBUILDING (See Internal-Combustion Engines)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Strains in Crankshafts Due to Vibration

The Special Committee of the Research Committee on the Strains in Crankshafts due to Vibration is about to begin its actual work. The tentative plan of investigation is given below. The membership of the Special Committee is as follows:

N. W. Akimoff, *Chairman*	Comdr. Wm. McIntee
B. A. Behrend	F. Hymans
Prof. A. H. Beyer	Lt-Comdr. M. W. Torbet
John E. Burkhardt	C. P. Wetherbee
H. C. Dickinson	Dr. E. C. Newcomb
Comdr. F. C. Cleary	Prof. Wm. H. Kavanaugh

General Object and Scope of Work

I Descriptive Part:
Shaft failures:—Description of circumstances and conditions
Vibrations:—Description of circumstances and conditions

II Design:
Usual principles of, in marine, land and automobile practice
Illustrations
Counterweights
General remarks on lubricating systems

III Elements of theory of elasticity required for this investigation

IV Dynamics of the reciprocating mechanism in its relation to subject at hand

V Elements of the theory of vibrations with special reference to torsional vibrations

VI Theory of damping devices

VII Methods of measuring amplitudes of vibrations and strains in crankshafts

VIII Outline of an analytical method of finding torsional "periods"

IX Synopsis of conclusions.

Research Resume of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches, which in the opinion of the investigators do not warrant a paper.

Automotive Vehicles and Equipment A6-21. Steering Knuckles. Report No. 265 of the Experimental Department of the Packard Motor Car Company gives a formula for the design of a steering spindle and steering arm for racing cars. The spindle is designed by the formula

$$D = \sqrt[3]{w\,d/12{,}150}$$

in which D = diameter of spindle at big end in inches, w = total weight on front wheels in pounds, and d = diameter of front tire in inches.

The material shall conform to specifications 6135 or 3435 of the S.A.E. and shall be heat-treated to give the following:

Elastic limit	110,000 lb. per sq. in.
Tensile strength	125,000 lb. per sq. in.
Elongation in 2 in.	17 per cent
Reduction in area	55 per cent
Brinell hardness	255–386

A steering arm shall be designed by the following formulas:

$$Z_b = \frac{w\ a}{18{,}000\ b}$$

$$D_b = \sqrt[3]{\frac{w\ a}{1765\ b}}$$

$$u = \sqrt[3]{\frac{w\ a}{3000\ b\ k^2}}$$

in which Z_b = minimum section modulus at point of lever arm a
w = total weight on front wheel in pounds
a = distance from center plane of wheel to spindle pin axis in inches
d = distance from spindle-pin axis from center of gravity to steering arm section in inches
D_b = diameter at section of arm
u = width of rectangular section with thickness v in which $k = u/v$

The width u shall be the dimension measured in the horizontal plane. The maximum value of k shall not exceed 2. Material used for the steering arm is the same of that of the steering spindle, but the heat treatment gives elastic limit at 100,000 lb. per sq. in., tensile strength 120,000, elongation in 2 in. 18 per cent, reduction of area 55 per cent and Brinell hardness 228 to 269. Packard Motor Car Company, Detroit, Mich. Address L. M. Woolson, Experimental Engineer.

Chemistry A1-21. Soda Glass. A soda glass of 30 per cent sodium oxide is produced as a by-product of one of the processes of refining nickel. This may be used as a black glass suitable for counters or table glass, and by leaching this glass a soluble alkali can be recovered with a residue which has the same properties as the water softener permutit Address John F. Thompson, Manager Technical Department, International Nickel Company, 43 Exchange Place, New York.

Hydraulics A1-21. Centrifugal Pumps. The measurement of hydraulic losses due to centrifugal pumps has been studied at the University of Michigan. Six propellers have been used and the effects of various dimensions have been carefully studied. The effect of air leakage in the suction line has been studied as well as the effect of this on capacity. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Hydraulics A2-21. Reservoir Pipe Connection. An investigation has shown that the velocity head in the pipe line at the entrance to a reservoir is not entirely lost. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Internal-Combustion Engines A2-21. Flame Propagation in Automobile Engines. For a graduating thesis at Rose Polytechnic Institute, R. J. Owen and M. G. Flesher determined the rate of flame propagation in an automobile engine in the following manner: One spark plug was removed and a special casting made which permitted the attachment of an ordinary indicator suited for gas-engine testing, together with a spark plug having extended plug removed. An electric motor through suitable reduction gearing drove at constant speed a drum which communicated motion to a continuously moving strip of paper. The strip of paper was carried across the drum of the indicator so that a continuous card was traced. At the same time a standard tuning fork of 250 vibrations per second traced a sinuous line which formed the measure of time intervals. The experiments were made on an Atlas-Knight engine fitted with a Stromberg carburetor. The auxiliary air was closed off and a pipe extension fitted to the main air intake. A pitot tube in this pipe extension served to measure the air used. The gasoline used in a definite time was also determined, so that from a combination of the two readings the ratio of air to gasoline could be found. Tests were made with different makes of gasoline and different proportions of air to gasoline. As was anticipated, the rate of flame propagation is much more rapid for these mixtures than for mixtures of gas and air as determined by previous experimenters. The time interval between ignition and the attainment of maximum pressure varied from 0.004 sec. to 0.014 sec. Each grade of gasoline showed a maximum rate of combustion for a definite ratio of air to gasoline, either side of which ratio the combustion was slower. Various trade gasolines gave the most rapid combustion at ratios of 12 to 1 or 13 to 1. A mixture of gasoline and benzol containing about 40 per cent of benzol showed most rapid combustion with a mixture of 16 to 1. Address Prof. F. C. Wagner, Rose Polytechnic Institute, Terre Haute, Ind.

Metallurgy and Metallography A10-21. Losses in Aluminum and Aluminum Alloy Melting. Report No. 2239 of the Bureau of Mines by Robert J. Anderson discusses the losses in melting non-ferrous metals. The factors to be considered are:

1. The type of furnace
2. The melting temperature
3. The length of time for melting and superheating to pouring temperature
4. The length of time during which metal remains in the furnace at pouring temperature
5. The constitution of furnace atmosphere in contact with the metal
6. The volume of air and products of combustion passing over the metal per unit of time.

The fuel consumption depends on furnace design, air supply fuel used relation of fuel to air, design of burner, and method of removnig waste gases. The domestic output of aluminum was 225,000,000 lb. per year for the year 1918 as primary metal. The amount of aluminum produced in the form of alloy amounts to 30,000,000 lb. The average recovery from remelting borings and scrap amounts to 65 or 70 per cent and the borings amount to 15 per cent of the casting. The average recovery from furnace dross containing 30 to 60 per cent metallics is not over 80 per cent. All aluminum is melted at least twice and much of it at least several times. The principal loss is due to oxidization, the average loss being about 2 per cent. The great fuel loss in melting aluminum is due to the fact that the furnaces used for this purpose utilize probably from two to eight per cent of the heat of the fuel. The probable loss in melting aluminum amounts to about $3,000,000 per year. Address Director, Bureau of Mines, Washington, D. C.

Metallurgy and Metallography A11-21. Volatilization Process. The Research Department of the School of Mines and Engineering of the University of Utah is publishing in connection with the U. S. Bureau of Mines a bulletin on the volatilization process of abstracting metals from their ores. Patents have been issued as a result of this research which have been assigned to the University for the use of the public. The Bulletin will appear in about six months. School of Mines and Engineering, University of Utah, Salt Lake City, Utah.

Properties of Engineering Materials A4-21. Mill Scale in Pipes. The National Tube Company has found that mill scale on the inside of pipes accelerates pitting and they have devised a mechanical means for its removal. This is an improvement in one of the operations of galvanizing and gives a better appearance to the pipe. Address F. N. Speller, Metallurgical Engineer, National Tube Company, Pittsburgh, Pa.

Pumps A1-21. Centrifugal Pumps. An improved form of centrifugal pump which gives equal efficiencies at varying heads. Address Prof. J. E. Emswiler, University of Michigan, Ann Arbor, Mich.

Welding A2-21. Oxy-Acetylene Welding and Cutting Blowpipes. R. S. Johnston of the Bureau of Standards has recently made a report which is printed in Mechanical Engineering for May 1921. The results of the investigation show that blowpipes in which oxygen is delivered at pressure in excess of the acetylene are subject to flashbacks. All blowpipes are subject to flashback phenomena on account of inherent defects in design. Conditions producing flashback are those existing within the blowpipe tip and head which choke off the flow of one of the gases. This back pressure is due to the confining or restricting the volume flow at the tip end. A blowpipe that cannot maintain under all operating conditions a neutral flame cannot be expected to produce sound welds. All blowpipes tested were incapable of maintaining a neutral flame under all conditions. The average operator checks the acetylene gas flow too much and actually develops an oxidizing rather than a neutral flame. A more satisfactory instrument than the blowpipes investigated will be necessary before the possible limiting strength, ductility or efficiency of welds may be determined. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Air B4-21. Air Through Orifices. Experiments to show the coefficients used in determining the flow of air through orifices. Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. Address Prof. E. H. Lockwood.

Aircraft B1-21. Air Propellers. Prof. W. F. Durand and E. P. Lesley are making a general survey of the tests made on 86 model air propellers tested during the past three years and reported on in progressive parts. The present investigation has for its purpose the general comparison and analysis of all results, reduction to non-dimensional coefficients and representation in tabular and graphical form with nomographic charts for purposes of design. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Apparatus and Instruments B5-21. Observation of Explosion within Gas-Engine Cylinder. See *Internal-Combustion Engines B5-21.*

Automotive Vehicles and Equipment B2-21. Tire Friction. Rolling friction of automobile tires. Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. Address Prof. E. H. Lockwood.

Automotive Vehicles and Equipment B3-21. Dynamometer Tests. Dynamometer tests of automobile power plants. Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Automotive Vehicles and Equipment B4-21. Radiators. Tests of automobile radiators, including description of types with their construction and the heat transmission. Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Automotive Vehicles and Equipment B5-21. Farm Tractors. A bulletin is being prepared by the Engineering Experiment Station of Purdue University on the tests of six farm tractors and one army caterpillar. These tests are made independently of soil conditions. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Chemistry B1-21. Nickel Compounds. An investigation of the properties of nickel compounds for commercial uses such as for paint and printing pigments, body colors for ceramic wear and soluble nickel compounds for fungacides. The study so far made indicates that black nickel sulphide, black nickel hydrate, and black nickel chromate would be valuable as pigments for paint and printing, while nickel oxide with zinc oxide seems to offer promise in the production of body colors in ceramic ware. Address John F. Thompson, Manager, Technical Dept., International Nickel Co , 43 Exchange Place, New York.

Fire Prevention B1-21. Fire Possibility of Locomotive Cinders. An investigation covering three years of work to determine actual fire hazard of locomotive cinders. Cinders of different sizes heated to known temperatures of 2000 deg. fahr. were dropped on various kinds of roofing with artificial wind velocities varying from 5 to 30 miles per hour. Cinders used so far have come from anthracite and bituminous coals. North Dakota lignites are now being examined. Address Prof. G. A. Young, Purdue University, Lafayette, Ind.

Fuel Utilization B1-21. Oil Torches and Furnaces. The design and performance of oil torches and oil heating furnaces operated on a vacuum system in place of the ordinary pressure system. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

Heat B15-21. Heating Boilers. Tests on two low-pressure heating boilers with various kinds of fuel have recently been made at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Heat B16-21. Steam Radiators. A study of heat transfer through radiators. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

Heat B17-21. Heat Transmission. A study of the physical properties of hydrocarbons which bear upon the problem of heat transmission is being made by W. R. Eckart. The study will include a review of all published data available. An attempt will be made to make this of practical use. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Heat B18-21. Heat Transmission. An experimental investigation of heat-exchange apparatus with fluids of different physical properties and under varying rates of flow is being continued by W. R. Eckart. Experimental work previously reported has been continued and in addition an extended series of tests with varying mixtures of steam and gasoline vapor on one side and water and oil on the other side are being made. The pressure and rates of flow are varied. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Internal-Combustion Engines B3-21. Hot Spot. An investigation by Prof. O. C. Berry and C. S. Kegerreis to determine the rate of vaporization of various fuels including kerosene at various temperatures and atmospheric pressure. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Internal-Combustion Engines B4-21. Factors Affecting Exhaust Temperatures. In order to properly utilize the hot spot it is necessary to know limits of temperature range in the exhaust gases from internal-combustion engines. Prof. O. C. Berry and C. S. Kegerreis have investigated this problem in connection with the effect of cooling-water temperature, inlet air, ignition timing, gasoline-air ratio, speed and load. A bulletin is being prepared on this matter. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Internal-Combustion Engines B5-21. Observation of Explosion within Gas-Engine Cylinder. The Bureau of Standards has developed a glass window attached to the spark plug and observed by means of a stroboscopic disk so as to observe the ignition flame during different times of the stroke. The device will probably be of value in permitting observations on the duration of luminous flame during the power stroke. The characteristic differences of color and brightness at different phases of combustion and their averages with changes in ignition timing, mixture ratio, compression pressure and other quantities. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Lubricants B2-21. Lubricating Oils. A set of tests on various lubricating oils in connection with gasoline motors to determine the best oil under operating conditions. These oils are also being examined for their physical and chemical characteristics. New tests are being devised to determine the value of an oil without making a breakdown test on an engine. University of Minnesota, Minneapolis, Minn. Address Prof. J. J. Flather.

Lubricants B3-21. A conference was held in Philadelphia at the Philadelphia Electric Company and attended by a large number of representatives from various industrial concerns and the Bureau of Standards to discuss the possibility of preparing uniform specimens for steam-turbine oils. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Machine Design B2-21. Friction in Ball Bearings. Tests on the friction in ball bearings are contemplated at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Machine Design B3-21. Fatigue and Machinability of Metals. A research on the fatigue and machinability of metals is being planned at the Mason Laboratory, Sheffield Scientific School, Yale University. Address Prof. E. H. Lockwood.

Metallurgy and Metallography B8-21. Mechanical Treatment of Steel. Elaborate study of the effects of the mechanical treatment on the properties of steel through rolling is being made at the Bureau of Standards. After rolling the steel the specimens are prepared for various mechanical tests including metallographic examination. An endeavor will be made to measure the effects of the various factors which enter into the mechanical treatment of metals. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Petroleum Asphalt and Wood Products B1-21. Prevention of Evaporation Losses in Lease Tanks. Report No. 2236 of the Bureau of Mines by J. H. Wiggins gives the results of tests performed in Oklahoma. The tests showed that by making the tanks gastight losses can be prevented which will soon pay for the cost of capping the tanks. The present method of handling oil shows that about $3^1/_2$ per cent of production is lost on the lease, of which a larger part could be saved by gastight tanks. Bureau of Mines, Washington, D. C. Address Director.

Properties of Engineering Materials B1-21. Monel Metal. An investigation on the mechanical properties of monel metal, dealing especially

with repeated stresses, alternating stresses, torsional stresses, and impact. Recent tests with the Izod machine indicate that monoi metal has a higher degree of toughness than any known metal or alloy. Address John F. Thompson, Manager, Technical Dept., International Nickel Company, 43 Exchange Place, New York.

Refrigeration B1-21. Refrigerating Constants. The Bureau of Standards is continuing its program of determining the constants used in refrigeration. So far the Bureau has determined the specific heat of brine, the specific heat and latent heat of ice, the properties of saturated ammonia, and heat transmission through certain insulating materials. Work is now being done on the properties of superheated ammonia and after this the properties of other refrigerants will be undertaken. These will include carbon dioxide, ethyl and methyl chlorides, and possibly sulphur dioxide. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Road Material and Equipment B1-21. Bituminous Pavements. A bulletin is being prepared for the Engineering Experiment Station of the A. and M. College of Texas by Prof. Roy M. Green on the bituminous pavements in Texas, with exception of the bithulithic. Professor Green is now connected with the Western Laboratories at Lincoln, Neb.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

Julian Simsohn and Associates D1-21. The laboratory of Julian S. Simsohn, Chemical Engineers, of Philadelphia, Pa. is equipped for research in water purification, fuels, and combustion in connection with power-plant operation. The work of this corporation is covered by yearly contracts with weekly inspection and tests of plant operation. The service was established in 1912. Address Julian S. Simsohn, Chemical Engineers, Philadelphia, Pa.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Cornell University E1-21. Research Activities. The Department of Experimental Engineering of Sibley College, Cornell University, has been active during the past year along several lines. Investigations made are not reported by printed bulletins and therefore printed matter is not available. The work completed includes the following:

1 Investigation of various makes of hand tire pumps for efficiency and capacity

2 Tests on a new vertical Una-Flow engine

3 Study of the effect of oversize tapping of nuts on the strength and character of the failure of bolts

4 Effect upon the strength of railroad rails of various ways of anchoring

5 Comparative tests of cast iron and of steel radiators

6 Investigation on the mechanical efficiency of a Ford engine

7 Investigation of the forces required to drive staples through paper

8 Study of the proper heat treatment for cotton bailing wire and clips.

The Leather Belting Exchange has moved its belt-testing laboratory from Pittsburgh to Cornell University and a number of experiments are now being made on belts. In addition to this the other work in progress is as follows:

Standardizing the instrument called "Microcharacter," devised for measuring the comparative hardness of crystals in bearing metals

Comparative properties of bolts with cut and rolled threads

Application of the Midgley indicator to a Continental engine

Investigations on the efficiencies of a 45-hp. Diesel engine operated on various fuels

Properties of lubricants under high pressures and low speeds

Design of a friction test machine to investigate the effect of centrifugal forces on the friction losses

Investigation on the tractive resistance of soils in connection with the use of the farm tractor

The theory of the flow viscometer

Address Prof. H. Diederichs, Head of Department of Experimental Engineering, Sibley College, Cornell University, Ithaca, N. Y.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 335 and 347 to 350 inclusive, as formulated at the meeting of April 19, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

Case No. 335

Inquiry: (*a*) Are manhole frames when of the flanged type, considered reinforcing rings and so necessitate their thickness to be at least that of the shell plate, or are they not so considered, so that they can have a thickness less than the shell plate provided their strength meets the requirements of Par. 260?

(*b*) As no method of calculating the strength of flanged manhole frames is given in the Code, would the following method be acceptable? From twice the median line, *ABCDE*, in Fig. 11, subtract twice the rivet-hole diameter and multiply the result by the thickness of the frame and this by the tensile strength.

Reply: (*a*) The thickness of the shell plate referred to in Pars. 259 and 260 is that required by Par. 180 and the thickness and strength of manhole frames and reinforcing rings shall conform to those required for such a shell-plate thickness. When the shell plate is made of greater thickness, such excess thickness shall be given no consideration in the calculations in these paragraphs.

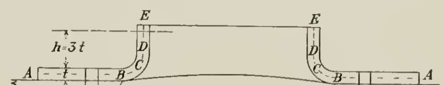


Fig. 11 Cross-Section of Flanged Manhole Frame

(*b*) It is the opinion of the Committee that safe results will be obtained by using as a reinforcement to the ring the flange height (h) up to three times the flange thickness (See Fig. 11).

Case No. 347

Inquiry: Does the requirement of Par. 195 of the Boiler Code for an increase of $^1/_8$ in. in thickness of a dished head fitted with a manhole opening, apply only to concave heads, or to both concave and convex heads?

Reply: It was the intent of the Committee that the increase in thickness of $^1/_8$ in. for dished heads with manhole openings shall apply in all cases whether the heads are concave or convex.

Case No. 348

Inquiry: Would the attachment of a forged-steel manhole neck to a convex head, as shown in Fig. 16, be considered the equivalent of a flanged opening supported by an attached flue and thus be exempted from the requirement for the $^1/_8$ in. increase in thickness specified in Par. 195 of the Boiler Code?

Reply: The manhole neck shown in Fig. 16 is not supported in the sense that it assists the convex head in withstanding the stress due to the steam pressure, and accordingly it is the opinion of the

Committee that it cannot be considered that the head there shown is "supported by an attached flue," and therefore it cannot be exempted from the requirement for the $^1/_8$ in. increase in thickness.

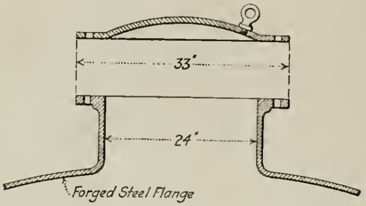


FIG. 16 DISHED HEAD WITH FORGED STEEL MANHOLE NECK

CASE No. 349

Inquiry: Is it permissible, under the requirements of the Boiler Code, in fitting dished heads to the ends of air cylinders or steam drums, to so form the convex head that its flanged edges fit over the outside of the end of the shell, as shown in Fig. 17, instead of within the shell as is usual, in order that a tighter joint may be obtained by calking the edges of the flange to the outer surface of the shell?

Reply: It is the opinion of the Committee that the form of construction proposed is entirely in accord with the requirements of the Boiler Code.

CASE No. 350

Inquiry: Is it permissible, under the rules of the Boiler Code, in fitting different courses of the shell of a boiler at the ends of butt-strapped joints, to weld them together autogenously, in order to avoid the use of plugs or "dutchmen" to render the joints tight?

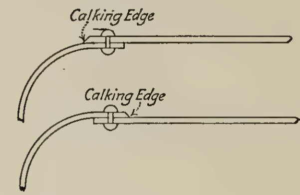


FIG. 17 FORMS OF JOINTS FOR DISHED HEADS IN CYLINDRICAL SHELLS

Reply: It is the opinion of the Committee that if the stress upon the joint is fully carried by the butt straps, the use of welding to render the ends of the joints tight is fully in accord with the requirements of Par. 186 of the Code.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Engineering Appraisement

TO THE EDITOR:

Many years have elapsed since the need for the establishment of the value of a property was first recognized. In recent years many conditions have arisen which have necessitated the application of a great deal of engineering skill in properly establishing property values. With the development of the science of appraisement, many technical terms have been introduced for the purpose of explaining the various property conditions which are met with in establishing correct values.

"Property," as the word is commonly understood, may be broadly divided into two classes: one, physical or tangible property; and the other, non-physical or intangible property. Physical property may include such items as land, buildings, machinery, equipment, patterns, drawings, furniture, fixtures, etc. Non-physical or intangible property may include such items as patent rights, trade marks, trade names, good will, business values, etc.

"Value" and "Worth" are nearly synonymous when applied to the inventory of a property. Many conditions, however, are involved in establishing the value of a piece of property. Among these considerations is the use to which this value is to be put, when once determined. In establishing a value of the inventory of a property for insurance purposes, for instance, we have to consider only the present or reproduction value of that property. But if the appraisement is made to establish correct depreciation charges for cost purposes, an altogether different basis of value must be considered.

"Depreciation" signifies a reduction in worth and results, usually, from one or more of several causes. These causes may be, first, wear and tear; second, physical decay; third, inadequacy; fourth, obsolescence.

"Reproduction" Cost, or reproduction value, is the term usually applied to the value which is placed upon an inventory of a property for insurance purposes. In establishing reproduction value, the cost of a machine, as of the date at which the appraisal value is established, must be first obtained. To this must be added an allowance for freight between point of purchase and point of use, and the cost of installation. Reproduction value should never be used as a basis for determining annual depreciation for either cost or tax purposes. "Reproduction value," "cost to replace new," "replacement costs," and "cost of reproduction" are synonymous and are used in reference to an assumed value based on the estimated cost of reproducing the property.

"Cost Value" is the value established at the time used, on the basis of the prices which indicate the actual purchase cost plus freight allowance and cost of installation as shown by the company's books and records. This cost value is subject to a ruling of the Internal Revenue Branch of the Treasury Department which modifies the application of cost values to the extent that where property has been purchased or acquired prior to March 1, 1913, the cost value applied to the appraisement will be the purchase cost as of that date. For all property acquired subsequent to March 1, 1913, actual cost values as shown by the books and records of the company may be used. It is upon this original cost, or purchase value as of March 1, 1913, that depreciation rates are applied in order to determine proper depreciation charges for cost purposes or for tax purposes. Further, it is in the proper establishment of original cost figures and proper depreciation allowances that the careful and scientific appraisement influences the profit showing of the business.

From the standpoint of the engineer, there is probably no other portion of the work involved in making an appraisement which requires more engineering knowledge and skill than that which has to do with the average life of the particular piece of property under consideration. Values may have been properly established, either with respect to cost or with respect to reproduction. Depreciation may have been accurately figured and extensions accurately made. Totals may have been properly summarized and the value of the property carefully shown. All of these elements, however, may grossly misrepresent the going value of a piece of property

if the depreciation study has been improperly made and the average life of a machine has been improperly determined.

No prescribed rule may be laid down to indicate the average lives or depreciation rates of various kinds of property. The Treasury Department recognizes this principle in determining the average life of a piece of equipment under various conditions and kinds of use, in prescribing that the burden of proof as to correct property values and correct depreciation rests with the taxpayer.

After a complete inventory has been made of all of the various classes of property which are to be appraised, and after reproduction costs of these various classes of property have been established, actual cost figures must be applied to the various items as shown on the inventory in order to set up a correct cost value. Idle equipment must be separated from equipment and machinery in use. Depreciation must be applied upon the estimated average life of the particular piece of equipment. Present depreciated costs must be computed by deducting the amount of estimated depreciation from the cost value of the property.

After these various steps have been completed and the appraisal properly summarized to indicate totals of various classes of property by units for insurance purposes and by departments for cost and tax purposes, provision must be made for maintaining a complete record of all purchases of additional machinery and equipment which may take place in the future. For when an appraisal has been properly made and provision has been made for taking care of additions of property, a true record may, with very little trouble, be maintained so that it will show at all times a very close approximation of the cost value of the property as it exists. A proper statement of reproduction values may not be readily established without the assistance of a competent engineer trained in the methods of making such an appraisement.

In establishing the value of a property by means of an appraisal, two broad classes of business may be considered: namely, industrial property and utility property. Utility valuation in recent years has called for a great deal of engineering knowledge and technical skill, and the natural result of the application of this talent in utility appraisement has been to bring it to a high standard of perfection, while up to the time that federal income-tax requirements necessitated a more exact statement of property values, industrial appraisement was not so exacting in its requirements and therefore had not reached the same stage of refinement.

Appraisals may be made for many special purposes, and in the case of the appraisements of utility properties the outright sale of the property or an application for a readjustment of rates for service may be involved. There are five prime purposes for which appraisements of industrial properties may be made: First, for the proper determination of reproduction values for insurance purposes; second, for determining proper annual depreciation charges for cost purposes; third, for determining proper annual depreciation charges for federal tax purposes; fourth, for the determination of invested capital; and fifth, for financial purposes.

In briefly explaining these various uses of a report of appraisement, we will take them up in order as follows:

First, reproduction values of property vary with market conditions. It is therefore necessary to have a property revalued from the reproduction standpoint frequently so that proper and ample insurance protection may be maintained at all times. In the case of a serious fire loss a complete inventory of property is always on hand for adjusting fire losses, and insurance is maintained on an ample basis to cover such losses.

The second use to which a report of appraisement of a property may be put is in determining proper annual depreciation charges for the purpose of making provision for depreciation in charges to production cost. A report of an appraisement should be summarized departmentally, where departmental burden rates are being applied, so that after depreciation charges have been calculated on the basis of original cost or reproduction value as of March 1, 1913, they may be distributed to the various departments within the establishment to which they apply. These departmental values may also be used in connection with the distribution of other fixed charges such as insurance, taxes, etc. It has been the part of good business and the maintenance of a conservative policy in the past to use liberal depreciation rates. The result of this has been to depreciate the purchase cost of equipment in a plant more rapidly than the depreciation has actually taken place. With present conditions, and a heavy tax facing business, in a great many cases it is desirable to revise this past method of applying depreciation, in order to approach more nearly the actual condition. Again, in many cases of old and conservative companies many items of equipment and machinery which may be properly capitalized have been written directly into expense. This procedure naturally eliminates the possibility of applying depreciation to these values and therefore lowers correspondingly the amount of depreciation which may be written into costs and therefore deducted from profits. This condition may be remedied only by means of a proper engineering appraisement.

Third, much the same conditions prevail with regard to ascertaining the proper amount of annual depreciation for federal tax purposes as apply to the requirements of proper cost accounting. Overdepreciation precludes a proper statement of the affairs of a business, and in many cases an overstatement of profits. Charges to expense account of capital items reduce the capital asset account and reduce the amount of depreciation which should have been charged to production cost and therefore deducted from profits. The Internal Revenue Branch of the Treasury Department has placed the burden of proof of a proper statement of fixed assets and proper depreciation charges upon the taxpayer, and each business must therefore show a proper statement of its affairs in order to make a proper return of its income to the Government. Imperfect records of plant accounts preclude the possibility of proper deductions being made from fixed-asset accounts and from depreciation accounts when machines or equipment are sold or otherwise disposed of. Again we have a condition where it is impossible to make a proper statement of fixed-asset values or depreciation amounts without an appraisal.

Fourth, for the determination of invested capital. There are a number of items which may enter into the determination of invested capital. As we have stated, the assets of a business are divided between tangible and intangible assets according to their nature. From the standpoint of tax exemption these are again divided as between admissible and inadmissible assets. In establishing the amount which may be claimed for exemption under the 8 per cent clause of the Treasury ruling, a correct inventory of all plant items must be established. This inventory may also include other items which are usually subject to appraisement, and which may be included as a portion of invested capital. This inventory should be valued at cost prices, and when properly established forms a part of the schedule upon which the amount of invested capital is based. The method of establishing this value differs from that used in the reproduction or usual cost appraisement and requires considerable knowledge of the application of the law.

Fifth, a clear statement of property values in the shape of an engineering appraisement may be very beneficial in cases where additional stock certificates are to be issued, where bonds are to be issued, in the case of mergers or consolidations, in the case of purchase, sale or lease of property, in the extension of bank credit, etc. While it is true that a banker will scrutinize more carefully the current assets and current liabilities than he will the other items on the statement of a business, it is equally true that where he finds a proper statement of fixed assets backed up by detailed statement of appraisal, he will have more confidence in the report of the affair of a business than he might otherwise have. As a basis for making a loan a banker must be able to judge of the potential capacity and productivity of the business. One of the factors to be taken into consideration is the true statement of the valuation of the property. Where many intricate problems present themselves, the skill and technical knowledge of an engineer are required to properly handle these problems.

Chicago, Ill. L. V. Estes.

The *Technical Review*, quoting from *Industritidningen Norden*, states that a Norwegian firm has succeeded in constructing special electric furnaces from which ferrochrome steel free from carbon can be turned out at a cost slightly higher than that of ordinary steel. An English firm has ordered 25,000 tons of the new steel, to be supplied during the next five years.

Lubrication and Hot Bearings

To the Editor:

The editorial by C. H. Norton in the May issue of Mechanical Engineering on the subject of lubrication and hot bearings is very interesting and contains some valuable ideas. However, it appears that Mr. Norton has been unduly influenced by the results of his experiments with a pair of journal boxes and that his final deductions and conclusions may not be safe in their entirety. Nor does it necessarily follow, assuming his data to be correct for a given condition, that they are safe for all conditions of operation.

Mr. Norton has not very completely described the journals and bearings used in his test, and such data as length and diameter of journal, pressure per square inch of projected area thereon when being operated, character and kind of metal used in the bearings—whether babbitt, bronze or brass—are not given. Inasmuch as the behavior of bearings under varying conditions of operation as well as under certain fixed conditions is very largely dependent upon a number of factors other than speed and lubrication, a complete description of bearings under test should accompany the records of results if it is desired that the data resulting from such tests are to be complete.

It is noted that during a test at a speed of 1000 ft. per min. most of the oil was scraped from the journal into the recess. This no doubt shows what may be expected to take place under the conditions obtaining during the test, but so far as the writer can see, there is no similarity between the conditions where a bearing is being continually supplied with oil, as is done in actual everyday practice, and where the oil supplied is managed as was done during the test described.

Regarding the value of oil grooves in bearing shells, it would appear that actual experience has shown that a bearing properly and carefully grooved is safer than one not grooved. So far as the grooves' effecting a reduction in the net bearing surface is concerned, any bearing so limited in wearing surface as not to permit of the cutting of small oil channels will not likely be a safe bearing to use, since any properly proportioned and designed bearing will permit of the use of suitable oil channels and still be liberally on the safe side so far as bearing surface is concerned.

In general, it may be stated that it is better to run any bearing reasonably cool rather than at high temperatures, even though such high temperatures may be considered safe; and, further, even though the internal friction of the oil may be less at the higher temperatures, because of the fact that after a bearing reaches a certain degree of heat only a small additional increase in temperature is required to develop serious trouble, which may result in a damaged bearing and the loss of the machine from service. It may be said also that thin oil for hot bearings is not by any means always the correct oil to use, for it often happens that a medium and sometimes a heavy oil is the only lubricant that can be safely used on bearings to reduce the temperature after they have gotten too warm for comfort.

Atlanta, Ga. C. T. Baker.

Diesel Engines in Kansas

To the Editor:

The fact that the manufacture of Diesel engines has been steadily increasing in the United States may be verified in many ways. One impressive instance that bears out this conclusion is that prominent manufacturers who formerly were engaged in steam-engine construction are now giving more of their time to the production of Diesel engines. One or two cases are reported in which manufacturers have discontinued steam-engine construction and are now devoting their entire attention to the Diesel engine.

In turning to Diesel-engine installations, it would be natural to assume that these were proceeding more or less uniformly, no locality being especially favored. Kansas, however, is a typical locality in which conditions are favorable for their use. Most of the towns in the state are small and well separated, a condition that is favorable to the small central station in each locality. Steam plants find it impractical in most cases to operate condensing because of the scarcity of water, and few of them make any attempt to improve the economy by utilizing exhaust steam for heating purposes. Furthermore, coal prices are comparatively high, and while Kansas is blest with an abundance of fuel oil, its cost for steam generation exceeds that of coal. Kansas could thus be considered a state that would be more than interested in the Diesel engine as a means of better economy in the production of power.

In studying the various installations of full-Diesel engines in Kansas some interesting facts are disclosed. On January 1, 1920, authoritative data show that the total installed rating of the central generating stations in the state was 138,000 kw.; 13.4 per cent of this power was generated by hydroelectric plants, 21.6 per cent was developed by the steam engine, 55.0 per cent by the steam turbine, and 10.0 per cent by gas and oil engines.

Since water power and steam turbines are confined to the large plants in the state, we can reasonably assume that the 21.6 per cent or 41,900 hp. developed by the steam engine and the 10.0 per cent or 19,300 hp. developed by the gas and oil engine are representative of the small central station. If this be true, 32 per cent of the power generated in the state by the small central station is gas or oil power, and 4100 hp. or 21 per cent of this is generated by full-Diesel engines.

To appreciate fully the work that the Diesel engine is doing in Kansas, it is necessary to go beyond central generating service. There are approximately 30,000 hp. of Diesel engines installed in the state for all classes of service. Only 10 per cent of this power is utilized by the small central station, however, the remainder being used in such service as irrigation projects, pipe-line pumping, flour mills, grain elevators and refrigerating plants. The first engine was installed in the state about 1912. Thus, in approximately ten years the total rating in horsepower of Diesel engines has increased so that today it is practically equal to that developed by the state's water power.

Manhattan, Kan. J. P. Calderwood.

Efficiency of Centrifugal Pumps

To the Editor:

The writer was particularly interested in the excellent paper, The Present Trend of Turbine Development, by L. F. Moody appearing in the April issue of Mechanical Engineering. One might, however, take a slight exception, to one of the curves of Fig. 13, namley, Curve *Q*, showing pump efficiencies attained up to the year 1920.

Referring to this curve, the writer would be greatly interested to learn if such high efficiencies as 65 per cent have been obtained with runners of as low a specific speed as 20. If such is the case it certainly is a very remarkable and creditable performance and data on such pumps would prove very interesting as the usual experience with pumps of that low specific speed is rather disappointing and the efficiency is much more likely to be between 40 and 50 per cent than 65 per cent.

A further study of the curve shows that for a specific speed of about 50 an efficiency of 80 per cent might be expected. This, too, is very unusual and much higher than is generally realized for runners of that specific speed; 60 to 70 per cent is more usual and corresponds rather closely to present American practice. It would be of interest to learn whether this curve was plotted from points actually obtained or constructed from theoretical analysis.

It should be stated here that curves as drawn in Fig. 13 applied to centrifugal pumps are a little misleading. The same applies to a lesser degree in regard to water turbines. The reason for this is that the efficiency is not entirely a function of the specific speed alone but is affected to a considerable degree by the capacity for which the pump is designed.

It is possible to design pumps of equal specific speed but of widely different capacities and each will show in general a different efficiency, usually increasing somewhat with the capacity. For this reason a pump having a specific speed of 50 would show an efficiency of 80 per cent only if the capacity were such as would permit it, and in the experience of the writer this is not usually obtained at discharges much less than 3000 gal. per min.

Ann Arbor, Mich. Allen F. Sherzer.

[The foregoing discussion of Mr. Moody's paper was referred to the author, who in reply has submitted the following communication.—Editor.]

To the Editor:

Prof. A. F. Sherzer's discussion of the writer's paper in the May issue on The Present Trend of Turbine Development has been read with interest.

In regard to Professor Sherzer's reference to Curve Q, in Fig. 13 of the paper, showing pump efficiencies, it should be explained that this curve was drawn tangent to the Curve M, representing pump efficiencies up to the year 1911. The latter curve was intended to be reproduced from Fig. 461 on page 603 of Pumping Machinery, by Prof. A. M. Greene, Jr., edition of 1911. The latter curve terminates at a specific speed of about 30, and the curve shown in Fig. 13 has been extended slightly beyond the original point, and in this extended portion does not represent actual results. I agree with Professor Sherzer's remarks regarding the poor efficiencies usually obtained in this part of the pump field. The highest result of which I have any record at hand in this part of the pump field is an efficiency of about 73 per cent at a specific speed of about 34, shown on the upper part of page 603 of Greene's Pumping Machinery.

The great dependence of pump and turbine efficiencies upon the dimensions of the machine has been alluded to in the article. Thus Curve H was stepped up in efficiency from Curve G, to allow for the increase in efficiency obtainable in larger turbines as compared to the small models from which the test results were obtained. As comparison of Curves J and K shows actual results on two turbines geometrically similar, but one of which was about double the size of the other. It is also stated in the article with regard to the generally lower efficiency of pumps as compared to turbines that "much of the difference the writer believes to be attributable to the generally smaller dimensions of pumps," and this point probably counts in some measure for the low efficiencies which Professor Sherzer mentions in connection with pumps of very low specific speeds, since such pumps are seldom built in large sizes.

Professor Camerer has formulated the effect of difference in size, etc., upon turbine performance, in the section beginning on page 299 of his book Vorlesungen über Wasserkraftmachinen (1914), and the same principles would apply to pumps as well as to turbines. The Camerer formula is not strictly correct, for the reason that it assumes all of the loss to be of the nature of pipe or channel friction, thus neglecting the portion of the losses in turbines or pumps due to loss of velocity head in turbulence, eddies, or final discharge. The Camerer method, however, does give us some idea of the effect of change of size upon turbine and pump performance

Philadelphia, Pa. Lewis F. Moody.

Measurement of Energy Used in Impulse Machines

To the Editor:

When considering the problem of arranging a motor for a machine of the impulse type, such as a punch, shear, etc., about the first thing to be determined is how many foot-pounds of energy are used up during each cycle of work. The plants which are fortunate enough to possess the laboratory equipment for determining this are very few in number, and the writer of this article believes that a simple and very accurate method developed and used by him may be of interest to engineers dealing with the problem of motor drives for such machines.

Machines of this class are usually equipped with a flywheel which stores up energy from the motor during the period in which the machine is inoperative, and which gives out this energy to the machine when a clutch is thrown in. Between strokes the flywheel is simply running loose, and if the motive power were shut off, it would gradually be brought to rest by its own friction on its bearings. When stopping in this way its deceleration is constant. The writer has plotted revolutions per minute against time for a number of flywheels coming to rest in this way, and has in each case found a straight-line law. Since the deceleration is constant, we know that the retarding torque is constant, because torque equals moment of inertia multiplied by angular acceleration (or deceleration) and the moment of inertia for any given flywheel is of course always the same. We also know that work equals torque multiplied by angle turned through (in radians), so that if we knew the angular deceleration o a flywheel, and counted the number of turns which it made in coming to rest from any given speed, we could tell the amount of work originally stored in it by the product of moment of inertia × angular acceleration × angle turned through in stopping. This last would be number of revolutions $\times\ 2\pi$. This formula can be more compactly written as $I\ \alpha\ \theta$.

Let us now consider an impulse machine with a flywheel large enough to give the machine sufficient energy to make a stroke. It must be possible to cut off the source of energy from the prime mover at will. This is done most conveniently by a motor with a switch, but other forms can be used. When the flywheel is up to speed, throw out the switch and simultaneously apply a revolution counter to the flywheel shaft. The flywheel wil now stop by its own friction and the number of turns it makes in stopping can be read from the revolution counter.

Now get the flywheel up to speed again and throw in the clutch so that the machine makes a power troke. The switch should be thrown out at the same time as the clutch is thrown in, so that this stroke is made by energy taken from the flywheel. The revolution counter should be applied at the *completion* of the stroke and the number of revolutions made by the wheel in stopping should be noted. Two or three men are of course necessary to perform these operations simultaneously.

If θ_1 be the angle turned through to stop when no stroke is made, the original energy in the wheel is

$$I\ \alpha\ \theta_1 \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

If θ_2 be the angle turned through to stop after a stroke is made, the energy remaining in the wheel is $I\ \alpha\ \theta_2$ and the energy given to the machine is the difference between the two or

$$I\ \alpha\ (\theta_1 - \theta_2 \quad \ldots\ldots\ldots\ldots\ldots [2]$$

We have yet to find α, the angular deceleration. We can get this as we know the original angular velocity of the wheel, which we call ω, from the formula

$$\tfrac{1}{2}\ I\ \omega^2 = \text{original energy in the wheel}$$

which is also given by [1] so that

$$\tfrac{1}{2}\ I\ \omega_2 = I\ \alpha\ \theta_1$$

or

$$\alpha = \frac{\omega_2.}{2\,\theta}$$

Substituting this in [2],

$$\text{Energy given to machine} = \tfrac{1}{2}\ I\ \omega^2 \left(1 - \frac{\theta_2}{\theta_1}\right)$$

This can be written in a more convenient form

$$W = \tfrac{1}{2}\,I\,\frac{(\text{r.p.m.})^2\pi^2}{900}\left(1 - \frac{N_2}{N_1}\right)$$

or

$$W = \frac{I\ (\text{r.p.m.})^2}{182}\left(1 - \frac{N_2}{N_1}\right)$$

where

I = moment of inertia of flywheel
= (weight in lb./32.2) × (rad. of gyration in ft.)^2

r.p.m. = rev. per min. of flywheel when running light between strokes

N_1 = number of revolutions to stop from full speed by friction alone

N_2 = number of revolutions to stop after a stroke has been made by energy in flywheel

W = energy in ft-lb. given to machine in one stroke.

The above formula gives the amount of work given to the machine for one stroke. If we know the number of strokes per minute, we can multiply W by this, divide by 33,000 and get the horsepower. If we have a speed-torque chart of the proposed motor and we know the allowable drop in speed during a stroke, it is obviously quite easy to work out the proper combination of motor and flywheel for any given machine. Of course, *any* flywheel which is large enough can be used for getting the work done during one working stroke.

The writer has used the above method in selecting motor drives for a large number of impulse machines, and has found that, with reasonable care, perfectly satisfactory results can be obtained.

C. O. Rhys.

Beverly, Mass.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

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The Need for Research

ARTHUR M. GREENE, JR.

THE word "research" may seem to some to be overworked in these days. When one stops to think of the many thing which have been developed during the last two decades from the results of research, we must realize its importance even more than before. One need only think of the gas-filled lamp, of long-distance telephony, of wireless telegraphy and telephony, of oil cracking, of the air brake, of the modern hydraulic turbine and centrifugal pump to prove what we have said. Many of the new inventions have come as the result of research in pure science where the application was not considered in the research, many have come from investigations to determine the facts for the development of a desired result. In any case the world has benefited; in any case we have extended the frontier of knowledge; in any case we have contributed something to the comfort of man and usually we have conserved nature's energy by more economic applications.

The problems of research which interest the mechanical engineer and which require solution are very numerous, and a few which are receiving the attention of the Research Committee of the A.S.M.E. will be mentioned in this short statement.

Few realize the great loss resulting from the inefficient use of gasoline in an efficient engine. The mechanical engineers of Great Britain have made several valuable reports on the gas engine and its action, and from these our knowledge has been greatly extended. The United States Bureau of Mines has very recently made an investigation of automobile action for the purpose of obtaining data for the proper ventilation of the new vehicular tunnel under the Hudson River at New York. This investigation has shown the inefficiency of the mixing devices used on the engines and points clearly to a great saving by careful and continuous inspection of the exhaust gases from the engine and adjustments of carburetors. The investigation points to the possibility of a development of some other type of mixing device to secure proper proportions of gas and fuel.

The use of steam at high pressure and high superheat in the new or projected power houses calls for a further study of the properties of saturated and superheated steam, as there are differences in these regions which must be harmonized. The research must be faced with absolute integrity and with no bias. Personal, reactional or commercial prejudices must be completely removed and the truth aimed for.

The researches devoted to the elimination of waste from friction are important, as this is present in all moving machinery. Two special committees of the Society are at work on this matter, one endeavoring to study lubricants and the other bearing metals. What are the peculiar properties of oils which reduce friction? What are the properties of metals which make a good bearing metal? Why is the friction loss what it is? The answers to these questions will help us reduce this great source of waste.

Meters for the measurement of flow of fluids have been known for many years, but the peculiar features of installation and maintenance, the limitations of different types, the proper care in operation and the correct theory underlying various types have not been stated clearly and collectively. A special committee of our Society is caring for this matter, and their preliminary report will appear at the Annual Meeting. At the present time they are engaged in studying the problem of pulsating flow.

The rupture of marine shafting subject to driving forces which do not stress it excessively, is due to the fact that the force is a periodic one and vibration is set up. The special committee of research on this subject is taking up another phase of research in collecting all information relating thereto and presenting it to the Society for the benefit of the profession. They will present it in a form which may be of use to the engineer—not only do we need investigation of natural phenomena but the work of research includes the presentation of complete data when this is scattered through technical literature extending over years.

Another phase of research for the mechanical engineer is that undertaken by our Mid-Continent Section, the investigation of the commercial development of industries near the supply of raw materials or near the points of consumption for the purpose of eliminating transportation costs and consequent waste.

The preliminary report of the Committee on the Elimination of Waste in Industry of The Federated American Engineering Societies represents another research of the mechanical engineer. This study has revealed many surprising facts not known before, and even facts which are contrary to accepted beliefs of the past. This mention is made to call attention to this type of research.

What can the profession do to help in this great activity?

First, we should insist on having data for our work. When not known we should investigate and determine the data.

Second, we should be willing to give our data to the profession after we have used it for our development work. Many data are buried where they are doing no work and their publication would not damage our business and would help the proiession.

Third, financial support can be given to those who are equipped to work for the profession in securing data as the result of research.

ARTHUR M. GREENE, JR.

The Waste Report

AS this issue of MECHANICAL ENGINEERING reaches the reader, the edited manuscript of the report of the American Engineering Council Committee on Elimination of Waste in Industry will be ready for the printer. Advance information indicates that the report will be notable for its contents, for the development of fundamental methods for evaluating waste, for the speed with which it was executed, and for the wonderful spirit of coöperation and sacrifice evidenced by the members of the Committee and the managers of the industries considered in the document. In itself it is an example of what can be done with a purpose, a plan, a schedule, and the highest type of unselfish team play.

The Committee proposed to analyze industrial waste, evaluate it, ascertain the causes and suggest measures for getting rid of it. One fact should be constantly borne in mind, however. The report is but preliminary in character, and this has been emphasized again and again by the Committee. It is the message brought

back by a reconnoitering party sent out to determine the best points for a concerted attack on waste in industry, the national economic problem of great magnitude. As expressed by one member of the Waste Committee, it corresponds to the preliminary assay of the metallurgist, the preliminary survey of the civil engineer or the estimate of the designer, all of which must be completed and digested before the actual engineering work can be started.

To conform to this avowed purpose it was important to obtain concrete information quickly. The work actually began on January 3, 1921, and five months later the findings were submitted to the American Engineering Council. The printed report will give the results obtained from intensive investigations of 75 plants in 5 industries, (Building trades, men's clothing, shoe manufacturing, printing and metal trades) and extensive reports on unemployment, strikes and lockouts, sales and purchasing policies, and health and accidents.

After thorough investigation the Committee, to its great surprise, found that there was no standardized method of analyzing and evaluating waste. The first duty was therefore to determine upon an analysis procedure and to set up standards by which waste might be measured. Arduous work was required, but the resulting method, which will be described in the report, is a monument to the Committee's efforts.

In its endeavor to determine the cause and place the responsibility for waste, the Waste Committee faced a severe problem. Obviously waste is not waste unless its wastefulness is known and appreciated. Responsibility for waste cannot be accepted by any individual or group if the waste itself is not acknowledged. The greatest value of the report, therefore, will be its indication of the whereabouts and extent of waste and its assignment of responsibility for waste elimination. This is a far different thing from assigning responsibility for the waste itself.

We can look forward, therefore, to the appearance of a document which will point out broadly the wastes in industry, evaluate them according to a scheme developed by the Committee, and definitely assign the responsibility for their abatement. The elimination of industrial waste is a fundamental requisite for the advancement of our civilization and the work started so ably by the Committee must be carried on coöperatively by commercial, industrial professional and technical societies and associations.

As the society of the industries, The American Society of Mechanical Engineers will devote its entire 1921 Annual Meeting program to the main topic of the Elimination of Waste in Industry, and each of its Professional Divisions will hold sessions which will treat of some definite technical phase of the problem in a thoroughly constructive way. This will be the first organized attack on the waste problem.

Dr. A. E. Kennelly the First French Exchange Professor

The scheme of regular annual exchange of professors between individual universities in France and the United States in academic fields has been extended into engineering and applied science. After negotiations started by Dr. MacLaurin of Massachusetts Institute of Technology in 1919 and consummated finally through the Institute of International Education, a relationship has been established between the French University Administration and a committee representing seven American institutions which goes into effect in the fall of 1921. The French have selected for their first representative, Professor J. Cavalier, rector of the University of Toulouse, and a well-known authority on metallurgical chemistry. He will divide his time during the ensuing academic year among the seven coöperating institutions, namely, Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania and Yale. Although it would have been impracticable to have included a larger number than seven in the American plan, yet it is hoped that other institutions may also derive benefit from the incoming French professor's visit.

The American representative will be Dr. A. E. Kennelly, professor of electrical engineering at Harvard University and the Massachusetts Institute of Technology. Dr. Kennelly has already left for Europe.

The methods of teaching engineering and applied science vary widely in the two countries and the increase in mutual understanding of each other's ideals and viewpoints will be especially fruitful in broadening the engineering profession of America. It is hoped that the plan will operate favorably and lead to an exchange of advanced students to further increase mutual study and mutual friendship.

Eugene Schneider Awarded John Fritz Medal for 1922

The John Fritz Medal for 1922, awarded to Charles Prosper Eugene Schneider, distinguished French engineer and scientist, for "achievement in metallurgy of iron and steel; for development of ordnance, especially the 75-mm. gun, and for notable patriotic contribution to the winning of the war," was presented to him at a meeting of American and British engineers in Paris on July 8.

M. Schneider heads the great Creusot engineering and steel works and shipbuilding plants of France, which with their subsidiaries have 100,000 employees. The remarkable achievements of France in the steel industry during the war were due largely to the genius and energy of Eugene Schneider and his associates in Le Creusot Steel Works. Within two and one-half years France nearly tripled the number of her blast furnaces and increased the number of her open-hearth furnaces by 60 per cent. During the war she increased her production of rifles 290-fold, of machine guns 70-fold, of 155-mm. shells 225-fold, and of 75-mm. shells beyond reckoning.

M. Schneider not only has led in the technical and commercial development of the great and varied steel and other engineering industries of France, but has also given effective attention to the well-being of his men and their families. His schools for workmen, foremen and engineers are among the best in the world. As early as 1877 his company introduced a pension system, antedating similar action by the French Government. He has done much to raise the standards, broaden the outlook and bind the loyalty of his men.

M. Schneider is a member of a number of French clubs and societies. He has received many honors in his own and of the countries for his achievements, among these being the award or the gold medal of the Mining and Metallurgical Society of America, presented to him in 1919.

Dr. Ernest Fox Nichols New President of M. I. T.

The Massachusetts Institute of Technology has selected Dr. Ernest Fox Nichols to succeed the late Dr. Richard C. MacLaurin as president of that institution. A close personal friend of Dr. MacLaurin, he is a full believer in the theory first enunciated by the latter that an engineering school is not doing its complete duty to itself unless it establishes the closest possible relations with the industry of the country. Under Dr. Nichols' guidance, therefore, M. I. T. will continue its plan of organized service to industry.

Dr. Nichols was born in Leavenworth, Kan., in 1869, and was graduated from the Kansas Agricultural College in 1888. He spent several years at Cornell University as a graduate student in mathematics and physics, receiving the degree of master of science in 1893 and doctor of science in 1897.

From 1892 to 1898 Dr. Nichols occupied the chair of physics and astronomy at Colgate University, during which time he was granted leave of absence of more than two years which he spent in study under Professors Planck and Rubens, at the University of Berlin. He was co-author with the latter of Certain Properties of Heat Waves of Great Wave Length, a research which gave physicists new methods of attack. While making this research he devised a new form of radiometer which he later used in this country in measuring the heat from the stars and planets.

In 1898 Dr. Nichols was appointed professor of physics at Dartmouth College, where he remained for five years. During this time he, with his assistant, Assistant-Professor Hull, discovered the pressure of a beam of light, and made accurate measurements of this force.

After a year as professor of experimental physics at Columbia University, Dr. Nichols went to England to lecture at the Royal Institution in London and the Cavendish Laboratory of Cambridge University. In 1905 he resumed his professorship at Columbia, remaining there until 1909, when he was appointed president of

Dartmouth, a position which he held for seven years. From 1916 to 1920 he was professor in physics at Yale. For the past year he has been director of the physical research at the Nela Park Laboratory of the National Electric Lamp Association, Cleveland.

Dr. Nichols has received honorary degrees from a number of colleges and is the author of many articles on scientific subjects.

Arthur M. Greene to be Dean of Enlarged School of Engineering at Princeton

During Commencement at Princeton University it was announced that the trustees of the University have planned to enlarge its School of Engineering for the purpose of giving courses in mechanical, chemical and mining engineering, in addition to those in civil and electrical engineering which have been offered for some years past. These courses will extend over four years, at the end of which time the bachelor's degree will be given. A fifth year will be required for an engineering degree. The plan of the school is one which will not compete with those of engineering schools giving a four-year course, the intention being to make each of the courses mentioned such that the student will secure sufficient engineering training in four years to become an assistant to an engineer, and so be self-supporting, and in addition receive a thorough grounding in physics, chemistry, mathematics, languages, literature, philosophy, economics and sociology to give him a broad outlook on everyday problems. The endeavor will be to make an engineer rather than a specialist.

The fifth year is to be devoted primarily to engineering subjects, including certain courses in engineering economics and possibly a limited amount of research.

Prof. Arthur M. Greene, Jr., of the Rensselaer Polytechnic Institute, has been called to become the dean of the new school and professor of mechanical engineering; he will take up his duties in the fall of 1922.

Professor Greene was born in Philadelphia. He was graduated from the University of Pennsylvania in 1893, receiving the degrees of M.E. and D.Sc. from that institution in 1894 and 1916, respectively. From 1894 to 1907 he was successively instructor in Drexel Institute, instructor in mechanical engineering at the University of Pennsylvania, and professor of mechanical engineering at the University of Missouri, where in 1906 he was Junior Dean of the School of Engineering. In 1907 he was called to the professorship of mechanical engineering at the Rensselaer Polytechnic Institute, where he planned, equipped and developed the present mechanical engineering laboratory. He also planned and equipped new mechanical laboratories at the Universities of Pennsylvania and Missouri.

Professor Greene has served as manager and vice-president of The American Society of Mechanical Engineers and at present is chairman of the Research Committee of the Society, a member of the Boiler Code Committee and chairman of its Special Committee on Steam Piping. He is one of the Society's representatives on the Engineering Division of the National Research Council and on the Executive Board of The Federated American Engineering Societies. He is a past-president of the Society for the Promotion of Engineering Education and the Society of Engineers of Eastern New York, a fellow of the American Association for the Advancement of Science, and a member of The Franklin Institute. He is the author of a number of important treatises on mechanical engineering subjects.

Bradley Stoughton Resigns Secretaryship of A.I.M.E.

After having discharged the duties of Secretary of the American Institute of Mining and Metallurgical Engineers since 1913, during which period the Institute has greatly grown in numbers and influence, Bradley Stoughton has resigned from this office in order to be at liberty to take up other professional activities.

Mr. Stoughton was graduated from Sheffield Scientific School in 1893, with the degree of Ph.B., and from Massachusetts Institute of Technology in 1896 as S.B. He was instructor in the latter institution the following year, and in 1897 became assistant to Prof. H. M. Howe at Columbia University. He was metallurgist for the Illinois Steel Company at South Chicago, Ill., during 1898–1899; chief of the cost statistical division of the American Steel and Wire Company, Cleveland, in 1900; and manager of the bessemer steel department of Benjamin Atha and Company, Newark, N. J., in 1901. From 1902 until his assumption of office in the A.I.M.E. he was in business as a consulting engineer. He was a member of the general engineering committee of the National Council of Defense in 1918–1919. He was for a time head of the metallurgical division and later vice-chairman of the engineering division of the National Research Council.

Mr. Stoughton is a member of the American Iron and Steel Institute, The Iron and Steel Institute (England), the American Society for Testing Materials, International Association for Testing Materials, and the American Electrochemical Society; a trustee of the American Civic Alliance; and a member of the Executive Committee of the N. Y. Association for Relief of the Blind. He is also a member of the Engineers' and Technology Clubs of New York.

He is the inventor of a converter for making steel castings, and a process for oil melting in cupolas. In 1908 he wrote a treatise on the Metallurgy of Iron and Steel which is a standard work on this subject.

Mr. Stoughton brought to the position of secretary a rare combination of abilities not only as a teacher, a designer, an inventor and a writer, but as a forceful speaker on all occasions, and he had an acquaintanceship with the best minds in the world, which he has greatly extended while secretary.

In accepting the resignation of Mr. Stoughton, the Board of Directors of the Institute issued the following words of appreciation:

> The Board of Directors of the Institute, having accepted with regret the resignation of Mr. Bradley Stoughton as Secretary, would put upon record its appreciation of his long and very efficient service to the Institute and further of his willingness to postpone an actual severance of relations with us until it may be convenient for the Board to elect a successor and even until such successor shall have had an opportunity of becoming acquainted with the details and routine of the office.
>
> The Board recognizes the fact that the duties of the office of Secretary have been greatly increased since Mr. Stoughton's first acceptance of this office eight years ago. Our membership at that time—in 1912—was 3500; today it is about 9900, which fact alone means a greatly increased correspondence. While Mr. Stoughton's predecessors in this office were not frequently called upon to travel, excepting upon the occasion of meetings outside of New York City, under the policy introduced some years ago of visiting the Local Sections or having the Institute adequately represented at the meetings of other scientific bodies, Mr. Stoughton has been called upon to travel, and the Board is pleased to believe that in his bearing and in his speeches he has worthily represented the Institute and has enhanced its appreciation among our many members who, for one reason or another, are not able to visit the headquarters frequently.
>
> The Board of Directors expresses the hope that in a new field of activity Mr. Stoughton may have the great success which his abilities deserve, and would put upon record its appreciation of the self-sacrifice with which he has devoted himself to the interests of our organization at the expense of his own professional preferment or financial advantage.

Franklin Institute Awards

At a meeting of the Franklin Institute held on May 18, 1921, honorary membership was conferred upon Gen. John J. Pershing and Frank J. Sprague, consulting engineers of New York City. Mr. Sprague was also presented the Franklin medal for his achievements in electric traction. He was the pioneer of the modern electric railway, inventing the multiple-unit system of electric train control, the constant-speed electric motors, the system of automatic braking train control, etc. He also inaugurated the high-speed electric elevator.

Another recent award of The Franklin Institute is that of the Edward Longstreth Medal of Merit to Jacob M. Spitzglass, vice-president and consulting engineer for the Republic Flow Meters Company, Chicago, Ill., "in consideration of the novelty of recording electrically the flow of liquids in pipes and the mechanical simplicity and excellence of this measuring apparatus." A description of the meter developed by Mr. Spitzglass was given by him in a paper presented before The American Society of Mechanical Engineers in 1919 and printed in the May 1919 issue of Mechanical Engineering, page 429.

William B. Cogswell Dies

William B. Cogswell, founder of the Solvay process and manager and vice-president of the Solvay Process Co., Syracuse, N. Y., died at his home in New York City on June 7, 1921. Mr. Cogswell was born in Oswego, N. Y., on September 22, 1834. He received his early education at Hamilton Academy and at a private school conducted by Professor Root of Syracuse. He completed his education at Rensselaer Polytechnic Institute, from which he was graduated in 1851.

For three years after leaving school Mr. Cogswell se·ved as an apprentice in a machine shop in Lawrence, Mass., and was then for a few years connected with a railroad as superintendent of machinery. In 1859 he became superintendent of the Broadway Foundry, of St. Louis, and in the following year organized the firm of Sweet Brothers & Co., Syracuse, which later became the Whitman & Barnes Manufacturing Co.

During the Civil War he was rated as a mechanical engineer in the Army and later was retained by the Franklin Iron Works to superintend the construction and operation of blast furnaces in Oneida County, N. Y. From 1874 to 1879 he was in the mining business. Three years later he became interested in the manufacture of ammonia soda. He went to Europe to make a study of the soda industry and was commissioned by Solway & Co., Belgium, to locate a plant in the United States in 1891. Through his efforts the Solvay Process Co. became famous.

Mr. Cogswell was a member of over a hundred scientific societies, social organizations and clubs, among which may be mentioned the American Academy of Arts and Sciences, the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Chemical Society, N. Y. State Chamber of Commerce, Sons of the Revolution, and the Colonial Society of America. He belonged to many social clubs in New York City and in Syracuse.

He became a member of the A.S.M.E. in 1880 at the time of its organization and served as one of the managers until 1882.

Death of Charles Maples Jarvis

Charles Maples Jarvis, for some years president of the American Hardware Corporation, New Britain, Conn., and for 22 years before that prominently identified with fabricated steel work, died on May 21, 1921, after an illness of two years. Mr. Jarvis was born on April 16, 1856, at Deposit, Delaware County, N. Y. He was graduated from the Sheffield Scientific School of Yale University in 1877 as a civil engineer. He then entered the employ of the Corrugated Metal Co. East Berlin, Conn., as engineer and draftsman. Later he became chief engineer and president of the company and on its absorption by the American Bridge Co. became a director of the latter as well as a vice-president and member of the executive committee. He retired when the company became a subsidiary of the U. S. Steel Corporation. Mr. Jarvis became a member of The American Society of Mechanical Engineers in 1890 and served as vice-president from 1897 to 1899.

Death of Samuel E. Tinkham

Samuel E. Tinkham, connected since 1874 with the engineering department of the City of Boston, Mass., and with its successor, the Department of Public Works, died on April 21, 1921. Mr. Tinkham was born on March 3, 1852, in Taunton, Mass. He was graduated from the Massachusetts Institute of Technology in 1873 in civil engineering and began work in the engineering department of Boston in 1874. In 1914 and 1915 he was acting division engineer of the bridge and ferry division of the Department of Public Works of Boston, and later became engineer of construction of the division. He was prominently connected with the management of the Boston Society of Civil Engineers for more than forty years and was its secretary from 1880 to 1882, and again continuously from 1887 to date. He also belonged to various fraternal, patriotic and social organizations.

U. S. Industrial Waste Commission Proposed

A bill intended to continue and to amplify the survey of the elimination of waste in industry, made by the committee of the F.A.E.S., has recently been introduced in Congress by Senator Calder. The bill provides for the presidential appointment of a United States Industrial Waste Commission consisting of the Secretary of Commerce as chairman and six others, who shall make a study of waste in the utilization of the available supplies in the United States of timber, power, transportation, oil, coal, and essential minerals, and shall recommend improved methods for their utilization. The Commission is also to recommend measures for elimination of intermittent and seasonal production and of national waste. It is to serve without compensation, adopt its own plan of procedure and submit its report to the President on or before Sept. 1, 1922.

John Crerar Library in New Home

The John Crerar Library, Chicago, first opened to the public in 1897, has recently moved into its new building at the corner of Michigan Avenue and Randolph Street. This library is a free public reference library of scientific and technical literature, endowed and maintained by a bequest of John Crerar, a prominent business man of Chicago who died in 1889. At the time of its first opening it had 15,000 volumes ready for use and 7,000 more in the hands of cataloguers. Its report for 1920 shows a total of over 425,000 volumes and 177,000 pamphlets and over 4000 periodicals currently received. Its property is valued at nearly $6,000,000 and it was used during 1920 by nearly 50,000 people despite the fact that it was closed for four months of the year during removal. It is estimated that the property on which the new building is located will provide for the needs of the Library for 150 years. The dedication took place on May 28 and was attended by representatives of various scientific and technical societies.

U. S. Patent Office Relief

The Lampert bill for Patent Office relief has been reported out favorably in the House and the House Committee on Rules will probably make a special rule for hastening its passage. The federal trade commission section which was incorporated in the Nolan bill and which prevented its passage in the Senate in the last session, has been omitted from the present bill, which otherwise closely parallels the Nolan bill.

The Lampert bill provides for about fifty additional employees in the Patent Office at Washington and for an increase of approximately $500,000 in the Patent Office appropriation. This will greatly relieve the serious condition due to the resignation, on account of inadequate compensation, of over 100 examiners and over 150 of the clerical force in the past sixteen months. On account of this shortage of employees, work in the Patent Office has been greatly delayed so that some 46,000 applications for patents are now pending and work throughout the office is months behind.

Under the Lampert bill there will be increases in the salaries of the examiners, commissioners, and clerks ranging all the way from $150 to $2300, according to the character of the work performed, and there will also be various modifications in procedure made necessary by changing conditions during the last few years.

Registration at Engineering Colleges in U. S.

A census of the registration at engineering colleges throughout the United States was recently made by *Engineering News-Record*. Returns from 81 institutions located in 36 states show a total registration for the college year 1920–1921 of 48,312 students in all engineering courses as against 46,395 for the previous year. There has been, therefore, a gain of 4.1 per cent. The figures reveal that mechanical engineering is the most popular of the engineering courses. This year 12,159 students were registered in mechanical engineering and last year 11,693, a gain of 466. Electrical engineering runs mechanical engineering a close second, the figures for this year and last year being respectively, 12,118 and 11,285, or a gain of 833. Civil engineering comes third with 8592 undergraduates this year and 8469 last year. Chemical engineering, with about 6500 students for the past two years, takes fourth place, while the mining engineering course, in fifth place, shows a considerably smaller registration than any of the others.

News of the Federated American Engineering Societies

A.E.C. Sends Resolution of Thanks to A.S.M.E.

The following resolution to the officers and members of The American Society of Mechanical Engineers has been received from American Engineering Council's Committee on Procedure, acting for the Executive Board of the Council:

Whereas, The members and officials of the American Society of Mechanical Engineers manifested great interest and gave unsparingly of their time and effort to the preliminary arrangements and meetings leading to the organization of The Federated American Engineering Societies; and

Whereas, The office facilities and clerical force of The American Society of Mechanical Engineers were made available and extensively used by officers of The Federated American Engineering Societies during their organization period; and

Whereas, The executive and administrative officers of The American Society of Mechanical Engineers were always most attentive to every request for advice and help; be it

Resolved: That the Executive Board of the American Engineering Council in behalf of The Federated American Engineering Societies hereby express the deep appreciation of the engineering fraternity for the valuable, efficient and effective help which has been rendered by The American Society of Mechanical Engineers.

Elimination of Waste Report Made Public at Executive Board Meeting on June 3

THE fourth meeting of the Executive Board of the American Engineering Council was held at St. Louis on the first anniversary of the Organizing Conference which met in Washington on June 3, 1920. As a result of invitations to the leading engineering organizations in the vicinity of St. Louis, a number of representatives of these bodies were present at the meeting.

The outstanding feature of the meeting was the presentation and consideration of the preliminary summary of the report of the Committee on the Elimination of Waste in Industry. This was fully discussed and the report referred back to the Committee for publication. The Committee on Procedure was authorized to accept the offer of The American Society of Mechanical Engineers to arrange for the publication of the complete report in book form. Announcements as to when and where copies of this report may be obtained will be made later.

Upon the recommendation of the Committee on Membership and Representation the following organizations were admitted to charter membership in the Federation: Iowa Engineering Society, Jamestown Engineering Society, and American Society of Safety Engineers. Under the constitution the opportunity of coming in as charter members expired on July 1, but considerable sentiment has developed in favor of extending the time for this purpose and as a result the Executive Board has decided to bring the matter before the next meeting of the American Engineering Council, to be held in January 1922.

Following a discussion as to the possibilities of coöperation between the Federation and the American Association of Engineers, L. W. Wallace, Dexter S. Kimball, and Calvert Townley were appointed a committee of three from the F.A.E.S. to consider this matter with a committee of three to be appointed by the Board of Directors of the A.A.E. The committee was not given any specific instructions. It is to report its findings to the Executive Board.

Among the recommendations of the Public Affairs Committee which were given the approval of the Executive Board were the following:

That no action should be taken in legislation pertaining to the Federal Power Commission; and

That the American Engineering Standards Committee plan for obtaining coöperation with Government departments be sanctioned.

The Committee on Licensing submitted a report containing its new recommendations on the uniform law. After considerable discussion it was decided to send the report back to the committee with the request that a hearing be held at which all interested may have an opportunity to speak and that following this hearing the report be redrafted so that it may receive further detailed consideration at the next meeting of the Executive Board—to be held sometime in September.

The Board approved support for the present bill in Congress to give increased assistance to the topographic mapping program recommended by the Board of Surveys and Maps, on which L. W. Wallace is serving as representative of American Engineering Council.

The recommendations concerning coöperation with the Personnel Research Federation were carried over for further consideration and the question of representation on the National Conference Board of the Building Industry was referred to the Committee on Procedure with power in the event that this matter should again be brought up. Upon recommendation of the Committee on Procedure, J. P. Healy, of Washington, D. C., was appointed alternate to Rudolph P. Miller on the National Board of Jurisdictional Awards in the Building Industry.

The Committee on Foreign Relations reported that it had participated in the reception and entertainment of delegations of Italian and French engineers visiting in this country. A resolution to British engineers expressing admiration for their effective work during the war, and sympathy for the sacrifices in life, health, and property which their services involved, was approved by the Board and a special committee was appointed to draft a similar resolution to French engineers.

Important Amendment to U. S. Patent Laws Proposed

Legislation to require the compulsory working in this country of patents issued to or controlled by nationals of foreign countries has been brought to the front by the introduction of Senate Bill 1838, which carries the following amendent to that section of the patent statutes which deals with the patenting in this country of inventions previously patented in a foreign country:

> Any patent or patents issued to a person or persons not citizens of the United States shall contain a proviso to the effect that if such patent so granted is not worked or put in operation so as to result in actual production of the article in reasonable quantities embodied in such patent in the continental limits of the United States within the period of two years from the date of its issue, the United States reserves the right to license any person or persons for purposes of manufacture in the United States, and to use and sell the subject matter thereof.

The amendment subjects this provision to a further provision empowering the Commissioner of Patents to determine a fair royalty to be paid the foreign owner of the patent by the licensee in consideration of the license.

Under the present patent system, a foreign inventor has the right to manufacture, use and vend his invention in this country for seventeen years. But as each of these rights is a separate entity, inventors can take advantage of the economic conditions prevailing in foreign countries and manufacture their inventions in their own countries at less expense than in United States. Even the expense of transportation and import tariffs do not usually increase the cost to such an extent that it would be more economical to manufacture the invention in this country. It has therefore become almost universal practice for a foreign owner of a United States patent to manufacture the invention in his own country, and then take advantage of his right to its sale in the United States.

Supporters of the amendment state that by granting to a foreign inventor the exclusive right to sell his invention in this country entirely independent of the requirement that it also be manufactured in this country, the United States patent laws foster the development of foreign industries and retard the development of our own. An example cited is that of the dye industry, in which practically all developments are held by German inventors or their assignees. While the United States is one of the large users of dyes, her dye industry has not prospered, by reason of the German-held United States patents, while the dye industry in Germany has grown enormously.

On the other hand, there is strong opposition to the amendment by those who point out that it would have a tendency to force the

working of patents in this country which are owned by foreign capital, defeating Americam manufacturers who are trying to make this country independent of, for instance, the German dye and other industries. For if the foreign-owned American patent were of sufficient value to warrant competition here, its owner would be willing to comply with the provision, rather than allow the manufacturing rights to pass into American hands. But if it were an unimportant patent he would lose little and the United States gain little if the patentee failed to comply with the compulsory working provision.

It is further argued that to enact a compulsory working clause applicable only to foreign owners of American patents might easily pave the way for such a clause applicable to all United States patents, even though owned by American citizens. The objections to such a situation are so apparent as to need no enumeration.

The amendment is undoubtedly an extremely important piece of legislation, affecting both the tariff system and foreign relations, and merits the careful attention of all interested in the protection and development of the United States industries.

This amendment, which is known as the Stanley bill, was inaugurated by the War Department and is intended to apply especially to war materials. The Senate Committee on Patents has recommended its immediate passage without amendment.

Licensing of Engineers in New York State

Frequent inquiries as to the working of the New York State Engineers' License Law, passed May 14, 1920, and amended May 6, 1921, have resulted in the publication of the following brief summary covering the chief provisions of the law.

No engineer unless licensed may legally practice professional engineering or land surveying after May 6, 1923, that is, two years after the date the law was amended.

In a corporation, partnership, or joint stock association engaged in the practice of engineering the engineer in responsible charge of the work must be licensed. Subordinate engineers who report to such an engineer need not necessarily be licensed. It is to be hoped, however, that the prestige of a license will be such that all engineers who are eligible for license will apply for one.

Some exemptions are allowed non-resident engineers practicing in New York State. No license is required for:

1 Offering to practice when having no established place of business in New York State
2 Practicing when having no established place of business, provided such practice does not aggregate more than thirty days in one calendar year and provided such non-resident engineer is legally qualified for such professional service in his own state or country
3 Practicing professional engineering or land surveying, provided application for license is pending, and fee has been paid. Such exemption to continue only for such reasonable time as is required for granting or denying of application.

Further exemptions are made for engineers practicing as pupils or under the direction of a licensed engineer, or practicing on work solely for the United States Government, and further, practicing solely as an employee of the state from the time act becomes effective until the expiration of the then existing term of office of such employee.

The registration fee is \$25 for a license either as a professional engineer or as a land surveyor, or \$35 if the license be for both combined. The yearly renewal fee is one dollar if made prior to December 31, with a penalty of ten cents for each month's delay in paying renewal, accumulating to a maximum of two dollars.

An Opportunity for Hydraulic Research

Offers which have been made recently to the Engineering Foundation, if supported by financial assistance, will make possible an extensive research in hydraulics. One of the largest hydraulic power companies in America has offered to coöperate with the Engineering Foundation by making its valuable facilities available in any way in which they can be properly used, and an eminent hydraulic engineer has also offered his advice in conducting such a research. To take advantage of this opportunity, the Foundation states that it needs a special fund of not less than \$25,000 a year for a number of years. Further information may be obtained from Alfred D. Flinn, secretary of the Foundation, 29 West 39th Street, New York, N. Y.

NEWS OF OTHER SOCIETIES

National Electric Light Association

Convention in Chicago on May 31 to June 3. The broad aspects of public relations, finance, operation and business were discussed by leading executives and engineers and by public-service commissioners. An analysis of the fundamental economics affecting the service rendered by electric light and power companies was made by Martin J. Insull in his presidential address. Mr. Insull saw the industry in a strong position, but in need of large sums of money to take care of the program of expansion demanded by the public.

Henry J. Pierce, of Seattle, Wash., surveyed the progress made in the utilization of water power in the United States since the enactment of the water-power act in June 1920. Up to the present time 223 applications for preliminary permits and licenses for development of an aggregate of over 15,000,000 hp. have been made to the Federal Power Commission. According to Mr. Pierce, the difficulty of utilizing the hydroelectric resources of the country comes from the fact that 70 per cent of the primary power used for manufacturing purposes is east of the Mississippi River, while 70 per cent of the hydroelectric resources of the country is west of the Rocky Mountains. The total amount of primary power developed and used at present east of the Rocky Mountains for all purposes other than by railway locomotives is 37,000,000 hp. and the total available water power in that region is about 15,000,000 hp., so that if all of this water power available were developed there would still be a shortage of 22,000,000 hp. to be supplied by steam. On the other hand, 40,000,000 hp. can be developed hydroelectrically west of the Rocky Mountains, and but 5,000,000 primary horsepower is now used, of which 2,000,000 hp. is developed by steam and 3,000,000 hp. hydroelectrically. Guido Semenza, head of the Italian railway electrification commission, spoke on the development in the utilization of water power and interconnection of electric plants in Italy. The hydraulic power committee, which was organized at the convention in Pasadena last year, reported the results of its studies on the development of efficient draft tubes, the control of tailwater level, the relation between rainfall and stream flow, evaporation, and the operation of hydraulic plants for maximum output. Surveying recent developments in the utilization of water power, the report mentions the 55,000-hp. turbines designed to operate under 305 ft. head for the Queenston-Niagara station of the Hydroelectric Power Commission of Ontario, and the use of 22,500-hp. turbines under 800 ft. head at the Kern River No. 3 station of the Southern California Edison Co.

A tendency to increase turbine speeds and to improve turbine economy by raising steam pressure was indicated in the report of the committee on prime movers. Single-cylinder turbines seem to be still limited to 45,000 kw. A new record as regards boiler sizes was established by the installation at the plant of the Ford Motor Co. of four boilers each rated at 2647 hp. Pressures and superheats are gradually rising, although 300 to 350 lb. per sq. in. and total temperatures of about 650 deg. fahr. seem to be the highest values being used at present. Information regarding the burning of "hogged fuel" by the Northwestern Electric Co. of Portland, Oregon was included. This fuel shows a loss of from 30 to 40 per cent in B.t.u. content after being in storage for a year, and it makes little difference whether the storage is indoor or outdoor. The use of lignite has not received any great impetus as a result of the acute demand for fuel during the war. However, very complete tests of lignite have been carried on both in the Bitterfeld station in Germany and at the Melbourne plant in Australia, so that the properties of this fuel under various operating conditions, as well as the design features to be embodied in stokers and furnaces, have been clearly defined. Continued interest has been manifested in the pulverized-fuel method of burning coal. High ratings are obtained in new plants where boilers have ample combustion space and are designed expressly for burning pulverized fuel. The Lakeside plant in Milwaukee, designed for burning pulverized fuel, has recently been put in operation and will have an ultimate capacity of 200,000 kw. Processes for the recovery of by-products from raw coal have been developed further in England and Germany than in this country. Attention was called to the fact that The American Society of Mechanical Engineers is revising piping stand-

ards for pressures higher than 250 lb. per sq. in., acting as the sponsor body designated by the American Engineering Standards Committee with a view to adopting an American standard for such pressures. Following the presentation of the report of the committee on prime movers a discussion ensued on the best specifications for lubricating oils and the economy of burning pulverized fuel. W. J. Santmyer, Puget Sound Light & Power Co., stated that with pulverized-fuel plants, efficiencies are obtained which are unbelievable, boilers can be forced to remarkable overloads, and equipment is particularly flexible in operation. He referred to one 500-hp. installation where the boilers could be put on the line and made to carry 300 to 400 per cent rating in 40 minutes. Joseph Harrington, Brady Foundry Co., questioned the economy of pulverizing coal containing more than 15 per cent ash or 8 per cent moisture. Modern stokers, he said, can burn anything from lignite to anthracite coal and have horizontal efficiency curves from 150 to 250 per cent rating, can increase from 150 to 250 per cent rating in three to four minutes, and can burn coal containing 40 per cent ash without clinker formation.

Technical sessions were also held on electrical apparatus, overhead systems, underground systems, electric meters and inductive interference. An exhaustive account of the technical, commercial, and financial features of the convention is given in the *Electrical World* for June 4.

Society of Automotive Engineers

Semi-annual meeting at West Baden, Ind., on May 24 to 28. Sessions were held on aeronautics, highway transport, general research, combustion and fuel research.

A paper by L. E. Pierce and G. J. Mead on Aviation Power Plant Development stressed the necessity of better installations of the power plant to eliminate engine failures in the air. These generally result from minor defects in the operation of the gasoline, cooling or lubricating systems, which are independent of the engine itself. Discussing this paper Elmer Sperry urged the study of the Diesel engine as a possible power plant for the aeroplane of the future, particularly in view of the fact that this type of engine burns a fuel whose low volatility reduces the fire hazard. The present status of commercial air transportation was surveyed by V. E. Clark in a paper entitled Air Transportation and the Business Man. Mr. Clark admitted that no air-transportation project has proved to be a financial success; but he recalled that it was not until 50 years after the invention of the locomotive that railroad investments returned profits and the manufacture of the automobile became commercially successful in 20 years. The aeroplane is now only 12 years old. The Need for Federal Control in Commercial Aviation was discussed by S. H. Philbin, who presented the matter from a legal standpoint.

In Transport Engineering Education, C. J. Tilden emphasized the need of providing a proper curriculum in the universities in order that men could be given an education which would fit them for the practical management of motor-transport companies. The Vehicle and the Road was presented by A. T. Goldbeck of the Bureau of Public Roads. Mr. Goldbeck advocated greater coöperation between the highway engineer and the automotive engineer. He thought that it might eventually become necessary to lessen the weight concentrated on each wheel by increasing the number of wheels in large motor trucks used for highway transport.

C. W. Stratford explained the research work on lubrication that has been done under his direction on the Pacific Coast. W. E. Lay described the plan recently inaugurated at the University of Michigan to place the laboratory and personnel facilities of the university at the disposal of commercial organizations to promote advanced research study. A paper on Practice and Theory in Clutch Design, by Herbert Chase, contained particulars concerning American and British practice in clutch design, and compared the advantages and disadvantages of various types of clutches.

Turbulence in Theory and in Practice, by H. L. Horning, embodied a collection of data from the experimental results obtained by Chatelier and Mallard, Wheeler and Mason, Prof. Bertram Hopkinson, Sir Dugald Clerk, Harry Ricardo, and other investigators, as well as from a large number of experiments conducted under Mr. Horning's observation. By developing high turbulence in a mixture it is possible to drive off the surface layers of the combustion chamber and thus force their full contents to contribute to the heat and pressure before the expansion stroke commences. Turbulence tends to accelerate the combustion of the entire mixture and makes it possible to obtain high speeds without advancing the spark excessively. C. A. French submitted a hypothesis on the action of flame and combustion in internal-combustion engines. A paper by Sir Dugald Clerk on Cylinder Actions in Gas and Gasoline Engines outlined the fundamental thermodynamic theory of the present-day automotive engine.

The possibility of developing a high-compression engine for use in automotive vehicles was discussed by F. C. Ziesenheim. The conclusion reached by Mr. Ziesenheim was that this type of engine should receive careful study as one of the possible factors in deferring the fuel shortage. George P. Dorris described a manifold developed for the purpose of trapping and distilling the higher ends of modern engine fuels, thus preventing their entering the combustion chamber in liquid form. The Elements of Automobile Fuel Economy were enumerated by W. S. James of the Bureau of Standards. Thomas Midgley, Jr., informed the members of the recent discovery of a fuel dope that was more effective in eliminating fuel knock than any used previously. Owing to the effectiveness of this substance only a small percentage need be added to the fuel, and Mr. Midgley felt that by its use higher compressions might be developed in Otto-cycle engines and eventually a thermal efficiency might be secured which would be comparable to that of the Diesel engine.

American Iron and Steel Institute

General meeting in New York on May 27. Business conditions and remedies for the prevailing depression were the chief subjects of discussion. A notable incident was an appreciation by Gen. John J. Pershing of the activities of the iron and steel industry during the war. In his presidential address Judge Gary expressed his views of the present business situation and its difficulties. He felt that the country was now headed in the right direction, and progress toward recovery, though slow at present, would increase in due time. A number of short speeches by leaders of the steel industry upon present business conditions followed Judge Gary's address.

The educational work being conducted by the American Steel & Wire Co., of Cleveland was described by Charles R. Sturdevant. Seven courses have been established: an intensive course for salesmen, a special business English course for general office forces, Americanization courses for non-English-speaking employees, vestibule schools for skilled and unskilled workers, a trades course for upgrading craftsmen, a special apprentice course for a limited number of technically trained men, and a course for foremen and supervisors. The Americanization, vestibule and trades courses are elementary; the courses for salesmen and foremen are intermediate; the student apprentice course is advanced; the business English is a special course and the library is used as an accessory. Admittance to any of the courses is voluntary on the part of the employee, who is not thereby required to sign indentures or agreements to remain with the company after completing the course. Results have been very gratifying.

Harlow D. Savage, Combustion Engineering Corporation, New York, presented a digest of the work that has been done in the last three years in the equipping of steam power plants to use powdered coal as fuel. There are now throughout the United States about ten commercial plants of large size burning pulverized coal. Some of these plants have been in operation for nearly three years. Mr. Savage asserted that with a correctly designed and properly operated pulverized-fuel system it is fair to expect an efficiency of 77 per cent, judging from results obtained in tests and in actual operation of plants.

The composition, properties and uses of stainless steel, and the method of manufacturing this alloy, were explained by Elwood Haynes, president, Haynes Stellite Co., Kokomo, Ind. Stainless steel must contain iron, chromium and carbon, and may contain various other elements, such as manganese, molybdenum, tungsten, silicon, etc. Immunity to atmospheric influences is acquired when the chromium content reaches at least 8 per cent, and the

highest immunity when the chromium content is 11 or 12 per cent. The best results in the manufacture of stainless steel are obtained by means of the crucible or electric furnace. Stainless steel may be forged at temperatures varying from 800 to 1200 deg. cent. and be readily rolled into rods and sheets under proper conditions. By proper annealing, a bar containing 15 per cent chromium can be rendered sufficiently soft to be worked in the lathe, though even when annealed it is much harder than ordinary machinery steel. When thin strips are heated and allowed to cool in the air they become almost file-hard.

A summary of the practical and commercial features of molybdenum steels was presented by Arthur H. Hunter, president, Atlas Crucible Steel Co., Dunkirk, N. Y. Molybdenum steels, compared with other alloy steels in the same category from a commercial standpoint and treated to the same tensile strength, show a slightly higher elastic limit, a higher elongation, and a much higher reduction of area.

Taylor Society

Spring meeting at Cleveland on May 19, 20 and 21. An address of welcome was made by Alexander C. Brown, president of the Cleveland Chamber of Commerce, who enumerated the present national problems, such as business depression and unemployment, and said that one of the dangers of the situation is that the Government may attempt to settle too many of these problems. He declared that one of the functions of the Taylor Society is to focus its attention on many of these problems and do what it can to solve them without the necessity of legislation. Technical sessions were held on sales executives, administrative officers, plant managers, personnel administration and industrial relations.

Howard G. Benedict, consulting management engineer, Cleveland, spoke on performance rating and bonuses for salaried employees. He described a plan he had formerly tried for rating men and setting a money value on coöperation. Each salaried employee was periodically rated by a rating committee with respect to attitude on coöperation, reliability, ability, action, leadership, and personality. Definite elements were considered in rating each quality. For example, reliability was considered as made up of honesty, truthfulness, dependability, straightforwardness and sincerity.

Morris L. Cooke, consulting management engineer, Philadelphia, in a paper on Unemployment Scores suggested the adoption of standards to measure "unemployment within employment," that is, insufficient work to keep employees busy all of the working time. The test of efficiency in management, he said, is the percentage by which the amount of time actually occupied in production work falls short of the possible maximum based on a predetermined proper length of working day.

Carl Snyder, statistician, Federal Reserve Bank, New York, discussed the value of an index number of physical production to administrator and manager. He showed with charts that industrial production in the United States has been moving upward at a uniform rate during the last fifty years. Assuming that there will not be a sudden change, it would seem that, since present underproduction is more striking than overproduction was last year, a violent reaction must soon take place. Production data, he believed, can be developed to a point where it will not be hard to make fairly accurate forecasts, the problem of overproduction of a particular commodity being really one of unbalanced general production. By maintaining elaborate statistics concerning production in all industries, the supply and the demand of any particular commodity could be made to correspond. Another advantage of the regulation of production would be the elimination of violent fluctuations in prices.

At the session on industrial relations a symposium was held on joint action of employees and management in establishing standards, tasks, rates and other standard conditions.

American Society of Refrigerating Engineers

Spring meeting in Chicago on May 25 to 27. Exceptions were taken to the refrigeration code in its present form. One dealt with the pressure at which the release devices for different refrigerating media should be set. Assuming the value given for ammonia to be correct, the pressures listed for ethyl chloride, sulphur dioxide and methyl chloride are too high and should be reduced to correspond with the pressure given for ammonia. The same reasoning applies to other tabulations. A propeller for brine agitation and circulation designed in accordance with formulas developed by O. G. Halvorsen, professor in marine engineering at the technical college at Trondhjem, Norway, was described by E. A. Burrows. In Spray Cooling Systems, P. K. Lindsay brought out the great increase in cooling capacity obtained by the use of sprays over a basin or pond without the sprays, indicated the piping arrangement used and the operating pressure, described the nozzles, and summarized the average cooling results from a well-designed spray system with unrestricted air circulation. Prof. E. A. Fessenden outlined the results of a series of tests on welded ammonia containers. Four types were tested: (1) Flange-steel shell, acetylene-welded longitudinal seam, concave heads welded to shell; (2) seamless-pipe shell, convex heads acetylene-welded to shell; (3) seamless-pipe shell, concave heads forge-welded to shell; and (4) flange-steel shell, acetylene-welded longitudinal seam, convex heads acetylene-welded to shell. Professor Fessenden concluded that vessels with forge-welded seams are the least desirable. Welds joining fittings for pipe connections to the vessel are almost as likely to cause failure as the longitudinal and circumferential seams. In acetylene welds the principal defects seem to be the coarse granular structure and porous spots obtained and the occasional poor adhesion of the welding material to the original plate. A new type of nozzle which gives a hollow, cone-shaped spray was described by S. C. Bloom. Multiple-Effect Compression, by H. C. White, contained a report of comparative tests on a single-acting compressor and a compressor equipped with the Voorhees device. Other papers were: Arc Welding Applied to Refrigerating Machines, by A. M. Candy; Refrigeration in the Manufacture of Rubber, by J. H. Vance; Modern Air-Compressor Practice and Testing, by Harry Feldbush; Water Treatment for Raw-Water Ice, by John J. Felsecker; and Eggshell Sterilization for Cold Storage, by Elmer Anderson.

International Railway Fuel Association

Annual convention in Chicago on May 24 to 26. Committee reports were presented on briquets and subnormal fuels, fuel accounting, pulverized fuel, locomotive feedwater heating and coal storage. Progress in burning pulverized coal in locomotives and in stationary railway plants was surveyed by the committee on pulverized fuel. Tests were made on a locomotive by the Lehigh Valley Railroad to determine the practicability of burning pulverized North Dakota lignite containing 15 per cent moisture and Red Lodge sludge (Montana sub-bituminous coal) without resulting in serious honeycomb formation or unusual disintegration of brickwork. The results were successful with the exception of the honeycomb formation which with either coal developed rapidly on the back flue sheet when the locomotive worked hard and seriously hampered operation. In stationary practice two new plants burning pulverized coal were completed and put into operation during the year, namely, the St. Francis plant of the Milwaukee Electric Railway & Light Co. and the Oklahoma City Plant of Morris & Co. Progress in the simplification of the Locomotive Feed Water Heater Co. and the Worthington feedwater heaters was reported by the committee on feedwater heating. That fuel accounting be handled by the auditing department was recommended by the committee on fuel accounting. Every railroad engaged in interstate commerce is guided in its final accounts by certain rules and regulations laid down by the Interstate Commerce Commission. The accounting department of every railroad understands these regulations and knows how to meet the requirements with regard to the allocation of fuel charges to operating expenses. Some of the technical papers were: Present Railway Situation, by Samuel O. Dunn; Fuel Conditions on the French Railways, by M. de Boysson; Preparation and Distribution of Fuel, by P. E. Blast; Fuel Department Organization by L. G. Plant; and Value of Individual Fuel Performance Records, by Robert Collett. A very complete report of the convention is found in *Railway Age* for May 27 and June 3.

Standard Methods of Identification of Fluids Conveyed by Pipes in Power Houses and Industrial Plants

SAFETY and economy of time in making changes and additions to piping systems demand that in a given layout these systems should be so marked that the liquids or gases passing through them may be readily identified. Many firms have met this need by adopting color schemes of various kinds. In some cases the standard colors are applied only to the valves, fittings and insulation bands, all the pipes being of the same color. In others the color of the pipe in combination with the colors of the valves, fittings and insulation bands is employed to tell the tale.

Since, as is natural, these independent efforts to solve this problem have resulted in the use of a great variety of colors and in an absence of uniformity or standard practice, the American Engineering Standards Committee has been appealed to. After consideration the Committee asked the National Safety Council, Chicago, and The American Society of Mechanical Engineers to act as joint sponsors and to organize a Sectional Committee for this purpose. The members of this Committee are now being selected.

As a result of some recent and previous correspondence the A.S.M.E. Standards Department has gathered together some specific information concerning four systems in addition to the one recommended by an A.S.M.E. committee in 1911. The principal parts of these systems are printed below. A superficial examination of this table will, however, convince one that even though it is long it does not include all the fluids which are in common use in many laboratories and manufacturing plants. A few of the missing ones are oxygen, hydrogen, acetylene, natural gas, and lubricating liquids. It is also probable that acid-manufacturing plants have other materials which must be conveyed by pipe lines.

It can be readily seen, therefore, that with such a variety of materials to be conveyed, the problem of selecting a standard set of color combinations for easy and sure identification will not be an

VARIOUS COLOR SCHEMES FOR IDENTIFYING PIPES IN POWER HOUSES AND INDUSTRIAL PLANTS

Fluid to be Identified in Pipe	Report of A.S.M.E. Committee 1911	The New York Edison Company	Kodak Park Piping	University of Toronto	Westinghouse, Church, Kerr & Company
	Color of edges of all flanges, fittings and valves	Color of pipe fittings, and insulation bands	Color of band	Color of pipe	Color of pipe
Air	gray	black pipe and fittings		dark blue	light green
Air, Compressed			white and black		
Ammonia Gas			white		
Ammonia, Liquid			white		
Brine Return			white and red		
Brine, Supply			white and yellow		
Drip, Gravity discharges from manifold to receiver, from receiver to header, header to boilers and blowdowns and reducer lines		orange pipe and P. Verm. fittings			
Drip, Holly System					cream, buff bands
Electric Lines and Feeders	black and red stripes alternately on flanges and fittings, body of pipe being black				
Drips, Blow off from water columns and all low-pressure drips, roof leaders, overboard discharges from hot-well pumps		lead pipe and black fittings			
Gas, Illuminating	aluminum		white and blue	dark brown	
Gas, Engine Service	black, red flanges				
Oil, Fuel	black				
Oil, Delivery and Discharge, brass or bronze	yellow	tan pipe and black fittings			
Oil, Cylinder, throughout station from barrel tanks to pumps, to overhead tanks, to cylinders		tan pipe and P. Verm. fittings			
Oil, Return, from all bearings and catchalls to filter tanks		tan pipe and light-green fittings			pink
Refrigerating Systems	white and green stripes alternately on flanges and fittings, body of pipe being black				
Steam, High-Pressure	white		black	dark yellow	cream
Steam, Low-Pressure			red		
Steam, Exhaust	buff	buff pipe and fittings, green bands		black	
Steam, Exhaust and Drips					buff
Steam, Live, to engines, turbines, boiler cross-overs, boiler and main headers		black pipe and fittings, brass bands			
Steam, Boiler Blow-off					
Steam, Drip Lines, including drip receivers' discharge to boilers, blowdowns, reducer lines and manifolds		orange pipe and black fittings			black
Steam, Heating System					light gray
All steam lines not included		buff pipe and fittings, black bands			
Vacuum Return			green		
Vacuum Cleaner			green and red		
Water, Fresh, Low-Pressure	blue			gray	
Water, Fresh, High-Pressure (boiler feed)	blue and white				
Water, Salt	green	light green pipe, black fittings			medium blue
Water, Cistern			white and green		
Water, Tank			white and brown		
Water, Well			yellow and black		
Water, Mill			yellow		
Water, Ontario			hrown		
Water, Hemlock			blue		
Water, Cooling			green and black		
Water, Warm, fresh, mains from outlets of jackets and cooling coils to F. W. heaters and hot wells to pumps to feedwater heaters		dark blue-pipe and black fittings			
Water, Feed, from heaters and pumps to boiler drums		Pompeian red pipe and fittings			
Water, Fire Lines, priming lines and all other service using water from fire pumps		permanent vermilion pipe and fittings			
Water, Fire Protection					red
All Fresh-Water Pipe from meters to inlet nozzles for F. W. heaters, water jackets, oil coolers, step-bearing pumps, or to any point where temperature of water changes or mixes with other water		dark blue pipe and P. Verm. fittings			
All Other Water					light blue
Reservoir Return			red and black		

easy one. In fact, one correspondent, Mr. G. E. Sanford, safety engineer of the General Electric Company, remarks that there does not seem to be a sufficient number of satisfactory colors to go around. Two other important considerations in this connection are, first, the tendency of certain colors to fade and in so doing to dangerously approach some other color, thus leading the workman into a false sense of security; and second, the prevalence of color blindness among workers of all classes. On this point Mr. Sanford says:

> From my experience in investigating this matter in plants all over the country, I am thoroughly of the belief that the best plan would be to paint a black band a foot more or less long on each side of each union, valve, or at any place where the pipe line could be taken apart, or at any place where attachments could be made. On that black surface should be stenciled in plain white or aluminum letters, at least one inch high where practicable, the name of the material in the pipe, so that markings on overhead lines could be read from the floor in ordinary well-lighted buildings, provided, of course, that the ceiling was not over the average height.

All those who are in any way interested in the solution of this problem would do well to communicate with C. B. LePage, Secretary of Standards and Technical Committees of the A.S.M.E., stating the phase of the problem which interests them most and volunteering all data at their disposal.

Conference of Secretaries of National Standardizing Bodies

The Secretary of the American Engineering Standards Committee, Dr. P. G. Agnew, has recently returned from London where he attended a conference of the secretaries of the national standardizing bodies. This conference was called by the Secretary of the British Engineering Standards Association, Mr. C. le Maistre, and other countries represented were as follows: Belgium, by G. Gerard; Canada, by R. J. Durley; Holland, by E. Hijmans; Norway, by A. Eriksen; and Switzerland, by M. Zollinger. The object of the conference was the interchange of experience and the furtherance of coöperation between the various national bodies in their work of industrial and engineering standardization. After the conference Dr. Agnew visited France, Switzerland, and Germany for a more detailed study of the standardization work in those countries.

It was found that the same general method of procedure is followed in the different countries: namely, technical decisions concerning any specific piece of work are in the hands of a working committee which is so constituted as to be broadly representative, from both the technical and the managerial points of view, of the particular branch of the national industry concerned. This method, the discussion brought out, is followed whether the work is of the nature of specifications, methods of test, or dimensional standardization.

The conference made the following suggestions which will be submitted by the secretaries to their respective organizations for approval.

The conference advocated that for the present coöperation proceed along such informal lines as the interchange of publications, a reciprocal arrangement for making foreign standards available to the industries of each country through their sale by the offices of the national bodies, the exchange of information as to the status of work in progress, etc.

The conference felt that an attempt to form a general international standardizing body should not be made at the present time but in cases in which formal organization should ater be found necessary, the organization should preferably be by subject or industry, somewhat along the lines of the International Electrotechnical Commission.

Arrangements are being made for close coöperation between the national standardizing bodies and the International Chamber of Commerce. A committee has been organized to develop interest in the subject on the part of industrial and commercial interests, and diffuse information on standardization. It is the policy of the International Chamber of Commerce to further the standardization movement by such means, considering only the more general aspects of the problem, and the policies to be followed, leaving the details of industrial standardization to the national bodies, who will coöperate directly with the national organizations of the International Chamber of Commerce in their respective countries.

Rock Island Excursion

(Continued from page 471)

modern equipment and modern methods were shown ready for use in munitions manufacture. Colonel Jordan led the party through the beautifully-laid-out grounds, the well-arranged and maintained 36 acres of storerooms, and the 2400-kw. hydroelectric station operating at 12 ft. head, all on this wooded island of 900 acres in the Mississippi River.

Luncheon was served in the Arsenal cafeteria, after which the party adjourned to Welfare Hall where the opening session of the Ordnance Division was held, with President Carman in the chair. The technical program was contributed by the officers of the Ordnance Department and was illustrated by moving pictures and lantern slides. In the opening paper, Col. C. L' H. Ruggles made a plea for a policy of munitions preparedness which will enable the country to furnish necessary munitions of satisfactory quality at the time and place required by its armies. He advocated the setting aside of money every year for the maintenance of the large stock of munitions which had been made up for use in the world war.

The remainder of the program was made up of five papers dealing with Progress in Ordnance Development Since the Armistice, namely:

- Artillery, Major G. F. Jenks
- Tanks, Tractors and Trailers, Major L. B. Moody
- Artillery Ammunition, Major W. B. Hardig
- Small-Arms Machine Guns and Their Ammunition, Major L. O. Wright
- Aircraft Armament, Major W. A. Borden.

These papers will be abstracted in a future issue of Mechanical Engineering. Following the technical session, guests were given an exhibition of tractors and tanks in action.

In the evening a dinner was served at the Hotel Blackhawk in Davenport which was attended by the visiting members of the A.S.M.E. and the members of the Tri-Cities engineering societies. Max Sklovsky acted as toastmaster of the banquet and introduced William Butterworth, president of the John Deere Plow Company, who welcomed the guests. President Carman responded for the Society and emphasized the important responsibility of the engineering profession in giving service to the community. Col. A. E. White, president of the American Steel Treaters' Society, made an eloquent address in which he pointed out the necessity for engineering societies to get together for their local activities. He spoke of his experience with the American Steel Treaters' Society, where he found that when engineers in a locality were coöperating the local sections of all of the national societies flourished, and where they did not coöperate the local section of each society was not successful. Calvin W. Rice, Secretary of the Society, Ralph P. Hayes, Chairman of the Davenport Engineering Society, Col. Harry B. Jordan, Commandent at Rock Island Arsenal, and Col. C. L'H. Ruggles of the Ordnance Department, made short addresses.

The following morning a few of the members entered a blind bogie golf tournament held on the Rock Island Arsenal links, Prizes were awarded to J. Edward McDonald, Calvin W. Rice. James F. Lardner, Col. A. E. White, W. H. Kenerson, and H. A. Soverhill. Bert F. Baker, who trailed the field for net score, was awarded a medal on which was significantly inscribed A. A. H. O. G., which interpreted means, Ancient and Honorable Order of Goats. Other of the visitors availed themselves of the opportunity of visiting some of the industrial plants in the locality, leaving for home in the afternoon.

Great credit is due the members of the Tri-Cities Section for the success of an exceedingly interesting two-days' trip. The executive committee of the Tri-Cities Section is: C. R. Adams, Chairman, E. Ransome Jackson, Charles A. Carlson, Clarence W. Fiske, James E. Lardner and H. A. Soverhill.

An Industrial Relations Conference, authorized by Governor William C. Sproul, Pennsylvania, is being arranged by Dr. Clifford B. Connelley, Commissioner of Department of Labor and Industry, Commonwealth of Pennsylvania, to be held at Harrisburg, Pennsylvania, October 24 to 27th.

LIBRARY NOTES AND BOOK REVIEWS

Steam Boiler Engineering

Steam Boiler Engineering (Helios): A Treatise on Steam Boilers and the Design and Operation of Boiler Plants. Twenty-seventh edition. Heine Safety Boiler Co., St. Louis, Mo., 1920. Cloth, 6 by 9 in., 639 pp., illus., diagrams, charts, tables, $1.75.

The first Helios appeared in July 1893. The present volume is announced as the 27th printing or 13th edition. It is really a new book and a very remarkable book. There is little to remind one of the old Helios other than Colonel Meier's preface and the gilded picture of the sun god with his four-horse chariot on the cover. There are 639 octavo pages and while engineers are used to generosity of this sort from boiler manufacturers, one must marvel that any particular manufacturer can give so much. In fact, if it were not for the acknowledged propaganda of the first section and of occasional passages elsewhere, we should have to call this the best textbook on steam boilers that is available. Naturally, therefore, the book represents to a large extent the results of research and publication by others. It is a thorough and adequate presentation of these results.

The steam tables by Goodenough are used throughout the work. The chapter on piping is excellent, containing perhaps more detail than is to be found in any book not devoted exclusively to this subject, and this detail is presented with a good sense of proportion and the relative importance of the topics included. There is a remarkably extensive index covering 21 pages, and it seems to be a good working index.

Fault can be found with the new Helios as with any other book, and no doubt the next one can be made better. One way of making it better will be to drop the time-honored plan of tabulating analyses of coals by states. This is not a useful way. The argument for such a tabulation should be the field, and subordinate to this the geographical location in the field. Fig. 204 showing the coal fields of the United States is rather carelessly drawn. The illustrations are occasionally arranged out of their numerical sequence. The discussion of superheater design on page 81 refers superficially to the mean temperature difference without giving any careful definition of that term. Among miscellaneous fuels there is no mention of garbage or city refuse. The section on the cost of generating steam is entirely inadequate. The paragraph on page 73 with relation to the steam consumption of large turbines as affected by superheat is almost incomprehensible, but upon careful reading it is possible to guess what the writer intended.—W. D. E.

The Conservation of Textiles. By Harvey Gerald Elledge and Alice Lucille Wakefield. Laundryowners National Association, La Salle, Ill., 1921. Cloth, 6 x 8 in., 162 pp. illus., $1.

The results of an investigation of the causes of deterioration in textiles, particularly from laundering, accompanied by advice upon conservation.

The Engineer. By John Hays Hammond. Charles Scribner's Sons. New York, 1921. (Vocational series.) Cloth 194 pp., 4 x 7 in., $1.25.

Mr. Hammond's book is intended as guide and counselor for the youth attracted toward engineering as a profession. Its advantages and disadvantages, the qualities required for success, the best kind of education are clearly set forth, followed by chapters which explain the fields occupied by the major divisions of engineering—mechanical, civil, mining, chemical, marine and military. The book is well fitted to assist in the selection of a career.

Engineering Construction. Part I. In Steel and Timber. By William Henry Warren. Third edition. Longmans, Green and Co., New York, 1921. Cloth, 6 x 9 in., 486 pp., plates, illus., diagrams, $10.

The third edition of this work attempts to include in one volume a summary of the subject: railway and highway bridge design and construction suited for students and engineers. The present edition has been carefully revised, and appendices added on Australian timbers and on recent steel column experiments and formulas.

Die Formstoffe der Eisen—und Stahlgiesserei. By Carl Irresberger. Julius Springer, Berlin, 1921. Paper, 6 x 10 in., 245 pp., illus., 24 Marks.

An extensive treatise on molding sands and their preparation for use in iron and steel founding. The occurrence of suitable sands, clays and loams, their mineralogical formations, properties and the methods of testing are described and the added materials, core binders and facings are discussed. Approximately one-half of the volume is devoted to the questions of drying, grinding and mixing molding sands, the purification of used sand, automatic sand-mixers, etc.

Funfstellige Tafeln der Kreis- und Hyperbelfunktionen. By Keiichi Hayashi. Berlin, Walter de Gruyter & Co., 1921. 182 pp., 9 x 6 in., paper.

The values given in this table are in ten-thousandths from 0 to 0.1, in thousandths from 0.1 to 3, in hundredths from 3 to 6.3 and in tenths from 6.3 to 10. The circular and hyperbolic functions of any number are printed side by side, making it unnecessary to consult two places when using formulas containing both functions.

Lubricating and Allied Oils. By Elliott A. Evans. E. P. Dutton & Co., New York, 1921. (The Directly-Useful Technical Series.) Cloth, 6 x 9 in., 128 pp., illus., $4.

This handbook describes the chemical and physical tests commonly used for determining the properties of a lubricating oil, and discusses those branches of the subject which are of interest. The book is intended to assist chemists in compiling specifications and examining lubricating oils, and to give engineers an insight into the properties and applications of such oils, and the interpretation of specifications.

The Microscope; Its Design, Construction and Applications. Edited by F. S. Spiers. J. B. Lippincott Co., Philadelphia, 1920. Cloth, 7 x 10 in., 260 pp., plates, diagrams, $5.

This volume contains the papers and addresses delivered at a meeting held in January 1920, at the initiative of Sir Robert Hadfield, by the Faraday Society, the Royal Microscopical Society, the Optical Society and the Photomicrographic Society. One purpose of the symposium was to stimulate the study of and research in microscopical science by indicating lines of progress in the design of the instrument, showing recent improvements in the microscope and its technique, and its varied uses as an instrument of research. The papers cover a wide field, including among other subjects the mechanical design, optics and manufacture of microscopes; their applications, especially in metallography, metallurgy, engineering and meteorology; their testing. An historical introduction is given and a bibliography of the chief literature.

National Electrical Safety Code. Issued by U. S. Bureau of Standards. Third edition. Wash., Govt. Printing Office, 1921. (Handbook series, no. 3.) Cloth, 5 x 8 in., 366 pp., $0.40.

About four years ago the Bureau of Standards published the completed text of this Code for examination and trial use, an early revision being contemplated. War conditions interfered with this trial, so that the publication of a new edition has been greatly delayed. The revision is now completed and the revised code is now published in this handbook for more convenient use. The discussion of the rules has been segregated under a separate cover so as to reduce the bulk of the main volume, and will appear as Bureau of Standards Handbook No. 4, now in press.

Oil Fuel. By Edward Butler. Fourth edition. J. B. Lippincott Co., Philadelphia, 1921. Cloth, 5 x 8 in., 310 pp., illus., $3.75.

This book is intended as an exhaustively and systematically classified record of the developments and progress in the application of oil fuel for all steam raising, metallurgical and other purposes, except internal-combustion engines, for which liquid fuel can be used successfully.

The Open Hearth; Its Relation to the Steel Industry, Its Design and Operation. First edition. The Wellman-Seaver-Morgan Co., Cleveland, 1920. Cloth, 9 x 11 in., 378 pp., illus., $7.50. (Sold by U. P. C. Book Co., Inc., N. Y.)

This is a practical book on the design and construction of the open-hearth furnace, and on its use in modern steel making. The methods of working, the gas producers, metal mixers, charging machines and other auxiliaries are described, so that the volume forms a complete, though brief account of open-hearth practice, very fully illustrated by drawings, half-tones and tables of data.

Personnel Relations in Industry. By A. M. Simons. The Ronald Press Co., New York, 1921. Cloth, 6 x 9 in., 341 pp., $3.

The first part of this work gives a survey of the situation in American industry and analyzes the elements of the employment problem. The specific stages through which the questions at issue have passed are then reviewed, after which the author summarizes the best recent thought on the broad question of democracy in industry. Throughout the author has tried to call attention to the scientific laws that have merged from recent study of the subject, and to determine the reactions of human nature to the conditions presented in the various industrial problems.

Die Praktische Nutzanwendung der Prufung des Eisens Durch Aetzverfahren und mit Hilfe des Mikroskopes. By E. Preuss. Second edition. Julius Springer, Berlin, 1921. Paper, 6 x 9 in., 124 pp., illus., 14 Marks.

The present book is intended as a guide in the practical use of microscopic methods of testing the quality of iron, of sufficient scope to meet the ordinary needs of steel-works metallurgists and testing engineers. The methods of etching and polishing are given, and the useful tests for determining structure, controlling heating, tempering, etc. are described.

Relativity, The Electron Theory and Gravitation. By E. Cunningham. Second edition. Longmans, Green and Co., New York, 1921. Cloth, 6 x 9 in., 148 pp., $3.50.

The primary purpose of this monograph was to set out as clearly and simply as possible the relation of the principle of relativity to the electron theory, in a way useful to the general reader and especially to the experimental physicist. In the present edition a second section has been added, which presents the general principle in its present form.

Sheet-Metal Drafting. By Ellsworth M. Longfield. First edition. McGraw-Hill Book Company, Inc., New York, 1921. (Industrial education series.) Cloth, 6 x 9 in., 236 pp., illus., $2.25.

This text was prepared especially for correspondence-study instruction in the Extension Division of the University of Wisconsin. It is also adapted as a textbook for vocational schools. The underlying principles of sheet-metal pattern drafting are presented, the principles being arranged in sequence with due regard to the factors governing the student's progress through a course of instruction.

Small Motors, Transformers, Electromagnets. By H. M. Stoller, F. E. Austin, E. W. Seeger. American Technical Society, Chicago, 1920. Cloth, 6 x 8 in., 320 pp., illus., $3.

The first section of this book discusses small motors, automobile starting motors and charging generators and farm lighting outfits. Typical designs are given for d.c. motors of all standard voltages, ranging from 0.01 hp. to 0.5 hp. in size, and for a.c. induction motors from 0.125 to 0.5 hp. in size.

The second section, on small low-tension and high-tension transformers, treats of those which will transform from 110 to 220 volts and down to the lower voltages. The concluding section includes typical designs of electromagnets for direct and alternating current work and induction coils. Flat-plunger, cone-plunger, horseshoe and clapper electromagnets and portative magnets are considered.

Statique Graphique et Resistance des Materiaux. By Louis Roy. Gauthier-Villars et Cie, Paris, 1921. (Cours de mécanique appliquée, 2.) Paper, 6 x 10 in., 213 pp., 30 francs.

This volume on graphic statics and resistance of materials is the second of a series of volumes by professors in the Institute of Electrotechnics and Applied Mechanics of the University of Toulouse, presenting the course in applied mechanics given to students at the Institute. The author has attempted to present the subject as rigorously as its nature permits and to cover completely those applications of actual interest to the engineer. By omission of other questions, the text has been compressed to moderate size.

Telephotography. By Cyril F. Lan-Davis. Second edition, by L. B. Booth. E. P. Dutton & Co., New York, 1921. Cloth, 5 x 7 in., 116 pp., Illus., plates, $2.00.

The book expounds the theory of telephotography, describes the commercial lenses and gives the practical methods in careful detail. The various applications are fully illustrated.

The Third Power Kink Book. Compiled by the editorial staff of Power. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth 6 x 9 in., 264 pp., illus., $1.50

A collection of some three hundred unconventional but practical ways of meeting power-plant emergencies, of the kind that arise in operation and in repair work.

Thomas' Register of American Manufacturers. Twelfth edition. Thomas Publishing Co., New York. 19 x 10 Cloth, 10 x 12 in., $15.

The twelfth edition of this popular directory of manufacturers and dealers presents no novelties in arrangement or contents. According to its publishers, however, over 200,000 changes have been made in order to keep the lists complete and accurate. The Register is a directory of first hands in all lines, classified under several thousand subjects and fully indexed, so that the makers of any article may readily be found. Companies are also listed alphabetically, with data upon branch offices, capital, location, etc. A list of trade names is given, showing the owners of the various trade marks. In addition to these main divisions, the Register also contains lists of representative banks, commercial organizations, exporters and importers, and trade papers, making it a most complete work of reference for buyers and sellers.

La Theorie de la Relativite Restreinte et Generalisee. By A. Einstein. Gauthier-Villars et Cie, Paris, 1921. Paper, 5 x 7 in., 120 pp., 7 francs.

This French edition of Dr. Einstein's popular presentation of the theory of relativity is based on the second German edition. A lengthy preface by Emile Borel discusses the value of the theory and the limits of its practical use.

United States Steel—A Corporation with a Soul. By Arundel Cotter. Doubleday, Page and Co., Garden City, N. Y., 1921. Cloth, 6 x 8 in., 312 pp., portraits, plates, $3.

This is an enlarged and modernized edition of The Authentic History of the United States Steel Corporation. It gives a well written account of the reasons for its organization, its history, activities, aims and policies, relations with its employees, together with some account of important officials, past and present.

Die Warmeverluste Durch Ebene Wande unter Besonderer Berücksichtigung des Bauwesens. By Karl Hencky. R. Oldenbourg, München und Berlin, 1921. Paper, 7 x 10 in., 124 pp., illus., tables, 26 marks.

This work is based on extensive experiments on the heat conductivity of walls of the usual types and of the customary building materials, carried out at the Munich Technical High School. From the results of these and general laws of the conduction of heat, the author has formulated equations to be used in designing heating installations. The book is intended for architects and for engineers engaged in the design of heating plants, as a practical aid in calculating the size of installations.

Wirtschaftliche Verwertung der Brennstoffe. By G. de Grahl. Second revised edition. R. Oldenbourg, München and Berlin, 1921. Paper, 8 x 11 in., 485 pp., plates, illus., charts, diagrams, 110 marks.

This work on the economical utilization of fuels first appeared in 1915, when the economic isolation of Germany began to be effective. The present edition has been entirely rewritten in the light of the fuel situation after the war, and is an exhaustive treatise on the utilization of the available fuel supply under present conditions. After a description of the solid, gaseous and liquid fuels, in which their efficiencies are compared, the author discusses the processes for converting and enriching them. Gas production, by-products, nitrogen utilization are treated in detail. The subject of combustion is then taken up, and an extended critical discussion of methods of firing, especially for steam production, is included. Another chapter discusses heating for municipalities, waste heat utilization, etc. The concluding chapter treats of the economics of energy in general.

Wireless Telegraphy with Special Reference to the Quenched-Spark System. By Bernard Leggett. E. P. Dutton & Co., New York, 1921. (The Directly-Useful Technical Series.) Cloth, 6 x 9 in., 485 pp., illus., plates, $12.

This volume is intended to provide a treatise in English on radiotelegraphy in which particular attention is given to the quenched-spark system. Bibliographies are appended to many chapters.

THE ENGINEERING INDEX

(Registered U. S. Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENTS

Dust Explosions. An Explosion of Hard Rubber Dust, David J. Price and Hylton R. Brown. Chem. & Metallurgical Eng., vol. 24, no. 17, April 27, 1921, pp. 737–740, 5 figs. Results of investigation of recent explosion in reduction of hard-rubber scrap department of large industrial plant. Recommendations for prevention and precautions to be taken in hard-rubber grinding.

AERODROMES

France. French State Aerodromes for Civil Use. Aviation, vol. 10, no. 20, May 16, 1921, pp. 638–639, 6 figs. Types of aerodrome built by French government.

AERODYNAMICS

Wind-Tunnel Experiments. Extract from a Report of the Resistance of Spheres of Small Diameter in an Airstream of High Velocity, Capt. Toussaint and Lieut. Hayer. Aerial Age, vol. 13, no. 9, May 9, 1921, pp. 199–200, 3 figs. Interpretation of results found in wind-tunnel experiments at Aerotechnical Inst. of Saint-Cyr, France, and comparison with results found by other experimenters.

AERONAUTICAL INSTRUMENTS

Accelerometer. Accelerometer Design, F. H. Norton and Edward P. Warner. Nat. Advisory Committee for Aeronautics, no. 100, 1921, 16 pp. 14 figs. Experimental work carried out by technical staff of Nat. Advisory Committee for Aeronautics for the purpose of recording errors due to accelerations acting in other than required direction and also errors due to angular accelerations.

Driftograph. The Driftograph. Sci. Am. Monthly, vol. 3, no. 5, May 1921, pp. 453–454, 1 fig. Instrument for determining drift of aircraft. Translated from Génie Civil.

AERONAUTICS

National Advisory Committee. Special Report of the National Advisory Committee for Aeronautics. Aviation, vol. 10, no. 18, May 2, 1921, pp. 553–558. Federal regulation of air navigation; air routes to cover whole U. S.; coöperation among government departments. Submitted to President of U. S., April 9, 1921.

Special Report of the National Advisory Committee for Aeronautics. Aerial Age, vol. 13, no. 9, May 9, 1921, pp. 200–202. (Concluded.)

Reactive Propulsion in Air. Possibility of Reactive Propulsion in Air, B. T. Koleroff. Aviation, vol. 10, no. 20, May 16, 1921, pp. 624–625. Underlying principles to which device operating by reactive propulsion must conform.

Research Laboratory. The Aeronautic Research Laboratory at the Institute of St. Cyr, John Jay Ide. Automotive Industries, vol. 44, no. 16, April 21, 1921, pp. 853–855, 5 figs. Facilities for aerodynamic investigations include two wind tunnels of different size, whirling arm, and two electrically operated trucks running on rails, all of which are equipped for determining characteristics of airfoils. One truck is designed for testing propellers.

Tests. Review on Experimental Aerotechnics (Revue d'aérotechnique expérimentale), L. Toussaint. Revue générale des Sciences, vol. 32, no. 7, April 15, 1921, pp. 203–213, 2 figs. Aerodynamic principles experimentally established at principal aeronautical laboratories of the world.

AEROPLANE ENGINES

Cooling Systems. Cooling System Flight Test of Loening M-8. U. S. War Dept., Air Service Information Circular, vol. 3, no. 206, April 30, 1921, 8 pp. 5 figs. Object was to determine effectiveness of cooling system of Loening monoplane, model M-8.

Design. The Ultimate Airplane Engine, Jesse G. Vincent. Aviation, vol. 10, no. 18, May 2, 1921, pp. 567–569. Possibilities of utilizing steam engine, steam turbine or electrical propulsion for aeroplane propulsion.

Exhaust Silencer. The Martin Exhaust Silencer. Aeronautics, vol. 20, no. 392, April 21, 1921, pp. 278, 2 figs. Silencer built of light-gage iron sheet, riveted and welded together.

Haacke. The Haacke 30 H. P. Aero Engine. Flight. vol. 13, no. 14, April 7, 1921, pp. 239–240, 5 figs. Two-cylinder opposed air-cooled model developing 30 hp.

Liberty. Performance of a Liberty 12 Airplane Engine, S. W. Sparrow and H. S. White. Nat. Advisory Committee for Aeronautics, no. 102, 1921, 20 pp. 16 figs. Tests conducted in altitude chamber of dynamometer laboratory of Bur. of Standards. Engine was tested under full power run at ground altitude at speeds from 1200 to 2000 r.p.m. and at speeds at 1600 and 1700 r.p.m. at full throttle from ground altitude to 25,000 ft. in steps of 5000 ft. Propeller-load runs and friction-horsepower runs were also examined.

Test of a Standard Liberty Cylinder Mounted on a Universal Engine Crank Case. U. S. War Dept., Air Service Information Circular, vol. 2, no. 199, April 25, 1921, 10 pp. 6 figs. Measurement of power friction losses, temperatures and heat-transfer characteristics of standard Liberty cylinder when mounted on universal engine.

Napier "Cub." The Napier "Cub" Engine. Automobile Engr., vol. 11, no. 149, April 1921, pp. 146–147, 2 figs. Four sets of four cylinders. Included angle between uppermost blocks of cylinders is 52 1/2 deg. and between bottom blocks 127 1/2 deg. Engine develops 1000 hp.

Operation with Automobile Gasoline. Operating Liberty "12" and Wright-Hispano 300-Hp. Engines on Automobile Gasoline. U. S. War Dept., Air Service Information Circular, vol. 3, no. 227, May 10, 1921, 4 pp. It is recommended that use of such fuel in engines should be avoided whenever possible and in cases of necessity engines should be run throttled while on or near ground.

Performance. Investigation of the Effect of Air Conditions Upon the Power of Aviation Engines, Harold S. White. Armour Engr., vol. 12, no. 3, Mar. 1921, pp. 135–144, 3 figs. Investigations of theory establishing that power is proportional to density or inversely proportional to absolute temperature. Development of new theory.

Some Factors of Airplane Engine Performance, Victor R. Gage. Nat. Advisory Committee for Aeronautics, Report No. 108, 1921, 29 pp., 28 figs. Tests on Liberty 12 and three models of Hispano-Suiza made in altitude chamber where conditions simulated altitudes up to about 30,000 ft. at engine speeds ranging from 1,200 to 2200 r.p.m.

Power at High Altitudes. Influence of Flight at High Altitudes on Power of Aeroplane Engines (Influence du vol à haute altitude sur la puissance du moteur d'un aéroplane), M. Collette. Arts et Métiers, vol. 74, no. 2, Feb. 1921, pp. 49–51, 4 figs. Graph for determining altimetric reduction of power of aeroplane engines from temperature and barometric pressure.

AEROPLANE PROPELLERS

Design. Aeronautic Propeller Design, F. W. Caldwell. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 467–480, 26 figs. Propeller-design theories and aerodynamic principles are discussed mathematically, as well as elements governing best propeller diameter for obtaining highest thrust. Consideration is given in detail to adjustable-pitch and reversible propellers as well as to those made up of laminations or sheets of paper or fabric impregnated with bakelite as binder.

Variable-Pitch. The Parker Variable Pitch Airscrew. Flight, vol. 13, no. 15, April 14, 1921, pp. 257, 2 figs. Pitch changes automatically as density of air decreases with altitude, also when engine misfires or slows down.

AEROPLANES

Aerofoils. Aerodynamic Characteristics of Aerofoils. Nat. Advisory Committee for Aeronautics, report no. 93, 1921, 83 pp, 218 figs. Collection of data on aerofoils from published report of leading aerodynamic laboratories of U. S. and Europe. Charts and tables for use of designing engineers and for general reference.

The German Lachmann Slotted Aerofoil. Flight, vol. 13, no. 14, April 7, 1921, pp. 242, 2 figs. Translated from Flugsport.

The Resistance of Aerofoils, W. F. Gerhardt Aerial Age, vol. 13, no. 8, May 2, 1921, pp. 175–178, 13 figs. Methods of plotting aerofoil characteristics, (Concluded.)

All-Metal. German All-Metal Commercial Machines, Alfred Gradenwitz. Aeronautics, vol. 20, no. 394, May 5, 1921, pp. 314–316, 5 figs. Dornier types.

The New German All-Metal Aeroplanes (Les nouveaux avions métalliques allemands), E. H. Lémonon. Aerophile, vol. 29, nos. 5–6, Mar. 1–15, 1921, pp. 71–78, 16 figs. Junkers types.

Design. Influence of Span and Load Per Square Meter on the Air Forces of the Supporting Surface, A. Betz. Aerial Age, vol. 13, no. 10, May 16, 1921, pp. 224–225, 4 figs. Formulas. Translated from Technische Berichte.

Load Factors. Aeronautics, vol. 20, no. 391, April 14, 1921, pp. 254–255. Scale of load factors and factors of safety prepared by British Advisory Committee for Aeronautics.

Flight Endurance. Notes on Airplane Flight Endurance. U. S. War Dept., Air Service Information Circular, vol. 3, no. 210, May 1, 1921, 6 pp., 1 fig. Chart for determining minimum horsepower required or maximum horsepower available at any altitude that aeroplane can reach.

Flight Without Propellers. New Air Transport Theory, Harry Harper. Motor Transport, vol.

Note.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

32, no. 843, April 25, 1921, pp. 442–443. Pulsating wing invented by Prof. Raimund Nimführ. Wing is hollow with air bags inside, underneath section taking form of flexible membrane, which can be set beating or pulsating by action of pneumatic pumps which alternately fill or empty air bags. Aeroplane without propellers, impelled by pulsating wing, is to be manufactured by American syndicate.

Hispano-Suiza. Performance of a 300-Horsepower Hispano-Suiza Airplane Engine, S. W. Sparrow and H. S. White. Nat. Advisory Committee for Aeronautics report no. 103, 1921, 22 pp. 16 figs. Test showed inadequacy of carburetor altitude control of air-fuel ratio for heights above 20,000 ft.

Saulnier. The R. Saulnier Triple-Motored Monoplane (Le monoplan trimoteur R. Saulnier). Aérophile, vol. 29, nos. 5–6, Mar. 1–15, 1921, pp. 67–69, 6 figs. Characteristics: Engines, 3 Lorraine-Dietrich of 370 hp. each; weight loaded, 7000 kg.; useful weight, 2700 kg.

Strutless Supporting Planes. Aeroplanes with Strutless Supporting Planes (Flugzeuge mit verspannungslosen Tragflächen), E. Meyer. Schweizerische Bauzeitung, vol. 77, no. 15, Apr 9, 1921, pp. 166–168, 7 figs. Points out aerodynamic superiority of aeroplanes with freely supported strutless planes based on the Junkers principle, and refers to various recent commercial and sport types constructed with view to reducing the resistance-producing parts to a minimum.

Struts. The Design of Long Struts Exposed to the Air, John Case. Aeronautics, vol. 20, nos. 391 and 392, April 14 and 21, 1921, pp. 257–258, 4 figs., and 272–274, 5 figs. Apr. 14: formulas for computing dimensions of different types. Apr. 21: Method of designing taper struts having parallel hole.

[See also HELICOPTERS; PARACHUTES, SEAPLANES.]

AIR

Moisture Content. The Moisture Content of Atmospheric Air (Der Wasserdampfgehalt der Luft), Karl Reyscher. Gesundheits-Ingenieur, vol. 44, no. 15, Apr. 9, 1921, pp. 168–170, 1 fig. Values for pressures in saturated steam, weight of steam and of pure air, etc. are given in tabular form from which curves are developed.

AIR MACHINERY

Classification. Classification and Nomenclature of Air Machinery (Gliederung und Bezeichnung der Luftfördermaschinen), M. Berlowitz. Gesundheits-Ingenieur, vol. 44, no. 13, Mar. 26, 1921, pp. 141–143, 1 fig. Suggestions for a standardization of terms for pumps and compressors.

AIRCRAFT CONSTRUCTION MATERIALS

Brazing. Report on Investigation of Dip Brazing with 80–20 Brass. U. S. War Dept., Air Service Information Circular, vol. 3, no. 203, April 30, 1921, 8 pp. 8 figs. Objects were to determine best flux to use in brazing and effects of heat treatment on brazed joints, and to develop satisfactory method of brazing with 80 per cent copper and 20 per cent zinc mixture.

Plywood. Plywood in Airplane Construction, Armin Elmendorf. Aviation, vol. 10, no. 21, May 23, 1921, pp. 660–663, 7 figs. Uses in construction of semi-monocoque fuselage. Table of weights of veneer. (Concluded.)

AIRSHIPS

German. Development and Present Status of German Airships. Automotive Industries, vol. 44, no. 20, May 19, 1921, pp. 1057–1065, 1 fig. Tables giving characteristics of German airships built up to May 1921. Survey of technical successes and failures of various types. Comparison of performance of R-34 with that of German L-59 which made trip to East Africa.

Hangars. See HANGARS.

Mooring Gear. Airship Mooring Gear. Engineering, vol. 111, no. 2884, April 8, 1921, pp. 423–424 and 426, 4 figs. Experimental mooring mast designed and installed by British Air Ministry.

An American System of Airship Mooring. Aeronautics, vol. 20, no. 391, April 14, 1921, p. 256, 4 figs. Airship is anchored to 5 trolleys running under circular slots in platform.

Mooring Masts for Airships. Aviation, vol. 10, no. 21, May 23, 1921, p. 665, 1 fig. Webbed-steel structure 115 ft. in height, with revolving circular platform housed-in at top and above platform mooring. Apparatus of cylindrical form swung on gimbals, which permits ship when moored to sway with wind. Mast erected at Pulham, England.

R-36. The Passenger-Carrying Airship R-36. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 454–456 and 458, 28 figs. partly on supp. plate. Characteristics: Overall length, 672 ft. 2 in.; maximum diameter of hull, 78 ft. 9 in.; height from bumping bags to top of hull structure, 91 ft. 7 in.; gas capacity, 2,196,000 cu. ft.; carried in 19 bags; gross lift, 64.5 tons.

Rigid. Circumferential Wiring of Rigids, E. H. Lewitt. Aeronautics, vol. 20, no. 395, May 12, 1921, pp. 336–338, 8 figs. Study of stresses.

[See also AERODROMES.]

ALCOHOL

Coke-Oven Gas. The Manufacture of Alcohol from Coke-Oven Gas, C. F. Tidman. Jl. Soc. Chem. Industry, vol. 40, no. 8, April 30, 1921, pp. 86T–89T, 2 figs. Record of work carried out at Skinningrove Iron Works, England.

Industrial. Industrial Alcohol (L'alcool industriel), Charles Blanchet. Revue de l'Ingenieur et Index technique, vol. 28, no. 4, April 1921, pp. 179–185. Requirements for manufacture of industrial alcohol. Possibility of utilizing alcohol as automobile fuel. (To be continued.)

Industrial Alcohol and Prohibition Enforcement, Martin H. Ittner. Chem. Age (N. Y.), vol. 29, no. 6, June 1921, pp. 211–212. Resolutions adopted by Am. Chem. Soc. urge that all legislation for enforcement of prohibition "be so clearly drawn as not to restrict the activities of legitimate industries which must have industrial alcohol."

ALLOY STEELS

Chromium-Tungsten. Constitution of Chromium: Tungsten Steels. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, pp. 791–793, 8 figs. Recent Japanese work throwing light upon complex reactions giving self-hardening and red-hardness properties to modern high-speed steels. From Sci. Reports of Tohoku University.

ALLOYS

See ALUMINUM ALLOYS; ZINC ALLOYS; BEARING METALS; BRONZES; COPPER ALLOYS; GUN METAL; PHOSPHOR BRONZE.

ALUMINUM

Casting Losses. Losses in Aluminum and Aluminum-Alloy Melting, Robert J. Anderson, U. S. Dept. of Interior, Bur. of Mines, Reports of Investigations, no. 2239, April 1921, 6 pp. Factors in operation of furnaces that affect casting losses.

ALUMINUM ALLOYS

Melting Practice. Iron-Pot Melting Practice for Aluminum Alloys, Robert J. Anderson. Metal Industry (N. Y.), vol. 19, no. 5, May 1921, pp. 189–190. Design of iron-pot furnaces.

AMMONIA CONDENSERS

Selection. The Proper Selection of Ammonia Condensers, W. H. Motz. Power, vol. 53, no. 17, April 26, 1921, pp. 659–662, 4 figs. Economic considerations.

ANEMOMETERS

Comparison of. Comparison of Anemometers (Sur la comparabilité des anémomètres), M. C.-E. Brazier. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 14, April 4, 1921, pp. 843–845. Comparison of various types in currents of air inclined at an angle.

APPRENTICES, TRAINING OF

Methods. Programs of Apprenticeship and Special Training in Representative Corporations—XII, J. V. L. Morris. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 778–779, 4 figs. Method of training apprentices at plant of Packard Motor Car Co., Detroit, Mich.

National Instructional Factories. Industrial Training. Times Eng. Supp., no. 558, April 1921, p. 132. Discusses organization of national instructional factories for training and education industrial apprentices.

Railways. Paris-Orleans Apprentice Work Organized. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 313–316, 4 figs. Description of development of courses for apprentices of Paris-Orleans during war. Translated from Revue Générale des Chemins de Fer.

AUTOGENOUS WELDING

German Code, Revised. Revision of Acetylene Code (Abänderung des Entwurfes der Acetylenverordnung). Autogene Metallbearbeitung, vol. 14, no. 7, Apr. 1, 1921, pp. 98–107. Proposal is result of conference of members of German Acetylene Assn. for Autogenous Metalworking, Federation of German Autogene Industry, and government officials, and represents a complete revision of existing code of 1914 and of proposal of Bavarian Government.

AUTOMOBILE ENGINES

Carburetors. See CARBURETORS.

Heavier Oil Fuels, Use of. Experiences with the Use of Heavier Oil Fuels in Automobile Engines (Erfahrungen und Erwägungen über die Verwendung schwererer Brennstoffe im Automobilmotor), J. Plünzke. Motorwagen, vol. 24, nos. 8 and 9, Mar. 20 and 31, 1921, pp. 150–158 and 169–178, 41 figs. Discussion, based on experience, of means of improving carburetor type of engine for rational use of medium-weight in place of light oils.

Highway. Non-Detachable Head Used in New Stock Engine, J. Edward Schipper. Automotive Industries, vol. 44, no. 16, April 21, 1921, pp. 844–846, 4 figs. Engine manufactured by Highway Engine Co. has four cylinders, 3¾ by 5 in., and develops maximum of 48 hp. Both halves of crankcase and water-jacket cover are aluminum castings. Valve caps are screwed into cylinder head. Full pressure lubrication employed.

Valves, Grinding-in. Electric Machines for Grinding-in Valves. (Elektrische Ventileinschleifmaschine), H. Seiler. Allgemeine Automobil-Zeitung, vol. 22, no. 5, Jan. 29, 1921, p. 29, 2 figs. Describes German patented machine which can also be used as a drilling machine and consists mainly of a small electric motor of 1/15 to 1/20 hp. with the necessary gear.

AUTOMOBILE FUELS

Characteristics. The Character of Various Fuels for Internal Combustion Engines—III, H. T. Tizard and D. R. Pye. Automobile Engr., vol. 11, no. 149, April 1921, pp. 134–137, 2 figs. Influence of specific heat and dissociation of working fluid. Calculation of final temperature and work done during expansion.

Research. Résumé of Bureau of Standards Fuel Study, H. C. Dickinson. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 482–486, 6 figs. Two types of experiments were undertaken; steady runs to determine rate of fuel consumption under load conditions, at about one-fifth maximum mean effective pressure and speed of 1200 r.p.m., and series of repeated accelerations from 10 to about 30 m.p.h. In each case fuel consumption was recorded.

The Influence of Various Fuels on the Performane of Internal Combustion Engines—III and IV, H. R. Ricardo. Automobile Engr., vol. 11, nos. 149 and 150, April and May 1921, pp. 130–133, 5 figs., and 169–175, 14 figs. April: Experimental study of relationship between detonation point and spontaneous ignition temperature. May: Experimental investigation of power output from different fuels, with constant and with adjusted compression ratios.

The Influence of Various Fuels on Engine Performance—II and III, H. R. Ricardo. Automotive Industries, vol. 44, nos. 16 and 19, April 21 and May 12, 1921, pp. 856–862, 6 figs., and 1003–1007, 12 figs. Research on detonation and effect thereon of combustion chamber design, turbulence, speed of rotation, temperature and pressure are discussed at length, and measurement of value of fuel in terms of its tendency to detonate are tabulated and plotted in their relation to other important factors.

[See also ALCOHOL.]

AUTOMOBILES

Bodies. Automobile Body Construction, P. E. Stone. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 404–409. Notes on strength and desirability of materials suitable for construction of enclosed type of body.

Some Examples of Modern Passenger Car Bodies Designed in Germany, Benno R. Dierfeld. Automotive Industries, vol. 44, no. 17, April 28, 1921, pp. 897–899, 11 figs. Designs embodying V-type radiator and windshield, concealed top and divided rear seat.

Cleaning Parts for Repair Work. Modern Boiling Apparatus for Automobile Factories and Repair Workshops (Neuzeitliche Abkochanlagen für Automobilfabriken und Ausbesserungswerkstätten), H. Toepel. Automobil-Rundschau, vol. 20, no. 5–6, Mar. 1921, pp. 53–55, 3 figs. Details of vats patented by Hannover Machine Constr. Corp. (Hanomag) for cleaning of automobile parts preliminary to repair work by boiling in lye.

Fuel Cocks. The Pallas Fuel Cock as Protection Against Theft of Automobiles (Der verschliessbare Pallas-Brennstoffhahn), E. Jaenichen. Allegemeine Automobil-Zeitung, vol. 22, no. 7, Feb. 12, 1921, p. 27, 2 figs. Describes fuel cock, connecting in fuel pipe to carburetor, which can be closed and opened with a key, construction being such that key fits only the one cock for which it is intended.

Manufacture. A Modern Automobile Factory. Eng. Production, vol. 2, no. 31, May 5, 1921, pp. 575–583, 26 figs. Production methods at works of Arrol-Johnston, Dumfries, Scotland.

Special Machines and Fixtures in the Franklin Plant, Franklin D. Jones. Mach. (N.Y.) vol. 27, no. 9, May 1921, pp. 823–830, 19 figs. Mechanical equipment designed either to increase production, perform special operations, or maintain established standards of accuracy.

Wrenches. Manufacture of Socket Wrenches, P. Baldus. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 868–869, 4 figs. Practices of various automobile manufacturers.

AVIATION

Aerial Lighthouses. The Aerial Lighthouse. Flight vol. 13, no. 16, April 21, 1921, pp. 280–283, 7 figs. Suggested design.

Canadian Air Board. Report of the Canadian Air Board for the Year 1920. Flying, vol. 10, no. 4, May 1921, pp. 139–143. Board was created (1) to regulate civil aviation, (2) to conduct civil government operations, and (3) to develop air defense of Canada, including organization and administration of Canadian Air Force.

Commercial. European Air Lines. Aeronautics, vol. 20, no. 395, May 12, 1921, pp. 332–334, 6 figs. Air routes which are now in operation in Europe, with fare tariffs and timetables.

Landings, Marking. Air Service Adopts Location Marker. Aviation, vol. 10, no. 17, April 25, 1921, p. 527, 2 figs. Specifications of locations marker adopted by U. S. Air Service.

Mail Service. Three Years of Air Mail Service. Aviation, vol. 10, no. 18, May 2, 1921, pp. 559–564, 5 figs. Comparison of performance of U. S. Air Mail Service and of British and Canadian civil flying.

National Advisory Committee for Aeronautics. Special Report of the National Advisory Committee for Aeronautics. Aerial Age, vol. 13, no. 8, May 2, 1921, pp. 178–180. Federal regulation of air navigation. Air routes to cover whole U. S. Coöperation among government departments.

Soaring Flight. The Soaring Flight of Birds and the Possibility of a Mechanical Imitation. (Der Segelflug der Vögel und die Möglichkeit einer Künstlichen Nachahmung), Carl Steiger. Schweizerische Bauzeitung, vol. 77, no. 15, Apr. 9, 1921, pp. 168–169. Critical discussion of Lilienthal's paper with above title reported in same journal (nos. 11 and 12, Mar., 1921).

Speed of Flights. The Question of Speed (Le problème de la vitesse), J. Philippe. Aéronautique, vol. 3, no. 22, Mar. 1921, pp. 136–137. Theoretical conditions necessary for obtaining high horizontal speed.

B

BEARING METALS

Anti-Friction. Anti-Friction Bearing Metals, P. W. Priestley. Metal Industry, (Lond.), vol. 18, no. 17, April 29, 1921, pp. 323–324. Typical compositions of anti-friction methods employed in construction of aeroplanes and automobile engines.

Research. Results of Investigation Covering Bearing Metals. Belting, vol. 18, no. 4, April 1921, pp. 63–64. Report of committee on mechanical standards, Canadian Pulp & Paper Assn., at recent Montreal convention.

BEARINGS

Examination. A Microphone "Stethoscope" for Bearings. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 546, 3 figs. Apparatus for examining condition of bearings and gears by electricity.

BEARINGS, BALL

Manufacture. The Ball Bearing—I, Henry L. Heathcote. Machy. (Lond.), vol. 18, no. 448, April 28, 1921, pp. 114–119, 3 figs. Notes on manufacture and testing.

The Ball Bearing: In the Making, Under Test and on Service, Henry L. Heathcote. Automobile Eng., vol. 11, no. 150, May 1921, pp. 180–187, 6 figs. Mathematical study of action of ball bearings, together with notes on their manufacture and suggested method of testing them.

The Manufacture of Ball Bearings. Engineering, vol. 111, nos. 2884 and 2885, April 8 and 15, 1921, pp. 415–418, 20 figs. partly on 3 supp. plates, and 445–449, 18 figs. Procedure at works of Ransome & Marles Bearing Co., England.

BEARINGS, ROLLER

Manufacture. Maintaining Continuity Throughout Roller Bearing Manufacture, J. Edward Schipper. Automotive Industries, vol. 44, no. 17, April 28, 1921, pp. 912–917, 22 figs. Methods used at plant of Timken Roller Bearing Co., Canton, Ohio.

N.K.A. A New Disk Type Bearing. Automotive Industries, vol. 44, no. 19, May 12, 1921, p. 996, 2 figs. N.K.A. Swedish disk. Disks are not cylindrical but are central sections of ellipsoid of revolution. Bearing comprises two race rings provided with grooves in which disks run.

BLAST-FURNACE GAS

Cleaning. Notes on the Cleaning of Blast-Furnace Gas, S. H. Fowles. Engineering, vol. 111, no. 2889, May 13, 1921, pp. 600–602, 7 figs. Methods of operating Halberg-Beth dry gas cleaning plant. (Abstract). Paper read before Iron & Steel Inst.

BLAST FURNACES

Charging. Husson Incline System of Charging Materials Into Blast Furnaces (Monte-charge incliné système "Husson" pour haut-fourneau), M. H. Barral. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 92–95, 9 figs. Modification of Staehler system.

Design. Stack Changes Effect Economy, H. R. Stuyvesant. Iron Trade Rev., vol. 68, no. 19, May 12, 1921, pp. 1312–1313 and 1316, 3 figs. Improvements in cooling equipment, lines and hearth of Alabama blast furnace, together with introduction of casting machine and new trestle.

BLOWING ENGINES

Gas-Driven. 13 H.P. Gas-Driven Blowing Engine. Engr., vol. 131, no. 3409, April 29, 1921, pp. 451–454, 4 figs. partly on supp. plate. Engines manufactured at Galloway Works, Manchester, England.

BLUEPRINTING

Machines. Recent Progress in Blue Printing. Sci. Am., vol. 124, no. 20, May 14, 1921, p. 389, 1 fig. Machines that print, wash and dry blueprints in continuous operation.

BOILER FEEDWATER

Analyses. The Interpretation of Boiler-Water Analyses, J. R. McDermet. Mech. Eng., vol. 43, no. 5, May 1921, pp. 319–320 and 342. Limitations and applications of technical or mineral analysis. Use of partial sanitary analysis as forecasting possible trouble due to pollution. Significance of analysis for dissolved gases in relation to conditions under which it is used.

BOILER FIRING

Pulverized Coal. Economical Firing of Steel Plant Boilers, Charles Longenecker. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 308–310 and 336. Comparison of hand-fired, stoker-fired and pulverized-coal-fired boilers. Test run on 520-hp. boiler fired by pulverized coal.

BOILER INSPECTION

Canada. Rules Governing the Inspection of Railway Stationary Boilers in Canada. Boiler Maker, vol. 21, no. 5, May 1921, pp. 137–138. Rules of Board of Railway Commissioners for Canada.

BOILER OPERATION

Losses. The Cost of Boiler Scale, W. F. Schaphorst. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 292, 1 fig. Chart for determining loss due to scale.

BOILERS

Electrically Heated. The Revel Electric Boiler (La chaudiere électrique revel). Industrie Electrique, vol. 30, no. 691, April 10, 1921, pp. 127–138, 3 figs. Pressure is automatically controlled by regulating surface of electrodes in contact with water.

The Utilization of Hydraulic Energy in the Electrification of Boilers (L'utilisation intégrale des forces hydrauliques par l'electrification des chaudières), P. Bergeon. Revue générale de l'Électricité, vol. 9, no. 17, April 23, 1921, pp. 561–567, 6 figs. Economical advantages of operating boilers by electricity.

Settings. Constructing Horizontal Boiler Settings, H. E. Dart. Boiler Maker, vol. 21, no. 5, May 1921, pp. 127–131, 5 figs. Typical setting designs adopted as standard by Hartford Steam Boiler Inspection and Insurance Co.

Single-Sheet. The Single-Sheet Lap-Seam Boiler, J. P. Morrison. Power, vol. 53, no. 17, April 26, 1921, pp. 652–655, 8 figs. Weaknesses in reliability of single-sheet, lap-seam boiler are pointed out by reference to numerous explosions.

BOILERS, WATER TUBE

Stirling. Development of the Stirling Boiler. Power, vol. 53, no. 16, April 19, 1921, pp. 632–634, 7 figs. Recent modifications making for standardization of classes, greater accessibility, elimination of priming and improved setting.

Seven Recent Changes in the Stirling Boiler Coal Age, vol. 19, no. 18, May 5, 1921, pp. 822–823, 3 figs. Front and rear steam drums raised, latter being protected by baffle. Steam now taken from rear drum. Superheater chamber enlarged. Bonding tile used front wall. Present standardization has reduced number of types from 14 to 3.

Tests. Boiler Tests with Pulverized Illinois Coal Henry Kreisinger and John Blizard. Mech. Eng., vol. 43, no. 5, May 1921, pp. 321–322 and 326, 2 figs. Tests of 468-hp. water-tube boiler fired with pulverized Illinois coal. Results showed that, contrary to customary specification, it is not necessary to pulverize coal to extreme fineness of 85 per cent through 200-mesh screen. Best results were obtained when coal was burned at rates from 0.5 lb. to 2 lb. per cu. ft. of combustion space per hour.

BORING HEADS

Modern Types. Modern Hollow Boring and Cutter Heads (Einige neuere Hohlbohr- und Messerköpfe), Valentin Litz. Werkstattstechnik, vol. 15, no. 7, Apr. 1, 1921, pp. 177–179, 32 figs. Details of various types used during and before war for boring out guns, shafts, rods, pipes, etc.

BORING MACHINES

Herbert. A New System of Precision Boring Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 553–554, 2 figs. Boring machine manufactured by Alfred Herbert, Coventry, England, and designed for rapid machining of jigs and fixtures.

BRAKING

Heating of Wheel Tires. The Heating of Railway Wheels in Consequence of Braking (L'échauffement des bandages des roues de véhicules de chemins de fer par suite du freinage), R. Zehnder-Spörry. Bulletin technique de la Suisse romande, vol. 47, no. 9, April 30, 1921, pp. 97–102, 6 figs. Calculation of heat liberated by friction produced by braking.

BRAZING

See AIRCRAFT CONSTRUCTION MATERIALS, Brazing.

BROACHING

Keyways. Guide Bushings for Keyway Broaching. Machy. (Lond.), vol. 18, no. 447, April 21, 1921 pp. 75–76, 3 figs. Formulas for designing bushings for broaching accurate keyways.

Typical Operations. Broaching as a Production Factor, J. H. Moore. Can. Machy., vol. 25, no. 16, April 21, 1921, pp. 33–37, 10 figs. Typical broaching operations.

BRONZES

Tempering. Tempering of Tin Bronzes (Sur la trempe des laitons à l'étain) M. Léon Guillet. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 17, April 25, 1921, pp. 1038–1041, 2 figs. Effect of tempering on mechanical properties. Experiments on various types of tin bronzes.

BUILDING CONSTRUCTION

Concrete. Putting Up a Concrete Building Under Severe Difficulties, H. C. Paddock. Contract Rec., vol. 35, no. 16, April 20, 1921, pp. 383–385, 7 figs. Fish-freezing plant on island of St. Pierre erected on rocky site. Materials and labor imported Fire of extreme severity destroyed concrete and necessitated partial rebuilding.

C

CAR DUMPERS

Tilting Unloader. A Rapid Tilting Cradle Unloader for Box Cars. Ry. Age, vol. 70, no. 16, April 22, 1921, pp. 999–1000, 2 figs. Design developed by Ottumwa Box Car Loader Co., Iowa.

CAR WHEELS

Tire-Fixing Rolls. Tire Fixing Rolls for Railway Wheels. Engr., vol. 131, no. 3408, April 22, 1921, pp. 441, 3 figs. Hydraulic press manufactured by B. & S. Massey, Openshaw, Manchester.

CARBURETORS

Atmos. An Interesting Carburetter. Automobile Eng., vol. 11, no. 150, May 1921, pp. 178–179, 3 figs. Atmos carburetors. Throttle is only moving part and forms the center portion of the venturi tube. Situated at right angles to the main venturi is an auxiliary venturi, at throat of which jet is placed with its controlling needle.

German Oekonom. The "Oekonom" Carbureto (Der Kraftstoffvernebler "Oekonom"), Wa. Ostwald. Allgemeine Automobil-Zeitung, vol. 22, no. 7, Feb. 12, 1921, pp. 28–29, 3 figs. Consists of aluminum casing provided with two glass windows, from which condition of mixture can be observed, and no fuel can leave apparatus which is not thoroughly vaporized.

Jet Calibration. Calibrating Carbureter Jets in Quantity by Actual Flow Measurement, J. Edward Schipper. Automotive Industries, vol. 44, no. 18, May 5, 1921, pp. 958–959, 3 figs. Apparatus used by Zenith Carburetor Co. consists of tank with constant head, device for holding jet, electrically controlled timing elements, and graduates for measuring volume of flow in unit time. Each operator can test 160 jets per hour by use of one calibrating machine.

Research. Experimental Research on the Best Proportion of Fuel and Air for Explosive Motors (Recherches expérimentales sur les valeurs du titre, en essence, du mélange d'alimentation des moteurs a explosion), J. Boudet. Arts et Métiers, no. 3, Dec. 1920, pp. 49–54, 7 figs. Comparative study of various types of carburetors.

CARS

Steel. Progress in the Development of the All-Steel Car, J. J. Tatum, Ry. Rev., vol. 68, no. 19, May 7, 1921, pp. 699–700. Advisability of using copper bearing steel for improving performance from standpoint of service and maintenance. Paper read before Can. Ry. Club.

CARS, COAL

100-Ton. New Norfolk & Western 100-Ton Coal Cars, John A. Pilcher. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 293–298, 9 figs. Body supported on side bearings instead of center plate. New type six-wheel truck.

120-Ton. The 120-Ton Coal Cars of the Virginian Railroad. Ry. & Locomotive Eng., vol. 34, no. 5, May 1921, pp. 121–124, 5 figs. Cars carried on six-wheeled trucks.

CARS, FREIGHT

Draft-Gear Tests. Draft Gear Tests of the Railroad Administration. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 301–304, 1 fig. Results from gears after three years' service; destructive tests and rivet-shearing tests.

High-Capacity. Real Operating Economy in the use of High-Capacity Cars. Ry. Rev., vol. 68, no. 17, April 23, 1921, pp. 629–635, 9 figs. Net revenue tonnage of freight train increased 20 per cent where 100-ton cars are used on Norfolk & Western Ry.

Reinforced-Concrete. Reinforced-Concrete Freight Cars (Eisenbahnwagenkasten aus Eisenbeton), Max Gensbaur. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 17, Apr. 23, 1921, pp. 445–446, 3 figs. States that use of such cars is shown to be technically and economically feasible; reinforced-concrete ore cars with bottom discharge do not increase weight as compared with steel trucks; a special hardening of inside surface of concrete superstructure is not necessary.

Steel. Repairs or Maintenance of Steel Freight Cars, S. Lynn. Can. Ry. Club, vol. 20, no. 3, Mar. 8, 1921, pp. 24–32. Outline of practice, with notes on experience of Pittsburgh and Lake Erie Railroad.

CARS, REFRIGERATOR

Design. A System of Transit Refrigeration and Heating, Lewis Penwell. A.S.R.E. Jl., vol. 7, no. 2, Sept. 1920, pp. 140–150, 2 figs. Equipment for refrigerating railway cars.

CAST IRON

Research. The Co-Operation of Scientific and Industrial Research in the Iron Foundry—II, Thos. Vickers. Foundry Trade Jl., vol. 23, no. 242, April 7, 1921, pp. 316–319. Scope of British Cast Iron Research Assn. (Concluded.)

CASTINGS

Blowers. Rigging for Speed in Blower Work, Herbert R. Simonds. Foundry, vol. 49, no. 9, May 1, 1921, pp. 359–363, 8 figs. Castings for forced-draft blower manufactured by Coppus Eng. & Equipment Co., Worcester, Mass.

Cracks. Annular Cracks, R. R. Clarke. Metal Industry (N.Y.), vol. 19, no. 5, May 1921, pp. 193–194, 10 figs. Discussion of various theories accounting for their formation.

Grain. The Development of Grain and Its Importance for Foundry Practice (Der Gefügeaufbau und seine Bedeutung für den Giessereibetrieb), H. Czochralski. Giesserei-Zeitung, vol. 18, nos. 6 and 7, Mar. 15 and Apr. 1, 1921, pp. 85–90 and 103–109, 30 figs. Discusses rules governing growth of crystals, speed of crystallization, etc. Illustrations and photomicrographs of idiomorphic and xenomorphic crystals, dendritic crystal formations, etc.

Non-Ferrous. Non-Ferrous Castings in Spinning Molds, Louis J. Josten. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1289–1292, 4 figs. Casting of non-ferrous bands by centrifugal casting machine at works of George C. Clark Metal Products Co., Detroit.

CEMENT, PORTLAND

Specifications. Portland Cement, R. E. Stradling. Concrete, vol. 16, no. 4, April 1921, pp. 223–233, 10 figs. Comparison of British, American, French and German specifications and methods of testing. (Concluded.)

Testing. Judging the Quality of Portland Cement, R. J. Colony. Eng. World, vol. 18, no. 5, May 1921, pp. 331–334, 8 figs. Triangular concentration diagram constructed from results obtained in anal-

yses made in laboratory of Board of Water Supply of the City of New York. Paper read before Am. Inst. Min. and Metallurgical Engrs.

CENTRAL STATIONS

Power Zones. Economic Generation of Electricity by Power Zones, H. H. Kuhn. Elec. Rev., (Chicago) vol. 78, no. 18, April 30, 1921, pp. 683–687, 2 figs. Suggests scheme for concentration of electrical generating equipment at centers of naturally divided districts with facilities for fuel or water-power production and transmission at minimum cost. Chart for determining centralized service rates.

Superpower Zones. Legal and Financial Aspects of Superpower Plan. Elec. World, vol. 77, no. 21, May 21, 1921, pp. 1153–1156, 3 figs. Discussion at meeting of Superpower Survey in New York on May 13. Preliminary to completing report on proposed establishment of superpower zone in Northeastern United States.

CHAINS

Manufacture. The Manufacture of Driving Chains. Eng. Production, vol. 2, no. 32, May 12, 1921, pp. 603–610, 22 figs. Procedure at works of Hans Renold, England.

CHRONOMETERS

Developments. Latest Developments in Chronometry (Les derniers progrès de la chronomètrie), Léopold Reverchon. Nature (Paris), no. 2450, Mar. 19, 1921, pp. 177–181, 10 figs. Guillaume balancing wheel for marine chronometer.

CHUCKS

Magnetic. Magnetic Chucks—VI, Ellsworth Sheldon Am. Mach., vol. 54, nos. 18 and 19, May 5 and 12, 1921, pp. 787–789, 11 figs., and 819–823, 13 figs. Description of Heald multiple magnet chuck.

COAL

Analysis. The Analysis of Coal, S. Royllingworth. Colliery Guardian, vol. 121, no. 3146, April 15, 1921, pp. 1094–1095, 4 figs. Determination of proximate analysis of coal. From book by same writer soon to be published by Colliery Guardian Co.

Briquetting. Factors to be Borne in Mind in Making Briquets of Fine Materials, J. E. Stevens. Coal Age, vol. 19, no. 15, April 14, 1921, pp. 663–666, 5 figs. Methods of briquetting coal and peat.

Salvage. Concentrating Tables Turn Incombustible Sludge from Pond Into Good Fuel, William Strain. Coal Age, vol. 19, no. 17, April 28, 1921, pp. 741–743, 5 figs. Elevator and sluice broke up lumps of clay and coal enabling concentrating tables to remove two-thirds of ash. Installation of Renton Coal Co., Renton, Washington.

Sulphur in, Analysis. The Analysis of Sulphur Forms in Coal, Alfred R. Powell. U. S. Dept. of Interior, Bur. of Mines, technical paper 254, 1921, 21 pp., 1 fig. The applicability of method of Powell and Parr to various kinds of coal. Method was found to give correct and accurate results for analysis of sulphur forms in coal.

COAL BREAKERS

Design. Preparation Methods Susquehanna Has Built Into Reconstructed Pennsylvania Breaker. Coal Age, vol. 19, no. 14, April 7, 1921, pp. 618–622, 4 figs. Jigs are placed stepped down like stairway, using single chute for feed and another for discharge. "Rock" from jigs is screened and hand-picked for clean coal of size just washed, undersize going to condemned-coal conveyor for retreatment.

Single Roll Crusher is Well Safeguarded Against Breakage by Tramp Iron. Coal Age, vol. 19, no. 14, April 7, 1921, pp. 623–624, 3 figs. Four rods opposing helical springs hold frame together. For fine crushing reversible wearing strip is provided in lower portion of breaker. Shear pin made small enough to be safely constructed of mild steel.

COAL DUST

Hazards. Coal-Dust Hazards in Industrial Plants, L. D. Tracy. U. S. Dept. of Interior, Bur. of Mines, Reports of Investigations, no. 2243, 6 pp. 1 fig. Recommendations in regard to methods of handling pulverized coal with a view to preventing dust explosions.

COAL HANDLING

Mines. At Plumville Coal is Dumped in Mine and Carried by Apron Conveyor to Tipple, Donald J. Baker. Coal Age, vol. 19, no. 16, April 21, 1921, pp. 699–703, 9 figs. Refuse from picking table is conveyed to separate rock house. Generators supplying power to mines are driven by natural-gas engines which are found cheaper than steam-driven machines.

Piers. Export Coal Facilities at the Curtis Bay, Md., Terminals of the Baltimore & Ohio Railroad, P. G. Lang, Jr. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 433–435, 5 figs. Electrically operated coal trimmers installed at coal-loading pier.

Rotary Shovel. Rotary Shovel That Clears Wide Path but Delivers to Fixed Point of Discharge, S. H. Hunt. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 789–791, 5 figs. Loading machines developed by Milwaukee Coke & Gas Co. Rotary motion is utilized in delivering material to mine car.

COAL WASHING

Methods. Method of Washing Coal for Metallurgical Coke at Risco, in Birmingham Field, E. P. Stewart. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 807–810, 5 figs. Coal crushed to 1 in. and under, jigged and delivered at steel plant with only 6 per cent moisture without use of drainage tanks or centrifugal driers. Water clarified for reuse contains only 0.15 per cent solids.

Washing Coal With Air Instead of With Water, L. E. Woods. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 810–812, 4 figs. Air forced upward through table deck and its load of material almost immediately, separates light from heavy particles. Machine has large capacity and product is dry.

COKE

Nomenclature. Report of Committee D-6 on Coke. Am. Soc. for Testing Matls., advance paper, 4 pp. Proposed tentative definitions of terms related to coke.

COKE HANDLING

Plants. Coke Handling System at Lawrence, Mass., H. B. Mosley. Am. Gas Jl., vol. 114, no. 20, May 14, 1921, pp. 421–422 and 433, 6 figs. Plants for handling, sizing and storing coke.

COKE OVENS

By-Product. By-product Coke Plant of the Jones & Laughlin Steel Co., C. R. Meissner. Chem. & Metallurgical Eng., vol. 24, no. 20, May 18, 1921, pp. 891–894, 7 figs. Description of installation and operation of standard Koppers coke-oven plant at Hazelwood, Pa., capable of coking under normal conditions 5000 tons of coal per day.

COMBUSTION

Composition of Gases. Theoretical Considerations on the Composition of Combustion Gases and Gasification of Carbon (Considérations theoriques au sujet de la composition des gaz de combustion et gazéification du carbone), M. J. Seigle. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 81–91, 3 figs. Equations establishing proportions of elementary constituents in gases from boilers, blast furnaces, etc.

Control. The Scientific Control of Combustion, H. T. Ringrose. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 565–566, 4 figs. CO_2 recorder consisting of porous pot inside which is placed paper cartridge containing granules of soda lime. Unit is placed inside testing box into which can be put varying quantities of carbon dioxide from gas cylinder, and tube is coupled up in connection with inside of pot to manometer. Vacuum produced is registered by manometer.

COMPRESSED AIR

Explosions in Lines. Explosions in Compressed-Air Lines, E. D. Gardner. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1293–1294. Rupture of pipe in Arizona copper mine. Explosions sometimes due to carbonized cylinder oils. Cylinder temperature large factor.

Losses in Pipes. Pressure Losses in Compressed Air Piping. Compressed Air Mag., vol. 26, no. 5, May 1921, pp. 10092. Comparative study with genuine and substitute packing materials made in German coal mine.

Mines. The Production and Transmission of Compressed Air in Mines, John T. Pringle. Trans. of North of England Inst. of Min. & Mech. Engrs., vol. 71, part 2, Feb. 1921, pp. 24–39 and (discussion) pp. 39–42, 9 figs. Also in Trans.Inst.Min.Engrs., vol. 60, pt. 2, Jan. 1921, pp. 146–151 and (discussion) 151–164, 9 figs. Requirements of compressors. Performance of Ingersoll type.

Pneumatic Tubes. Pneumatic Transmission of Messages on Warships. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 548–549, 10 figs. Apparatus for pneumatic transmission of messages, constructed by T. Cooke & Sons, York, England.

CONCRETE

Alkali Action on. Engineering Investigations, E. C. Bebb. U. S. Dept. of Int. Reclamation Rec., vol. 12, no. 5, May 1921, pp. 224–227, 3 figs. Progress in investigation of alkali action on concrete.

The Effect of Alkali Upon Concrete, S. H. McCrory. Public Works, vol. 50, no. 19, May 7, 1921, pp. 390–392, 1 fig. No method known of preventing such deterioration, but impermeability retards it.

Developments. Recent Developments in Concrete. Monthly Bul. Can. Inst. Min. & Metallurgy, no 109, May 1921, pp. 410–437, 16 figs. Survey of recent researches at representative institutions.

Proportioning Aggregates. A Logical Scheme for Determining the Concrete Making Value of Available Aggregates and Its Practical Application to the Production of Concrete of Pre-Determined Quality in the Field, G. M. Williams. Jl. Eng. Inst. of Canada, vol. 4, no. 5, May 1921, pp. 301–308, 6 figs. Investigation of current theories of proportioning concrete, and account of field tests.

CONCRETE, REINFORCED

Austrian Regulations. New Regulations for Reinforced Concrete in Austria (Neue Eisenbetonvorschriften in Oesterreich), Karl Haberkalt. Schweizerische Bauzeitung, vol. 77, nos. 13 and 14, Mar. 26 and Apr. 2, 1921, pp. 145–146 and 157–159, 2 figs. Includes table with new regulations giving permissible concrete stresses in kg. per sq. cm. Change from former regulations issued in 1911 by Bureau of Public Buildings was made in view of the shortage of building material due to changed conditions brought about by the war.

CONNECTING RODS

Manufacture. Making Motor-Car Engine Connecting Rods. Machy. (Lond.), vol. 18, no. 447, April 21, 1921, pp. 65–69, 11 figs. Machines and fixtures used for drilling, boring, milling, grinding, reaming and gaging operations.

CONVEYORS

Overhead. Overhead Conveyor System Solves Conveying Problem, F. N. Marcellus. Can. Manufacturer, vol. 41, no. 5, May 1921, pp. 45–47, 4 figs. System at works of London Machy. Co., Guelph, Canada.

Progressive Assembly. Progressive Assembly Conveyors, C. W. Starker. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 831–832. Advantages of system in which products being assembled are conveyed past assembler.

COOLING TOWERS

Types. Water Cooling Towers—II, L. V. Robinson. Beama, vol. 8, no. 4, April 1921, pp. 346–353, 4 figs. Comparative study of different types.

COPPER

Separation from Nickel. The Separation of Copper from Nickel (Trennung des Kupfers von Nickel). Elektrochemische Zeit., vol. 27, no. 7, Jan. 1921, pp. 61–63. Process devised by Hybinette (Christiania) according to which an anode containing alloy of copper and nickel is electrolyzed in a solution of nickel sulphate and a weak acid.

COPPER ALLOYS

Copper-Zinc. The Specific Heat of Copper-Zinc Alloys at High Temperatures (Ueber die spezifische Wärme technischer Cu-Zn-Liegierungen bei höheren Temperaturen), Fr. Doerinckel and Max Werner. Zeit. für anorganische u. allgemeine Chemie, vol. 115, no. 1–2, Jan. 14, 1921, pp. 1–48, 16 figs. Specific heat of technically important copper-zinc alloys was determined according to mixture method.

Heat Treatment. Heat Treatment of Copper Alloys, J. S. Glen Primrose. Metal Industry (Lond.), vol. 18, no. 15, April 15, 1921, pp. 281–286, 6 figs. Effect of heat treatment upon finer properties. Paper read before Instn. British Foundrymen.

COLD STORAGE

Plant Design. Antwerp's Government Cold Stores. Cold Storage, vol. 24, no. 277, April 21, 1921, pp. 97–99, 3 figs. Refrigeration is effected by mixed system of direct expansion through pipes suspended from ceiling and ventilation from two powerful air-circulating batteries.

CORK

Artificial. The Most Recent Processes for the Production of Artificial Cork (Die nuesten Verfahren zur Herstellung von kunstlichem Kork), S. Halen. Kunststoffe, vol. 10, no. 24, Dec. 11, 1920, pp. 219–220. Foreign and domestic patented processes.

COST ACCOUNTING

Machine-Tool Industry. Cost Accounting for the Machine Tool Builder. Am. Mach., vol. 54, no. 17, April 28, 1921, pp. 726–731, 1 fig. Report of Scovell, Wellington & Co. to National Machine Tool Builders' Assn.

Overhead. When Machines are Idle. Factory, vol. 26, no. 8, April 15, 1921, pp. 947–952, 2 figs. Consideration of overhead cost in dull periods. Opinions expressed by manufacturers and industrial engineers.

COSTS

Industrial. A Comparison of Pre-War and Post-War Production Costs in Engineering, R. J. A. Pearson. Engineering, vol. 111, no. 2887, April 29, 1921, pp. 537–540. Application of mathematical methods to investigate financial and industrial situations. Paper read before Royal Statistical Soc.

COUPLINGS

Flexible. The Flexible Couplings of the German General Electric Co. (Die AEG-Streifenkupplung), L. Hultzsch. Der praktische Maschinen-Konstrukteur, vol. 53, no. 51, Dec. 23, 1920, pp. 438–439, 4 figs. Patented flexible coupling employing leather belts and adapted to both constant and alternating direction of rotation.

COUPLINGS, CAR

Automatic. The Boonzaier Automatic Coupling. Model Engr. & Elecn., vol. 44, no. 1042, April 14, 1921, pp. 290–291, 2 figs. Combination hook and link secured by means of fork or bracket to existing drawgear. Action of coupling is performed by one coupling member overriding other on contact.

CRANES

Traveling. Designing Traveling Cranes with Regard for Safe Operation, Nicolaas Prakken Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 761–765, 10 figs. Typical safety appliances.

CUPOLAS

Design. Design of Cupola and Accessory Areas, Y. A. Dyer. Iron Age, vol. 107, no. 20, May 19, 1921 pp. 1313–1314 and 1347–1348, 1 fig. Ratios of tuyère to cupola and blast-pipe area; bustle pipe to blast pipe and tuyère areas. Height related to economic conditions.

Slag, Formation. Slag in Cupolas (Die Schlacken im Kupolofen), H. Kalpers. Zeit. für die gesamte Giessereipraxis, vol. 42, no. 15, Apr. 9, 1921, pp. 201–202. Deals with conditions causing slag formation and possibilities of combating them.

Supplementary Oil Firing. Recent Tests with Oil Addition in the Firing of Cupolas (Neuere Versuche mit Oelzusatzfeuerung für Kuppelofenbetrieb), Karl K. Berthold Stahl u. Eisen, vol. 41, no 12, Mar. 24, 1921, pp. 393–399, 1 fig. Account of tests, carried out in view of the coke shortage in Austria. It was possible to reduce the coke charge to extent of 4 to 5 kg. with an oil consumption of 1 kg. for each 100 kg. of charged iron. The hourly melting capacity was increased 30 to 50 per cent, the temperatures of iron fulfilled the highest requirements, and the so greatly feared enrichment with sulphur was con-

siderably reduced. Address before Austrian section of Assn. German Engrs., Vienna.

CUTTING TOOLS

Cutting Speeds. Cutting Speeds for Steel and Cast-Iron. Belting, vol. 18, no. 4, April 1921, pp. 72. Tables showing cutting speeds.

Diamond. The Diamond as a Cutting Tool. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 521–523, 10 figs. Its application in production work.

D

DIE CASTING

Methods. Die-Casting Methods and Metals—II and III, M. H. Potter. Foundry, vol. 49, nos. 9 and 10, May 1 and 15, 1921, pp. 342–344, 2 figs., and 404–406, 4 figs. Data regarding various metals and alloys which may be die cast are given and comparison is made between results from casting in sand and in dies. Methods of placing inserts in die castings. Details of cleaning baths and electroplating process.

DIE SINKING

Machine for. New Design of Die-Sinking Machine. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 843–844, 6 figs. Machine brought out by Billings & Spencer Co., Hartford, Conn. Some of features are wide range of work, adaptability both to low and high cutter speeds, and method of holding and clamping shanks of cutters.

DIES

Conical Parts. Dies for Producing A Conical Part Machy (Lond.), vol. 18, no. 447, April 21, 1921, pp. 78–81, 14 figs. Operations in manufacturing difficult shell.

DIESEL ENGINES

Fuel Injection. Devices for Injection of Fuel Oil with Use of Injection Air in Diesel Engines without Regulation of the Discharge Openings (Vorrichungen zum Einspritzen von Brennöl unter Ver wendung von Einblaseluft ohn Regelung der Ausspritz-Querschnitte), F. E. Bielefeld. Oel- u. Gasmascine, vol. 18, no. 3, Mar. 1921, pp. 37–39, 3 figs. Describes fuel-injection devices patented by author.

German Submarines. The German Submarine Diesel Engine, Holbrook C. Gibson. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 410–415, 10 figs. Engines were in majority of cases of Maschinenfabrik-Ausburg Nürnburg, four-cycle reversible type.

Manufacture. The First True Diesel Made in Canada. Mar. Eng., vol. 11, no. 4, April 1921, pp. 17–20, 6 figs. Manufacturing processes at works of Dominion Steel Products Co.

Marine. The Sulzer Marine Diesel Engines. Practical Engr., vol. 63, no. 1782, April 21, 1921, pp. 244–247, 3 figs. Efficiency curves of two-cycle and four-cycle engines.

Standard. Standard Fuel-Oil Vertical Two-Stroke-Cycle Diesel Engine. Power, vol. 53, no. 17, April 26, 1921, pp. 656–658, 7 figs. Engine manufactured hy Standard Fuel Oil Engine Co., Bucyrus, Ohio, in sizes from 50 to 200 hp.

Standardized. Standardized Diesel Engines—III, H. R. Setz. Mar. Eng., vol. 26, no. 5, May 1921, pp. 391–392, 1 fig. Description of valve-in-head method of scavenging for two-cycle type engine.

DRILLS

Breast. The Manufacture of a Breast Drill. Machy. (Lond.), vol. 18, no. 448, April 28, 1921, pp. 97–101, 11 figs. Practice of J. W. Bradley Small Tools Co., Leicester, England, in production of breast drills of single and two-speed types.

DROP FORGINGS

Heat Treatment. The Heat Treatment of Drop Forgings, Leslie Aitchison. Forging & Heat Treating, vol. 7, no. 5, May 1921, pp. 255–264, 6 figs. Influence of alloying elements on hardening. Mechanical effects of heat treatment.

Steel Castings vs. Drop Forgings Replace Steel Castings, F. B. Fairbanks. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 214–215, 3 figs. Claims forgings provide product of superior strength, toughness and resistance to shock and wear at lower cost.

DUST

Precipitation. Laying the Dust With Fog, Donovan McClure. Sci. Am. Monthly, vol. 3, no. 5, May 1921, pp. 419–420, 6 figs. Device for producing mist artificially.

E

EDUCATION, INDUSTRIAL

Employees. Today's Labor Problems, Charles Piez. Factory, vol. 26, no. 9, May 1, 1921, pp. 1059–1061. Urges instructing employees on subjects of wages, output, employer's profits, sympathetic strikes, and other questions about which they now have false notions.

ELECTRIC DRIVE

Steel Mills. The Steel-Mill Frequency Problem, B. G. Lamme. Elec. World, vol. 77, no. 17, April 23, 1921, pp. 921–923, 1 fig. Six general methods are pointed out for economically using 60-cycle purchased energy in plant with 25-cycle equipment.

ELECTRIC FURNACES

Electrode Economizers. Economizer Reduces Heat Dissipation, Frank Hodson. Iron Trade Rev., vol. 68, no. 17, April 28, 1921, pp. 1180–1181, 2 figs. Type of cooling ring or electrode economizer manufactured by Elec. Furnace Construction Co., Phila. Discussion presented at meeting of Am. Electrochemical Soc.

Foundries. Acid vs. Basic Electric Furnace for the Foundry, F. W. Brooke. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, p. 794. Uses to which each type is best suited.

Indirect Arc. A New Indirect Arc Furnace. Metal Industry (N. Y.), vol. 19, no. 5, May 1921, pp. 191–192, 2 figs. Three-phase gyrating electric furnace built by Volta Mfg. Co., Ontario.

Induction-Vacuum. The Influence of Gases on Metals (Gassers indvirkning paa metaller), Sigurd Hiorth Teknisk Ukeblad, vol. 68, nos. 7 and 8 Feb. 18 and 25, 1921, pp. 77–79 and 85–89, 6 figs. It is claimed that electric induction furnaces are excellently adapted to melting and heat-treating in vacuum. Notes on capacity of metals in molten state to absorb gases and retain them after congealing. Review of former works and experiments and brief account of author's work with the induction-vacuum furnace; process is said to be simple and inexpensive.

Smothered-Arc. Electric Furnaces for Melting Non-Ferrous Metals. Chem. & Metallurgical Eng. vol. 24, no. 18, May 4, 1921, p. 793, 1 fig. Typ. recently brought out by Gen. Elec. Co.

Smothered Arc for Nonferrous Furnaces. Foundry, vol. 49, no. 9, May 1, 1921, pp. 363–364, 2 figs. Electric furnaces developed by Gen. Elec. Co.

Steel Manufacture. Electric Furnaces for Making Steel—III, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 324–327, 3 figs. Classification of electric steel-making furnaces. General features and advantages of arc furnace and resistance furnace. Operating features of electric furnaces.

ELECTRIC LAMPS, ARC

New Type. A New Type of Arc Lamp (Eine neuartige Bogenlampe), Albert Bencke. Elektrotechnischer Anzeiger, vol. 38, no. 49–50, Mar. 30, 1921, pp. 289–290. Arc lamp invented by M. Gabaccini and accepted by French government for marine purposes.

ELECTRIC LOCOMOTIVES

Developments. Review of Recent Large Electric Locomotives, A. Laternser. Elecn. (Lond.), vol. 86, no. 2243, May 13, 1921, pp. 584–586, 6 figs. Comparative data of recent American and European electric locomotives. Translated from Schweizerische Bauzeitung.

Steam vs. Characteristics of the Electric Locomotive. Ry. Elec. Engr., vol. 12, no. 5, May 1921, pp. 195–200, 8 figs. Advantages of electric locomotive over steam locomotive. Paper read before Franklin Inst.

ELECTRIC PLANTS

Interconnection. Limitations of Interconnection. E. C. Stone Elec. World, vol. 77, no. 18, April 30, 1921, pp. 990–991. Rupturing capacity of oil switches under short-circuit conditions limits interconnection unless plants are well distributed.

Operation. Output of Nine Electric Systems in 1920. Exceeded 1,000,000,000 Kw.-Hr. Each. Elec. World, vol. 77, no. 17, April 23, 1921, pp. 924–927. Data on generated and purchased output of largest generating and distributing systems in U. S. and Canada during 1920.

ELECTRIC RAILWAYS

Braking, Regenerative. Operating Curves and Operating Safety of Different Methods of Regenerative Braking in Electric Railways (Ueber Betriebskurven und Betreibssicherheit verschiedener Verfahren der Nutsbremsung bei elektrischen Bahnen), W. Kummer. Schweizerische Bauzeitung, vol. 77, nos. 13 and 14, Mar. 26 and Apr. 2, 1921, pp. 139–142 and 151–155, 11 figs. Investigation of operating curves of motors with separate excitation, of d.c. motors with series excitation, and single-phase motors with series excitation. It is pointed out that operating safety is to a great extent dependent on the operating curves, and it is concluded that regenerative braking can only be regarded as actually safe on 3-phase current and single-phase a.c. railroads using the Oerlikon connection or the single-phase 3-phase current transformation.

ELECTRIC TRANSMISSION LINES

Design. Economical Design of a Transmission Line, Ryotaro Mitsuda. Researches of Electrotechnical Laboratory, no. 79, Sept. 1919, 212 pp., 137 figs. Equations for determining most economical voltage of transmission, size of conductors and spacing of towers.

High-Voltage. French Transmission Line for 100 Kv., M. A. Henriod. Elec. World, vol. 77, no. 18, April 30, 1921, pp. 982–985, 12 figs. Transmission of energy at 110,000 volts over 115 miles of mountains and wooded country.

220,000-Volt. 220,000-Volt Transmission Progress. John A. Koontz, Jl. Electricity & Western Industry, vol. 46, no. 10, May 15, 1921, pp. 477–479, 9 figs. Report of Engineering Sub-Committee to the Pacific Coast Division of National Electric Light Association. It is concluded from laboratory research that the most logical scheme for developing a 220,000-volt insulator "seems to be that of utilizing the present 10-in. unit. . . but providing means to properly take care of the voltage distribution throughout the string. . . when more than eight or nine units are used."

Wire Joints. Mechanical Resistance of Joints of Aerial Electric Transmission Lines (Essais de la résistance mécanique de joints de fils de lignes aériennes). Industrie Electrique, vol. 30, no. 691, April 10, 1921, pp. 125–127. Tests conducted by Administration of Swiss Telegraph.

ELECTRIC WELDING

Rails. Methods for the Electric Welding of Rails (Methoden der elektrischen Schienenschweissung), P. Max Grempe. Elektrotechnischer Anzeiger, vol. 38, nos. 36, 38 and 39, Mar. 5, 9 and 10, 1921, pp. 193–197, 211–213 and 215–217, 39 figs. Development and advantages of electric welding of rails.

ELECTRIC WELDING, ARC

Boiler Shells. The Electric Welding of a Corroded Boiler-Shell, A. Kenneth Dawson. Trans. of North of England Inst. of Min. & Mech. Engrs., vol. 71, part 1, Dec. 1920, pp. 8–12, 2 figs. Repairing corroded Lancashire boiler by use of portable electric-arc welding apparatus.

Kjellberg System. The Kjellberg Welding and Its Use in Ship Construction (Kjellbergsche Schweissung und deren Verwendung bei Schiffsneubauten), Oskar Kjellberg. Autogene Metallbearbeitung, vol. 13, nos. 23 and 24, Dec. 1 and 15, 1920, pp. 292–295 and 306–310, and vol. 14, nos. 1, 2, 4 and 5, Jan. 1, 15, Feb. 15 and Mar. 1, 1921, pp. 4–7, 27–30, 51–54 and 74–78, 35 figs. Description of author's arc welding system and report of investigations of work carried out with this process. Notes on recommendations for electrically welded pulls in the United States. Testimony of British Lloyd concerning welded ships and author's own opinion. Possibilities of repairs.

Heat Treatment of Welds. Effect of Heat Treatment on Nitride in Metal Arc Welds, James W. Owens, J. H. Ramage and J. A. Watts. Welding Engr., vol. 6, no. 4, April 1921, pp. 23–27, 16 figs. Experiments indicated that heat treatment to which deposited metal has been subjected determines form of nitride in metal, and that form in which nitride exists has very decided effect upon physical properties of metal. Paper read before Am. Welding Soc.

EMPLOYEES' REPRESENTATION

Shop Committee. Employe Representation in Management, R. L. Wilson. Textile World, vol. 49, no. 18, April 30, 1921, pp. 117–119. Shop committees organized by East Pittsburgh plant of Westinghouse Elec. & Mfg. Co.

ENGINEERING

Scholarship and Eminence in. Scholarship and Eminence in Engineering, Raymond Walter. Eng. Education, vol. 11, no. 8, April 1921, pp. 361–377. Study of scholastic training of group of eminent engineers conducted under auspices of Am. Assn. Collegiate Registrars showed "close correspondence between good scholarship in collegiate courses and professional eminence in engineering."

ENGINEERING SCHOOLS

Columbia School of Mines. The Columbia School of Mines Idea, George J. Young. Eng. & Min. Jl., vol. 111, no. 18, April 30, 1921, pp. 744–746. Six years' course established by Columbia University. First three years form basis of liberal education and last three are devoted to technical studies.

ENGINEERING SOCIETIES

Federated American Engineering Societies. The American Engineering Council, Dexter S. Kimball. Science, vol. 53, no. 1374, April 29, 1921, pp. 399–402. Purpose and aims of Federated American Engineering Societies. Address delivered before Engineers' Club of Phila.

Organization. On the Organization of an Engineering Society, Morris Llewellyn Cooke. Mech. Eng., vol. 43, no. 5, May 1921, pp. 323–325 and 356.

EXPLOSIVES

Liquid Oxygen. Liquid Oxygen Explosives. Engr., vol. 131, no. 3408, April 22, 1921, pp. 426–427. Survey of recent developments in Germany and U. S.

EXTRUSION OF METALS

Extruded and Drawn Brass Rods. Extruded and Drawn Bars (Gepresste und gezogene Stangen). Der praktische Maschinen-Konstrukteur, vol. 54, no. 17, Apr. 28, 1921, pp. 70–72, 8 figs. Details of production at the metal works of the German Genera Elec. Co.

EYEBOLTS

Strength. The Mechanical Qualities Required in Eyebolts: With Some Consideration of the Izod Test, in its Relation to the Question of Brittleness in Mild Steel, R. T. Rolfe. Jl. Instn. Mech. Engrs., no. 3, April 1921, pp. 177–189, 4 figs. partly on supp. plate. From consideration of results found in experimental investigation it is suggested that carbon content of steel should be 0.34 per cent, and Izod figure not less than 25 ft-lb.

F

FANS

Electric Drive. Motor Drive for Fans and Blowers, Gordon Fox. Power, vol. 53, no. 17, April 26, 1921, pp. 664–666, 4 figs. Rotary blowers and fans classified and described. Limitations, characteristics in operation and power requirements. Motors best adapted to different types and regulation to use for speed adjustment.

FATIGUE

Iron and Steel Works. Fatigue and Efficiency in Iron and Steel Works—VI, H M. Vernon. Eng. & Indus. Management, vol. 5 no. 16, April 21, 1921, pp. 461–462. Investigations carried out by British Indus. Fatigue Research Board.

FIRE HOSE

Specifications. Report of Committee D-11 on Rubber Products. Am. Soc. for Testing Matls.,

advance paper, 69 pp. 3 figs. Proposed tentative specifications for cotton rubber-lined fire hose for use by public fire departments.

FIRE PROTECTION

Smoke Shafts. Automatic Arrangement for the Opening of Smoke Shafts in Rooms Exposed to Fire. (Automatische Einrichtung zum Oeffnen von Abgaseschächten in feuergefährlichen Räumen), Max Becker. Feuerwehrtechnische Zeit., vol. 8, no. 23–24, Dec. 20, 1920, pp. 204–207, 3 figs. Manometric releasing device developed and patented by writer.

FLOW OF GASES

Meters. A Device for Measuring the Flow of Gases, Carle R. Hayward. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, pp. 780, 3 figs. Apparatus developed in metallurgical laboratory of Mass. Inst. of Technology.

Pipes. Flow of Gas Calculation Chart, E. T. Anderson. Gas Age, vol. 47, no. 8, April 25, 1921, p. 322, 1 fig. Chart for calculating flow of gas in pipe.

FLYING BOATS

Caproni. The Caproni Tandem Triplane. Aeronautics, vol. 20, no. 393, April 28, 1921, p. 299, 6 figs. Characteristics: Engines, 8 liberty 400 hp.; span, 100 ft.; length, 74 ft.; height, 31 ft. 6 in.; chord, 8 ft. 7 in.; gap, 8 ft. 7 in.; wing area, 7800 sq. ft.; weight empty, 30,000 lb.; speed at ground, 90 m.p.h.

The Caproni "Nineplandem" Flying Boat. Flight vol. 13, no. 17, April 28, 1921, pp. 289–291, 9 figs. Characteristics: Span, 98 ft. 6 in.; length overall, 79 ft.; chord, 9 ft. 4 in.; total wing area, 7680 sq. ft.; total weight empty, 32,800 lb.; cruising speed, 87 m.p.h.

FORGING

Drop Hammers. Air vs. Steam for Forge Shop Hammers, Chas. R. Edwards. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 220–221 and 229, 4 figs Compressed air gives better expansion, no hot water drip, no delay in starting. Compressed air fittings must be tighter because of lower temperature. Costs about same in each case.

Cost of Operating Hammers With Air or Steam, G. H. Richey. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 217–218. Calculations for ascertaining cost of operating hammers with compressed air and steam. Advantages of operating with air.

Spring Hammer. A New Forging Hammer (Ein neuer Bügelfeder-Hammer). Der praktische Maschinen-Konstrukteur, vol. 54, no. 14, Apr. 7, 1921, pp. 57–58, 3 figs. Describes new hammer built by Paul Rädeke, Berlin, mounted on four columns, main feature of which is the semi-circular laminated spring whose ends are attached to centrally located hammer face through links.

Swaging. Swaging Practice—III (Plaudereien aus der Gesenkschmiede), Paul Heinrich Schweissguth. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 12, Mar. 19, 1921, pp. 292–294, 48 figs. Shows how by folding and curling up finished metal articles, novel methods as to forming them from raw material may be developed. Pitchforks, carriage-top hardware and grubbing hoes used as examples of the value of method.

FORGING MACHINES

Nuts and Rivets. A Nut and Rivet Forging Machine. Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 543–544, 2 figs. Design for quantity production.

FORGING PLANTS

Layout. Shop Well Planned for Material Handling, Gilbert L. Lacher. Iron Age, vol. 107, no. 18, May 5, 1921, pp. 1159–1162, 5 figs. Layout of plant of Kropp Forge Co., Cicero, Ill.

FORMING TOOLS

Straight. Dimensions of Straight Forming Tools. Machy. (Lond.), vol. 18, no. 448, April 28, 1921, pp. 103–107, 1 fig. Tables giving depth of steps on straight forming tools measured at right angles to front face, corresponding to various differences between radii on work.

FOUNDRIES

Austria. The New Foundry Plant of the Automobile Department of the Austrian Munition Works in Steyr [Das neue Gusswerk der Oesterreichischen Waffenfabriksgesellschaft (Automobilabteilung) in Steyr], Carl Irresberger. Stahl u. Eisen, vol. 41, nos. 4, 9 and 12, Jan. 27, Mar. 3 and 24, 1921, pp. 105–110, 288–293 and 401–406, 36 figs. Plans were drawn on basis of a daily production of the total requirement of gray-iron, aluminum, brass, bronze and white-iron castings for at least 60 automobiles besides a yearly production of 800 to 1000 tons of machine-tool castings in pieces weighing up to 5 tons. Plant is divided into three parts, an automobile gray-iron casting, an aluminum and brass casting, and a machine-tool casting department.

Design. Foundry Design Needs Study, J. H. Hopp. Foundry, vol. 49, no. 9, May 1, 1921, pp. 345–347. Foundry buildings should be designed with view of coördinating structure with demands of operation and protecting equipment against elements. Paper read before Am. Foundrymen's Assn.

Equipment. A Modern American Foundry. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 507–510, 4 figs. Equipment and labor saving devices at foundry of Lycoming Motors Corp., Williamsport, Pa.

Malleable-Iron. Changing Losses to Profits in a New England Casting Plant, Herbert R. Simonds. Iron Trade Rev., vol. 68, no. 18, May 5, 1921, pp. 1237–1243, 13 figs. Reconstruction and reorganization of malleable iron foundry. System for recording operations is feature.

Metal. Utilization of Scrap and Residues in Metal Foundries—I, C. Diegel. Metal Industry (N.Y.), vol. 19, no. 5, May 1921, pp. 196–197. German practice. Translated from Betrieb.

Mold-Drying Ovens. The Voith Mold-Drying Oven Fired with Low-Grade Fuels (Die Voith'sche Trockenkammerfeurung fur minderwertige Brennstoffe), H. Adämmer. Stahl u. Eisen, vol. 41, no. 12, Mar. 24, 1921, pp. 399–401, 4 figs. Details of arrangement and operation of mold-drying ovens of the J. M. Voith Machine Works, Heidenheim, Germany, using good coke and also low-grade coke-lignite or coke breeze.

Navy Yard. Navy Foundry Covers Wide Range, S. W. Brinson. Foundry, vol. 49, no. 9, May 1, 1921, pp. 335–341, 11 figs. Shop at Norfolk is equipped to handle gray-iron, steel and non-ferrous castings. Handling facilities provided to care for materials.

FURNACES, ANNEALING

Electric. Electricity Applied to Annealing, George P. Mills. Foundry, vol. 49, no. 9, May 1, 1921, pp. 366–368. Pit furnaces heated electrically by means of resistance ribbon are described. Pyrometric control with either single or double-point recorder regulates temperature closely.

FURNACES, BOILER

Low-Grade-Fuel. Steam-Boiler Furnaces (Dampfkesselfeuerungen), H. Berner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no 15, Apr. 9, 1921, pp. 371–375, 8 figs. Change in requirements of furnaces due to use of low-grade fuels; combustion process and performance of low-grade fuels; the mechanical draft; change in furnace losses. Notes on horizontal and traveling grates; special furnaces for peat, wood and lignite, etc.

Rotary. Rotary Furnaces for the Economic Combustion of Coal Having Large Ash Content (Foyer rotatif pour la combustion économique des charbons très cendreux), L. Poirson. Chaleur & Industrie, vol. 2, no. 3, Mar. 1921, pp. 120–124, 6 figs. Grating is formed by inclined cylinder which is continuously rotating. Coal is burned inside cylinder.

FURNACES, HEATING

Sheet Bar vs. Mill Type. Heating Furnaces and Annealing Furnaces, W. Trinks. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 305–308, 7 figs. Critical comparison of pair (sheet bar) and of mill type furnaces. Sheet bar furnaces are continuous.

Sheet Furnaces. Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 222–227, 10 figs. Comparison of different types of sheet furnaces.

FURNACES, HEAT-TREATING

Car vs. Car-and-Ball. Car and Car-and-Ball Furnaces. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 873–875, 5 figs. Relative merits of heat-treating furnaces of car and car-and-ball types.

G

GAGES

Gage Blocks. Interference Methods for the Investigation of Gage Blocks (Interferenzmethoden zur Untersuchung von Endmassen), G. Berndt. Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 389–396, 20 figs. Notes on origin of interferences of equal thickness and their use in investigation of smoothness of surfaces and for measurement of differences in length (methods of Bureau of Standards, of Köster, and Göpel); absolute determination of length with interferences of equal thickness; interferences of equal inclination and their use in measurement technique. Definition of length of gage blocks.

Manufacture. A Modern Jig and Tool Works. Automobile Engr., vol. 11, no. 149, April 1921, pp. 138–141, 11 figs. Manufacture of precision gages and tool making at Robinhood Eng. Works, London.

Screw-Thread. The Manufacture of British Association Screw-Thread Gauges, T. Farrance Davey. Jl. Instn. Mech. Engrs., no. 3, April 1921, pp. 191–196. Design, methods and apparatus used in measurement, compensation and correction for errors in lathe, cutting tools, lapping, and heat treatment.

GAGING

Limit. The Principles of Limit Gauging, A. A. Remington. Engineering, vol. 111, nos. 2885 and 2886, April 15 and 22, 1921, pp. 441–443, 7 figs., and 480–482, 5 figs. Attempt to build up logical system of limit gaging from first principles. Exposition of Newall standard system, extensively used in England.

GALVANIZING

Developments. 60 Years Progress in Galvanizing, Clement F. Poppleton. Iron Trade Rev., vol. 68, no. 17, April 28, 1921, pp. 1170–1174, 4 figs. Comparison of English and American processes

GAS ENGINES

See BLOWING ENGINES, Gas-Driven.

GAS MANUFACTURE

Low-Temperature Carbonization. Low Temperature Carbonization of Coal, Steward J. Lloyd. Am. Gas Jl., vol. 114, no. 17, April 23, 1921, pp. 353–354 and pp. 363–364. Survey of recent developments.

Elliott Gas. Elliott Gas, a Substitute for Natural Gas, F. J. Denk. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 208–212, 5 figs. Process of manufacturing combination coal and water gas from bituminous coal.

GASES

Dust Precipitators. A New Electrical Precipitation Treater, Motoji Shibusawa and Jasujiro Niwa. Researches of Electrotechnical Laboratory, no. 82, Feb. 1921, 31 pp., 35 figs. Cottrell precipitator with glass-covered electrode.

GASOLINE ENGINES

Fuel Economizer. Fuel Economizer for Petrol Engines. Engineering, vol. 111, no. 2889, May 13, 1921, p. 585, 10 figs. Apparatus for reducing fuel consumption of gasoline engines which are operated for a great part of the time at less than full load It consists of heating chamber to bring about better vaporization of fuel and air valve to dilute mixture with heated air under all conditions of partial load. Manufactured by Lancashire Ordnance Accessories Co., Stockport, England.

GEARS

Helical. New Sykes Double Helical Gear Generator. Machy. (Lond.), vol. 18, no. 450, May 12, 1921, pp. 187–190, 4 figs. Application of pinion type of generating cutter.

The Sykes Double Helical Gear Generator. Engineering, vol. 111, no. 2887, April 29, 1921, pp. 520–522, 7 figs. Cutters are retained in gearing contact with wheel being cut and rotate during process of generation. Machine manufactured by Power Plant Co., West Drayton, England.

Involute. The Evolution of the Involute Gear Tooth —IV, A. Fisher, Machy. (Lond.), vol. 18, no. 447, April 21, 1921, pp. 70–72, 1 fig. Limitations necessitated partly by requirements of interchangeability and partly by solidity of metal.

Maag. The Maag System of Gearing—II. Engr., vol. 131, no. 3407, April 15, 1921, pp. 403–404, 2 figs. Teeth of each wheel are formed on pitch circle of diminished diameter at pressure angle of 15 deg. Thereafter teeth are pushed out radially at proportionate rates until teeth of one wheel touch teeth of other at point dividing line joining shaft centers in desired gear ratio.

Quantity Production. Quantity Production in a Gear Shop—II, Fred R. Daniels. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 863–867, 9 figs. Practice of Dittmer Gear & Mfg. Corp., Lockport, N. Y., in manufacture of gears for tractors, trucks, and automobiles.

Spur. Formulae for Measuring Spur Gears by the Pin Method, M. D. Wilson, Mach. (Lond.), vol. 18, no. 447, April 21, 1921, pp. 92–94, 4 figs.

The Shape of Spur-Wheel Teeth for Maximum Life (Die Zahnform des Stirnrades mit längster Lebensdauer), Eugen Stübler. Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 414–420, 9 figs. Writer describes and recommends the more accurate tooth flanks. Comparison of the trochoidal and cycloidal types of toothed gearing.

GRAIN ELEVATORS

Floating. Floating Pneumatic Grain Discharging Plant. Engr., vol. 131 no. 3406, April 8, 1921, pp. 378 and 381–384, 9 figs. Combination of pneumatic and band systems for simultaneously discharging from grain ship to lighters by spouts or by means of band conveyor across deck of ship to bands below quay. Capacity is 180 tons per hour. Plant is carried on reinforced-concrete pontoon.

GRINDING

Fixtures. The Use of Special Fixtures in Grinding Operations, Ellsworth Sheldon. Am. Mach., vol. 54, no. 17, April 28, 1921, pp. 736–739, 10 figs. Cylindrical work ground on dead centers. Special holding devices for grinding chuck shells. Magnetic chucks provided with holding strips and aligning bars.

Railway Shops. Economical Grinding Operations Reduce Repair Costs, Herbert R. Simonds. Abrasive Industry, vol. 2, no. 5, May 1921, pp. 153–159, 12 figs. Repair operations at Billerica, Mass., shops of Boston & Main Railroad.

Surface Grinding. Surface Grinding 700 Ball Races Every Hour, J. H. Moore. Can. Machy., vol. 25, no. 18, May 5, 1921, pp. 65–71, 24 figs. Relation of magnetic chucks to surface grinding. Methods of grinding steel forgings, gear blanks, cylinder castings, locomotive-crankpin washers, dies, push rods and connecting rods.

GRINDING MACHINES

British Types. Substantial Design Characterizes British Grinding Machines. Abrasive Industry, vol. 2, no. 5, May 1921, pp. 174–177, 8 figs. Typical British types.

GUN METAL

Specifications. Notes on Gun-Metal, R. T. Rolfe. Metal Industry, (Lond.), vol. 18, no. 14, April 8, 1921, pp. 265–268. Comparison of British Admiralty and British Air Board specifications.

H

HANDLING MATERIALS

Factories. How Materials Are Handled at the Buda Plant, S. Gordon Hyde. Material Handling Mag., vol. 2, no. 1, Mar. 1921, pp. 10–13, 7 figs. Material-handling methods of Buda Co., Harvey, Ill., manufacturers of heavy-duty four-cylinder gasoline engines, electrical industrial trucks and tractors for factory use, railroad gasoline motor cars, etc.

Purchasing and Handling Material in a Moderate Sized Factory—I, Guy V. Sweet. Indus. Manage.

ment, vol. 41, no. 9, May 1, 1921, pp. 335–337, 5 figs. Forms for keeping records of moving material.

Foundries. Handling 168 Tons for Every Ton Produced, Max Sklovsky. Material Handling Mag., vol. 2, no. 1, Mar. 1921, pp. 5–7, 1 fig. Analysis of material-handling system of modern foundry.

Steel Products. Efficient Handling and Trucking of Steel Products, E. C. Phillips. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1294–1295. Devices speed loading and unloading of motor trucks.

HANGARS

Design. Airship Sheds and Their Erection. Flight, vol. 13, no. 15, April 14, 1921, pp. 263–264, 1 fig. Types of hangar built in Germany during war.

The Great German Dirigible Centers (Les grands centres allemands de dirigeables), J. Sabatier. Aéronautique, vol. 3, no. 22, Mar. 1921, pp. 108–112, 6 figs. Typical designs of hangar and equipment used, notably underground installation of hydrogen tanks.

HEATING

Buildings. Warming Buildings with Refrigerating Equipment, Robertson Matthews. Power, vol. 53, no. 16, April 19, 1921, pp. 628–631, 3 figs. Theoretical study of utilization of low-temperature heat from atmosphere.

Technique. Recent Progress in the Industrial Heating Technique (La technique du chauffage industriel et son enseignement ses bases essentielles et ses progrès récents), Emilo Damour. Chimie & Industrie, vol. 5, no. 3, Mar. 1921, pp. 271–280, 2 figs. Compilation of suggestions in regard to economical utilization of fuel. Prepared under auspices of Central Bureau of Economical Heating, operated under joint control of French Ministries of Industrial Reconstruction and of Labor.

HEATING, ELECTRIC

Industrial. Industrial Electric Heating, A. E. Holloway and H. L. Garbutt. Jl. Electricity & Western Industry, vol. 46, no. 10, May 15, 1921, pp. 486–488 and 517–519, 4 figs. Report of Committee on Industrial Heating to Pacific Coast Section of National Electric Light Association.

HEATING, HOUSE

"Colec" System. The "Colec" System of Central and Radiant Heating, Herbert H. Berry. Elecn., vol. 86, no. 2238, April 8, 1921, pp. 419–420. Combination of coal and electricity for heating houses.

HEATING, STEAM

Central Stations. Load Dispatching in a Central Heating System, J. C. Butler. Power, vol. 53, no. 17, April 26, 1921, pp. 648–651, 7 figs. Meter board in chief engineer's office of Illinois Maintenance Co., Chicago. Flow of steam is measured and recorded.

Return Pipes, Proportions of. The Proportioning of Return Pipes in Steam Heating Installations (Die Bemessung der Kondensleitungen bei Dampfheizungen), O. Liersch. Gesundheits-Ingenieur, vol. 44, no. 7, Feb. 12, 1921, pp. 70–72, 2 figs. Investigation of the field of limitations of the usually employed rules for return pipes. Desiderata for the selection of suitable diameter, the calculation of which, especially for dry returns, is said to be impossible.

HELICOPTERS

Design. The Actual State of the Helicopter Problem, Dr. G. DeBothezat. Aerial Age, vol. 13, no. 11, May 23, 1921, pp. 247–249, 3 figs. Theory of blade-screw action, with notes on problem of descent when motor is stopped.

Karman-Petroczy. Tests Made with Captive Helicopters, Prof. Karman. Flight, vol. 13, no. 18, May 5, 1921, pp. 307–309, 4 figs. Machine consists of three-armed frame made of steel tubes, in which three LeRhone engines are built. Two wooden propellers, each 6 m. in diameter, rotate in opposite directions at about 600 r.p.m.

The Karman-Petroczy Helicopter. Aeronautics, vol. 20, no. 395, May 12, 1921, pp. 342, 2 figs. Three-armed frame made of steel tubes, in which three Le Rhone of 120 hp. each, are mounted. Engines drive two 20-ft. propellers revolving in opposite directions at about 600 r.p.m. Record of lift and stability tests.

Oehmichen-Peugeot. The Oehmichen-Peugeot Helicopter. Engr., vol. 131, no. 3407, April 15, 1921, pp. 411–412, 2 figs. Sustentation is partially derived from hydrogen-filled ballonet. Motor develops 25 hp. Two 2 bladed propellers of 21 ft. diameter rotate in same horizontal plane. Translated from Génie Civil.

Passàt. A New Helicopter. Aeronautics, vol. 20, no. 391, April 14, 1921, p. 253, 1 fig. Passat machine designed to give vertical lift by wing-flapping motion.

Pescara. Testing of Helicopters (Sur les résultats des essais récents d'un hélicoptère), M. Pescara. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 14, April 4, 1921, pp. 845–848, 1 fig. Pescara helicopter. There are two 6.40 meter six-bladed propellers rotating in opposite directions around same vertical axis. Motor is 60 hp. Hispano-Suiza.

The Pescara Helicopter. Aviation, vol. 10, no. 17, April 25, 1921, p. 531, 1 fig. Machine is fitted with two co-axial, six-bladed propellers of 20-ft. diameter. Propellers rotate in opposite directions.

Theory. The Helicopter. H. M. A. S. Riach. Aeronautics, vol. 20, no. 392, April 21, 1921, pp. 280–282, 11 figs. Study of forces produced in helicopter when it has motion of translation as well as motion of ascent vertically.

HOISTING MACHINERY

Design. The Calculation of Hoisting-Machine Elements (Die Berechnung einiger Hebezeuge), Adolf Fleck. Der praktische Maschinen-Konstrukteur, vol. 54, no. 17, Apr. 28, 1921, pp. 129–136, 14 figs. Gives examples of calculations of the most important elements and drives, including hand, electric and hydraulic.

HOISTS

Mine. A Giant Among Mine Hoists. Sci. Am., vol. 124, no. 20, May 14, 1921, p. 381, 1 fig. Mine hoist installed in Lake Superior copper district, Load of 20,000 lb. is raised per trip.

Alden Coal Co. Installs Large Hoist Which Brakes itself If Anything Goes Wrong, Lewis W. LeGrand. Coal Age, vol. 19, no. 18, May 5, 1921 pp. 797–798, 1 fig. Cylindro-conical electrically-driven back-geared 400-hp. platform cage hoist installed in shaft of Alden Coal Co., Alden, Pa.

HOUSING

Europe. Notes on the Housing Situation in Northern Europe. Monthly Labor Rev., vol., 12, no. 4, April 1921, pp. 127–133. Survey of laws passed to relieve emergency and of measures taken to stimulate building of houses.

Industrial. Erecting Houses on Quantity Production Basis. Contract Rec., vol. 35, no. 17, April 27, 1921, pp. 407–409, 10 figs. Typical examples of industrial homes at Walkerville, Ont. Contractor's methods ensure completion of job in 150 working days.

Industrial Housing, Leslie H. Allen. Textile World, vol. 49, no. 18, April 30, 1921, pp. 119–123. Arguments for and against company housing.

HYDRAULIC TURBINES

High-Speed. High-Speed Water Turbines (Schnelllaufende Wasserturbinen), Fr. Oesterlen. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 16, Apr. 16, 1921, pp. 409–414, 14 figs. Notes on development of high speed and rotor construction up to 1913; braking tests with a very high-speed turbine by Kaplan in 1913; latest development of the Francis high speed and Kaplan turbines up to rotor with only two rotatable blades; the new Kaplan draft-tube system; draft-tube construction and high-speed rotors in America.

Reaction. Maximum Efficiency of Reaction Turbines (Sur le maximum de rendement des turbines à libre déviation), M. deSparre. Comptes rendus des Séances de l' Académie des Sciences, vol. 172, no. 15, April 11, 1921, pp. 896–899. Theoretical study.

Turgo. The Turgo Impulse Water Turbine. Engr. vol. 131, No. 3407, April 15, 1921, pp. 411, 3 figs. Turgo runner of given dimensions is claimed to have 4 to 5 times capacity of runner of Pelton type of similar dimensions.

HYDROELECTRIC PLANTS

Canada. Canada Shows Rapid Hydro Development, J. B. Challis. Elec. World, vol. 77, no. 17, April 23, 1921, pp. 930–934, 9 figs. Work completed or under way during 1920 totals 650,000 hp. Total developments of Dominion now stand at 2,460,000 hp. Ontario shows greatest progress.

Nipigon Power Development of Ontario Hydro Commission, T. C. James. Elec. News, vol. 30, no. 8, Apr. 15, 1921, pp. 30–37, 20 figs. also in Contract Rec., vol. 35, no. 16, April 20, 1921, pp. 389–395, figs. 71. Twenty-five thousand horsepower now available to be increased to three times that amount as demand develops. Transmission at 110,000 volts.

Denmark. Hydroelectric Power Station in Denmark (Gudenaa-Centralens Indvielse), J. P. Schmidt. Ingeniören, vol. 30, no. 6, Jan. 19, 1921, pp. 29–30. Harnessing the Gudenaa River was commenced in 1918 by construction of dam half a mile long across river valley in order to form a storage reservoir of 1640 acres. Water emerges from reservoir through a 1000-ft. channel to power station with fall of 33 ft. Three duplex turbines are direct coupled to 1500 kw generators, producing current at 10,000 volts. Total output of 10,000,000 kw-hr. will be obtained annually.

Economics. Economics of Hydro-Electric Development, A. H. Gibson. Engr., vol. 131, nos. 3406–3407, April 8 and 15, 1921, pp. 367–369, 3 figs. and 393–394. Apr. 8: Derivation of formulas from general economic considerations and records of actual cases. Apr. 15. Examination of typical Canadian, American and European installations indicates that total annual costs, excluding transmission and taking 6 per cent as rate of interest on capital, amount very nearly to 9.5 per cent of capital cost.

Efficiency. Increasing the Efficiency of Water-Power Plants, Charles M. Allen. Power, vol. 53, no. 19, May 10, 1921, pp. 761–762, 2 figs. Speed-horse-power curves for various heads. Paper read before Technical Assn. of Pulp and Paper Industry.

Mt. Rainier National Park. Power Generation in Mt. Rainier National Park, C. P. Gordon. Jl. Electricity & Western Industry, vol. 46, no. 9, May 1, 1921, pp. 436–437, 3 figs. Installation for generation of 400 kw. at 2300 volts.

Norway. The Hydroelectric Plants on the Rjukanfos Waterfalls in Norway (Die Wasserkraftwerke am Rjukanfos und am Glomfjord in Norwegen), Gg. v. Troeltsch. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 13, Mar. 26, 1921, pp. 309–314, 8 figs. Notes on the two water-power stations located one directly beneath the other on Norway's most famous waterfall. Details of water inlet from upper to lower plant with 250 m. head; interesting features of the speed and pressure governors of the main turbines of lower station which have output of 16,400 hp. each; upper auxiliary turbine of 7000 hp. with 168 m. head, and use of water for supply of nitrogen factory; lower auxiliary turbines with same output and 250 m. head; interdependence of the two auxiliary turbines, regulation, etc.

Operation. Operation for Maximum Output, and Operating Records, Geo. H. Bragg. Jl. of Electricity & Western Industry, vol. 46, no. 10, May 15, 1921, pp. 504–508, 5 figs. Investigation of a number of western hydrolectric systems. Report of Sub-Committee of the Hydraulic Committee to Pacific Coast Section of National Electric Light Association.

Reservoirs. Importance of Reservoirs and Artificial Lakes in the Production and Distribution of Electrical Energy (Importanza dei serbatoi e dei laghi artificiali nella produzione e distribuzione dell'energia elettrica), Angelo Forti. Giornale del Genio Civile, vol. 59, Feb. 28, 1921, pp. 77–87, 8 figs. Economical study.

I

IMPACT TESTING

Machines. Apparatus for the Measurement of Impact (Apparat zum Messen von Stössen), H. Kreuger. Bauingenieur, vol. 2, no. 4, Feb. 28, 1921, pp. 103–106, 7 figs. Describes apparatus successfully used by author with good results for measuring effects of impact of falling weights and blasting agents against concrete and against other materials and structures under widely different conditions.

INDICATORS

Internal-Combustion-Engine. A New Type of Indicator for High-Speed Internal-Combustion Engines, Augustus Trowbridge. Power, vol. 53, no. 18, May 3, 1921, pp. 704–708, 16 figs. Diagram, electrically transmitted, shows velocity of cylinder pressure changes at every instant instead of actual pressures. Usual form for ascertaining power consumption may be constructed mathematically from it.

INDUSTRIAL CONDITIONS

Europe. Our National Industries and International Business, Dwight T. Farnham. Indus. Management vol. 41, no. 9, May 1, 1921, pp. 331–334. Altered European industrial conditions and their effect on American employer and employee.

INDUSTRIAL MANAGEMENT

Inspection. Principles of Inspection, Louis Ruthenburg and R. A. Crist. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 859–862. Review of principles upon which rational inspection methods are based, with special application to interchangeable manufacture.

Putting Inspection Where It Belongs, F. R. Schubert. Factory vol. 26, no. 9, May 1, 1921, pp. 1062–1064, 4 figs. Advises keeping inspection distinct from supervision.

The Organization of the Inspection Department, George S. Radford. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 356–360, 1 fig. Suggests organization plan for inspection force.

International Organization. Building an International Business Organization, George M. Gales. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 319–323. Writer's experience in organizing Liggett's International Ltd. Notes on Brittish personnel and English business attitude toward America.

Machine Cards. Alphabetical and Memonic Symbols on Tabulating Machine Cards, C. Moffitt Ford. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 347–350, 2 figs. Methods for expressing alphabetical, semi-alphabetical and memonic symbols on tabulating machine cards.

Production Systems. Controlling Production. Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 534–537, 4 figs. System of handling components in batches.

Routing Materials. System for Production Control. Machy. (Lond.), vol. 18, no. 450, May 12, 1921, pp. 179–181, 8 figs. Methods employed in plant of American Multigraph Co. for routing and recording progress of work.

Shop Analysis. The Zoning of Jobs, Hugh L. Clary. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 329–334, 4 figs. Suggests plans for analyzing certain classes of positions as to requirements for compensation.

INDUSTRIAL TRUCKS

Electric. Electric Trucks and Industrial Locomotives—V-VIII. Engr., vol. 131, nos. 3406–9, April 8, 15, 22 and 29, 1921, pp. 374–376, 10 figs., 402–403, 8 figs., 424–426, 8 figs., and 456–458, 8 figs. Typical British designs.

INSULATING MATERIALS

Research. Industrial Research Work on Insulating Materials. Engineering, vol. 111, no. 2886, April 22, 1921, pp. 482–484, 6 figs. Account of work undertaken by Research Committee of Vickers, Ltd., England.

INTERNAL-COMBUSTION ENGINES

Induction Pipes. Induction and Exhaust Pipes. Automobile Engr., vol. 11, no. 149, April 1921, pps 150–152, 18 figs. Résumé of some recent experiment. in Germany.

Silencers. Silencers for Internal-Combustion Marine Engines, Engineering, vol. 111, no. 2881, April 8, 1921, p. 422, 4 figs. Mechanism in which energy of exhaust gases is employed to put in motion comparatively large body of cooling water or air.

"Silent Record." "Silent Record" Internal-Combustion Engine. Engineering, vol. 111, no. 2888, May 6, 1921, p. 565, 2 figs. Engine constructed by Record Engineering Co., Burton-on-Trent, England. Engine has four cylinders and two cranks, each pair

of cylinders having common head and valve mixer and being fed with same charge.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; GASOLINE ENGINES; INDICATORS; OIL ENGINES.]

IRON

Electrodeposited. "Slip-Lines" and Twinning in Electro-Deposited Iron, W. E. Hughes. Engineering, vol. 111, no. 2889, May 13, 1921, p. 583, 10 figs. partly on suppl. plate. Photomicrographs showing various samples of electrodeposited iron. (Abstract). Paper read before Iron and Steel Inst.

Thermal Analysis. Analysis of Transformations Occurring in Quartz, Iron and Nickel Under Action of Heat (Sur une methode sensible d'analyse thermique et les transformations du quartz, du fer et du nickel), Albert Perrier and F. Wolfers. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 111–116, 4 figs. Results of experiments.

J

JIGS

Design. Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 54, nos. 17, 18 and 19, April 28, May 5 and 12, 1921, pp. 720–725, 12 figs. 770–772, 9 figs. and 816–819, 14 figs. Effect of design on manufacture. Consideration of limits of accuracy. Selection of working points. Relation of design to cost of machining. Drill-jig design. Location of rough and finished work. Correct and incorrect location and clamping. Types of jigs.

L

LABOR

Railroad Labor Board. Principles to Govern Agreements Defined by Labor Board. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 287–289. Text of board's decision on national agreements.

LABOR TURNOVER

Records. The analysis of Labor Records, David R. Craig. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 374–376, 1 fig. Chart for visualizing variables entering into labor turnover.

Reduction. Reducing Foreign Labor Turnover, Arthur Hanko. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 367–369, 4 figs. Writer's experience in handling foreign workers.

LATHES

Bench. Tools and Methods for Manufacturing Precision Bench Lathes. Machy. (Lond.), vol. 18, nos. 446, 448 and 450, April 14, 28 and May 12, 1921, pp. 33–37, 8 figs., 108–111, 10 figs., and 165–168, 7 figs. Processes used in manufacture of precision bench lathes. Practice in Manufacture of Potter bench lathes. Machining and inspection methods of Toolmakers & Light Machinery, Ltd., England.

Screw-Cutting. Cutting Threads on the Screw-Cutting Lathe (Gewindeschneiden auf der Leitspindeldrehbank), Gustaf Fäldt. Werkstattstechnik, vol. 15, nos. 6 and 7, Mar. 15 and April 1, 1921, pp. 151–155 and 182–188, 64 figs. Deals with shape, operation, position and manipulation of chasers and auxiliary tools, such as gages, supports and grinding devices.

Taper Turning. Taper Turning on Automatic Lathes by use of Concentrically Turned Cams (Kegeldrehen auf selbsttätigen Drehbanken mittels zentrisch gedrehter Vorhaltkurve), Hermann Zimmermann and Max Diener. Werkstattstechnik, vol. 15, no. 7, Apr. 1, 1921, pp. 181–182, 3 figs. Describes device for producing a sufficiently accurate taper.

LAUNCHING

Sideways. Freyssinet Process of Launching Reinforced Concrete Barges Sideways (Transportet lancet ment par le travers de coques de 1000 tonnes suivant les procédés Freyssinet), H. deLauriston. Génie Civil, vol. 78, no. 17, April 23, 1921, pp. 345–350, 8 figs.

LIFTING MAGNETS

Development and Uses. Construction of Lifting Magnets (Der Stand des Lastmagnetbaues), H. Wintermeyer. Elektrotechnischer Anzeiger, vol. 38, nos. 45–46 and 47, Mar. 23 and 24, 1921, pp. 263–265 and 273–274, 8 figs. Notes on present status of development and uses, especially in iron foundries.

Types. Electric Lifting Magnets. Eng. Production, vol. 2, no. 28, April 14, 1921, pp. 472–474, 3 figs. Typical designs. Paper read before Staffordshire Iron & Steel Inst.

LIGHTING

Industrial. The Safety Features of Industrial Lighting, Samuel G. Hibben. Trans. Illuminating Eng. Soc., vol. 16, no. 3, April 30, 1921, pp. 47–55, 12 figs. Relation between light speed and safety in industrial operations.

Technique. Illuminating Engineering and Engineers (Ueber Lichttechnik und Lichttechniker), J. Teichmüller. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 17, Apr. 23, 1921, pp. 435–440. Discussion of what is good illumination and for and with whom the illuminating engineer has to work. Natural and artificial light and lighting. Methods of calculating illumination of open and closed spaces; street lighting, etc. Faults in lighting plant. Schools, research institutes and technical associations for promotion of illuminating technique.

LIGNITE

Briquetting. Manufacturing of Briquets from Lignite. (Die Brikettierung der Braunkohle), H. Landsberg. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 16, Apr. 16, 1921, pp. 415–417, 1 fig. Relations between raw coal and briquets with regard to quantity and heating value, and the power and heat requirements in the manufacture of briquets are derived in a general way and presented with respect to the water volume to be evaporated.

North Dakota. The New Salem Lignite Field, Morton County, North Dakota, Eugene T. Hancock. U. S. Dept. of Interior, U. S. Geological Survey, no. 726–A, May 6, 1921, 39 pp., 9 figs. Fuel is of very low grade. Notes on its utilization.

Utilization. American Lignite Coals, Robert G. Skerrett. Sci. Am., vol. 134, no. 18, April 30, 1921, pp. 344 and 355, 1 fig. Carbonizing and briquetting plant under construction at Bienfait, Saskatchewan.

LOCOMOTIVE BOILERS

Tubes. Notes on Fractures in Locomotive Boiler Tubes, Henry Fowler. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 466–467, 11 figs. Analyses of superheater flue tubes taken out of engine of Midland Ry. locomotive which had run 60,000 miles. Photomicrographs. Paper read before Faraday Soc.

LOCOMOTIVES

Automatic Control of Cut-Off. Automatic Operation of Reverse Lever Accomplished, E. S. Pearce. Ry. Rev. vol. 68, no. 21, May 21, 1921, pp. 763–770, 13 figs. Apparatus consists of two differential valves set at a difference of 1 lb. per sq. in., one shortening cut-off when back pressure increases and the other lengthening cut-off when back pressure decreases.

British. British Locomotives in 1920, J. F. Gairns. Bul. Int. Ry. Assn., vol. 3, no. 4, April 1921, pp. 409–418, 6 figs. Characteristics of leading designs.

Locomotive Building in an English Shop, I. Wm. Chubb. Am. Mach., vol. 54, no. 17, April 28, 1921, pp. 713–719, 19 figs. Manufacturing processes at plant of Armstrong, Whitworth & Co.

New 4–6–4 Type Tank Locomotive, Furness Railway. Ry. Gaz., vol. 34, no. 14, April 8, 1921, pp. 538–539, 3 figs. Characteristics: Total wheel base of engine, 40 ft. 9 in.; diameter of coupled wheels, 5 ft. 8 in.; total length of frame, 45 ft. 9 in.; length of firebox, 8 ft. 6 in.

Connecting Rods. Machining Operations on Locomotive Connecting Rods, Frank A. Stanley. Am. Mach., vol. 54, no. 19, May 12, 1921, pp. 811–813, 12 figs. Practice in shops of Southern Pacific Co. at Sacramento, Cal.

Consolidation. Consolidation Locomotives for the Western Maryland. Ry. Age, vol. 70, no. 19, May 13, 1921, pp. 1117–1120, 8 figs. Comparison of recent designs of Consolidation types.

Most Powerful Consolidation Locomotive Ever Built. Ry. Rev., vol. 68, no. 20, May 14, 1921, pp. 735–737, 1 fig. Characteristics: Tractive effort, 68,200 lb.; cylinders, 27 in. by 32 in.; diameter of drivers, 61 in.; weight on drivers, 268,200 lb.; weight of locomotive, 294,900 lb.; weight of locomotive and tender, 565,000 lb.

Continuous Draft. Continuous Draft in Locomotives (Le tirage continu dans les locomotives), H. Daubois. Arts et Métiers, no. 3, Dec. 1920, pp. 55–57, 2 figs. Disadvantages of pulsating draft produced by exhaust-steam locomotives. Device for rendering draft continuous.

Design. Features of Locomotive Design Affecting Wear on Track. Ry Rev., vol. 68, no. 20, May 14, 1921, pp. 737–739, 4 figs. Paper read before Moncton Branch, Eng. Inst. Canada.

Some Features of the Design of Locomotives Introduced for the Purpose of Modifying Their Effect on the Track, Frank Williams. Jl. Eng. Inst. of Canada, vol. 4, no. 5, May 1921, pp. 309–311, 4 figs. Effect of static load, dynamic augment, impact, lateral flange thrust and abrasion on locomotive design.

The Design of Large Locomotives, M. H. Haig. Mech. Eng., vol. 43, no. 5, May 1921, pp. 311–314, and 326, 6 figs. Features which keep engine in service maximum length of time, reduce maintenance and repair costs, and increase revenue-earning power.

Injectors. The Advantages of the Exhaust Steam Injector, Clarence Roberts. Ry. Mech. Engr., vol. 95, no. 5, May 1921, pp. 290–291, 3 figs. Experience of French and English railways in use of exhaust-steam injector.

Mine. Experience Results in Radical Changes in Mine Locomotives for Heavy Duty, B. S. Beach. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 792–795, 4 figs. Leaf springs and equalizing-bar suspensions make derailments less frequent. Frames cut from steel plate resist inevitable violence in operation. Tandem operation makes bigger trips possible. Electric brakes prevent runaways.

Power Reverse Gear. Tests Demonstrate Precision of New Power Reverse Gear. Ry. Rev., vol. 68, no. 18, April 30, 1921, pp. 668–670, 2 figs. Gear developed by Franklin Ry. Supply Co.

Tests of Franklin Precision Power Reverse Gear. Ry. Age, vol. 70, no. 17, April 29, 1921, pp. 1043–1044 2 figs. Gear consists of 10 in. by 18 in. cylinder with all parts enclosed. Operating valve is attached to rear end of cylinder and is controlled by hand wheel in cab. This wheel is provided with indicator showing point of cut-off and is connected to gear by operating rod.

Production Methods. Automatic Production Methods in a Locomotive Works. Eng. Production, vol. 2, no. 30, April 28, 1921, pp. 545–550, 15 figs. Methods and tools employed at works at Lancashire & Yorkshire Ry. Co., England.

Reconstruction. Converted Express Locomotives, Lancashire & Yorkshire Railway. Ry. Gaz., vol. 34, no. 15, April 15, 1921, pp. 580–581, 2 figs. Four-cylinder 4–6–0 type engines being converted to superheated steam with larger cylinders, redistribution of weight and other modifications tending to increase their tractive effort and general utility.

Superheater. Modern Express Locomotives, M. Igel, Eng. Progress, vol. 2, no. 3, Mar. 1921, pp. 49–54. 10 figs. German superheating locomotives.

Valve Gears. Railway Machine Shop Practice—II, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 855–858, 8 figs. Methods of machining parts of locomotive valve gears, valves and pistons.

LUBRICANTS

Mineral. The Production of Mineral Lubricants. J. E. Pogue. Sci. Lubrication, vol. 1, no. 3, Mar. 1921, pp. 6–11. Statistics concerning use of petroleum lubricants in U. S.

M

MACHINE SHOPS

Layout. A Modern Tractor Building Machine Shop, J. V. Hunter. Am. Mach., vol. 54, no. 19, May 12, 1921, pp. 804–807. General layout of tools and equipment. Arrangements on cranes and conveyors. Heating and lighting systems.

MACHINE TOOLS

Semi-Automatic. Semi-Automatic Machines for Repetition Precision and Instrument Work—I. Machy. (Lond.), vol. 18, no. 446, April 14, 1921, pp. 49–51, 5 figs. Machine Tools manufactured by Mikron firm of Bienne-Madretsch, Switzerland.

MACHINERY

Depreciation. A Method for the Depreciation of Machinery, H. C. Marris. Eng. & Indus. Management, vol. 5, no. 15, April 14, 1921, p. 426, 1 fig. Method of determining depreciation of machinery. Graph illustrating differences between method of depreciation on logarithmic basis and method of equal annual fractions.

Noise Examination. The Examination of Noise in Mechanisms. Automobile Engr., vol. 11, no. 149, April 1921, pp. 148–149, 6 figs. Dual valve tectoscope for detecting a locating sound.

Vibrations. Eliminating Vibration, an Enemy of Production, Charles L. Hubbard. Factory, vol. 26, no. 9, May 1, 1921, pp. 1075–1078, 10 figs. Methods of insulating against foundation vibration.

MACHINING METHODS

Navy Yard. Large Machine Work at the Puget Sound Navy Yard, Fred H. Colvin. Am. Mach., vol. 54, no. 19, May 12, 1921, pp. 801–803, 9 figs. Machining Operations.

Pump Bodies. Machining Cast Iron Pump Body in 22 Minutes, A. H. Lloyd. Can. Machy., vol. 25, no. 17, April 28, 1921, pp. 32–34, 6 figs. Special chuck jaws are used and taper bore is produced by profile method.

Repetition Work. Interesting Operations on Repetition Work. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 513–518, 14 figs. Examples of works practice of Messrs. George Kent, England.

Swiveling Slide. Machining a Swiveling Slide. Eng. Production, vol. 2, no. 28, April 14, 1921, pp. 490–491, 5 figs. Notes on methods and tools employed.

MALLEABLE IRON

Casting. Malleable Iron (La fonte malléable), Christian Kluytmans. Fonderie Moderne, no. 3, Mar. 1921, pp. 49–54, 7 figs. European process of casting malleable iron.

Melting. American Malleable Cast Iron—X, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 19, May 12, 1921, pp. 1317–1321, 8 figs. Melting processes.

Foundries. American Malleable Cast Iron—IX, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 17, April 28, 1921, pp. 1175–1180, 7 figs. Notes on organization, layout, labor and equipment of malleable foundry.

MEASUREMENTS

Torque. A Simple Method for Torque Measurement (Ein einfaches Messverfahren Fur Drehmomente), W. Schmidt, Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 17, Apr. 23, 1921, pp. 441–444, 11 figs. Described method tested in experiments with model propellers and shown to be adaptable for the determination of performance of built-in boat engines.

Torsion. A New Electric Torsion Meter (Ein neuer elektrischer Verdrehungsmesser), Gg. Keinath. Dinglers polytechnisches Jl., vol. 335, no. 25, Dec. 11, 1920, pp. 265–268, 6 figs. Describes electric meter in which the relative position of two cross-sections of a shaft under torsion causes the change of air-gap of two choking coils. The relation of the currents indicated in both coils is measured showing that the indication is independent of oscillations of the auxiliary voltage.

METALS

Electrical Conductivity. The Measurement of Electrical Conductivity in Metals and Alloys at High Temperatures, John L. Haughton. Trans. Faraday Soc., vol. 16, no 2, Dec. 1920, pp. 392–401, 6 figs. In investigation of constitution of copper-

aluminum-zinc alloys it was found that liquidus and solidus occur, over short range, so close together that it was not possible to distinguish between them by means of thermal curves. Electrical conductivity measurements showed marked changes in direction of curve connecting conductivity and temperature at both solidus and liquidus.

Failure. The Mechanism of Failure of Metals from Internal Stress, W. H. Hatfield. Engineering, vol. 111, no. 2884, April 8, 1921, p. 435. Experiments on wrought iron, brass and silver. It is concluded that, except in certain cases where selective chemical or physico-chemical action causes separation of remains of crystals from each other, fractures are generally due to internal stresses introduced during processes of manufacture. (Abstract.) Paper read before Faraday Soc.

Fatigue. Metal Fatigue Under Repeated Stresses. Jl. Soc. Automotive Engrs., vol 8, no. 5, May 1921, pp. 417–418. Survey of tests by various experimenters. Paper read before Am. Iron & Steel Inst.

Microstructure. Internal Stresses in Relation to Micro-Structure, J. C. W. Humfrey. Engineering, vol. 111, no. 2884, April 8, 1921, pp. 419–420, 2 figs. Study of microstructure of metals and of mechanism of their behavior under plastic deformation. It is suggested that elastic limit be determined by alternating tests rather than by tensile tests. (Abstract.) Paper read before Faraday Soc.

Structure. The Crystalline Structure of Metals, Zay Jeffries and R. S. Archer. Chem. & Metallurgical Eng., vol. 24, no. 18, May 4, 1921, pp. 771–779, 18 figs. Definition of crystallinity. Discussion of methods used in X-ray analysis of atomic spacing and statement of results of such studies made to present time.

METEOROLOGY

Aviation. What the Weather Bureau Does for Air Pilots. Aviation, vol. 10, no. 19, May 9, 1921, pp. 595–597, 1 fig. Upon receipt of telephonic or telegraphic requests giving course of projected flight, Bureau furnishes all information as to fog, smoke, wind, visibility, etc. List of stations to which applications may be addressed.

Weather Control. The Artificial Control of Weather, Napier Shaw. Aeronautics, vol. 20, nos. 391 and 392, April 14 and 21, 1921, pp. 260–261, and 283–284. Also in Aerial Age, vol. 13, no. 9, May 9, pp. 203–205. Methods proposed to British Meteorological Office during war. Dissipation of fog by heat. Lecture before Cambridge Univ. Aeronautical Soc.

METRIC SYSTEM

Arguments Against Adoption in U. S. Why the Metric System Should Not Be Adopted, W. R. Ingalls. Min. & Metallurgy, no. 173, May 1921, pp. 15–16. Reasons against compulsory adoption of metric system in U. S.

Arguments in Favor of Adoption in U. S. Why It Should Be Done the Metric Way, Howard Richards, Jr. Min. & Metallurgy, no. 173, May 1921, pp. 13–14. Advantages of system. Reasons why it should be adopted in U. S.

Compulsory Adoption in U. S. Another Thoroughly Vicious Compulsory Metric Bill is Introduced. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 800c–800d. Bill introduced in House of Representatives on April 11, 1921 "to fix the metric system of weights and measures as the single standard of weights and measures for certain uses."

South America. Are the South American Countries Metric? C. C. Stutz. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 871–872. Confusion due to double and in many cases triple standard of weights and measures.

MILLING

Fixtures. Milling Square-Stem Pinions, Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 849–851, 4 figs. Fixtures designed by Brown-Lipe-Chapin Co., Syracuse, N. Y.

Production Systems. Interesting Milling Operations. Eng. Production, vol. 2, no. 28, April 14, 1921, pp. 475–480, 15 figs. Production systems at works of Alfred Herbert, England.

MILLING CUTTERS

Face and Form Mills. Metal Cutting Tools,—IX A. L. DeLeeuw. Am. Mach., vol. 54, nos. 17 and 19' April 28 and May 12, 1921, pp. 732–735, 5 figs.,' and 807–810, 13 figs. April 28: Types of face-mills. May 12: Principle of construction of form mill.

MILLING MACHINES

Horizontal. Horizontal Milling Machine. Engineering, vol. 111, no. 2886, April 22, 1921, pp. 484–486 5 figs. Heavy constant-speed-drive horizontal milling machines built by Brown & Sharpe Mfg. Co., Providence, R. I.

MINERS' LAMPS

Gauzes. The Relative Safety of Brass, Copper, and Steel Gauzes in Miners' Flame Safety-Lamps, L. C. Ilsley and A. B. Hooker. U. S. Dept. of Interior, Bur. of Mines, no. 228, 1921, 39 pp., 18 figs. Tests. For conditions of high temperature, steel proved superior to either brass or copper; for low temperatures, advantage of steel over brass or copper was little. Brass proved more satisfactory than copper.

MOLDING METHODS

Austrian Foundry. Molding Cylinders in an Austrian Shop, Charles Irresberger. Foundry, vol. 49, no. 10, May 15, 1921, pp. 383–390, 38 figs. Processes at large foundry in Salzburg, Austria.

Propellers. Molding Propellers by Thacher Process, Enrique Touceda. Iron Age, vol. 107, no 20 May 19, 1921, pp. 1310–1312, 4 figs Method calculated to insure accurate product requiring no machining. Blades and wheels of semi-steel. Paper read before Am. Inst. Min. & Metallurgical Engrs.

MONEL METAL

Reflecting Power. Reflecting Power of Monel Metal, Stellite, and Zinc, W. W. Coblentz U. S. Dept. of Cmmerce, Sci. Paper, Bur. of Standards, no. 379, June 10, 1920, pp. 249–252, 1 fig. It was found that in infra-red spectrum reflectivity of monel metal is practically same as that of nickel. Invisible spectrum reflectivity is slightly lower than that of nickel.

MOTION-PICTURE PROJECTION

Substitute for Reel Film. Is the Reel Film the Only Medium for Photographing of Motion Pictures? (Ist das Filmband das einzige Mittel für Verwirklichung des Laufbildesg?) Karl Geutil. Deutsche Optische Wochenschrift, vol. 7, no. 13, Mar. 27, 1921, pp. 215–217, 4 figs. Discusses possibilities of substituting the mutoscope principle of film leaves in combination with the epidiascope in place of the inflammable reel film of celluloid.

MOTOR TRUCKS

Trailers. The Tracking and Steering of Trailers Analyzed by a Graphic Method, Marius C. Krarup. Automotive Industries, vol. 44, nos. 18 and 19, May 5 and 12, 1921, pp. 955–957, 7 figs., and 1008–1011, 4 figs. Engineering investigation of factors bearing upon steering and tracking of various trailer outfits. Free trailing more suitable for short hauling outfits; and steady steering for slow hauling. Graphic method of analysis.

MOTORCYCLES

Performance. Comparative Motorcycle Performance, D. S. Heather. Automobile Eng., vol. 11, no. 150, May 1921, pp. 187–194, 22 figs. Tests for determining effect of road service irregularities of mud, and also to study deceleration resulting from wind resistance.

MOTORSHIPS

Standardization. Motor Shipbuilding. Times Eng. Supp., no. 558, April 1921, p. 125. Extent to which standardization both of machinery and hulls has been adopted.

O

OIL ENGINES

Fuel Injection. Air-Injection or Mechanical-Injection—IV, J. L. Chaloner. Motorship, vol. 6, no. 5, May 1921, p. 399. Comparison from exhaust temperatures record of relative degree of combustion for two systems. (Concluded.)

OIL FIELDS

Montana. Oil Possibilities in Montana, L. S. Ropes. Eng. & Min. Jl., vol. 111, no. 18, April 30, 1921, pp. 754–755. Favorable oil formations noted in searching for coal fields.

Northwestern Canada. The search for Oil in the West. Can. Min. Jl., vol. 42, no. 16, April 22, 1921, p. 313–323, 20 figs. Account of prospecting operations. Notes on geology of region. Paper read before Can. Inst. Min. & Metallurgy.

South America. The Oil Resources of South America, Henry B. Milner. Min. Mag., vol. 24, no. 4, April 1921, pp. 203–210, 1 fig. Republics of Argentine, Ecuador, Columbia and Venezuela are believed to offer substantial opportunities for profitable investigations because they include areas in which both geological and structural conditions are suitable to oil accumulation.

Underground Conditions. Underground Conditions in Oil Fields, A. W. Ambrose. U. S. Dept. of Interior, Bur, of Mines, bulletin 195, 1921, 248 pp., 43 figs. Points out general method of procedure in studying underground conditions in oil fields, and urges coöperation between technical and practical men in application of engineering methods in developments of oil field.

OIL FUEL

Safety Tank. Safety Tank for Storing Inflammable Liquids (Schutzgas Lagerungen feuergefährlicher Flüssigkeiten), H. von Löw. Automobil-Rundschau, vol. 20, no. 5–6, Mar. 1921, pp. 51–53, 5 figs. Details of different arrangements employing a non-inflammable gas under pressure to force out liquid from tank and also to prevent flame or sparks from reaching it.

Specifications. New Fuel Oil Specifications. Oil News, vol. 9, no. 8, April 20, 1921, p. 28. Specifications for various grades used by U. S. Government.

OIL SHALES

Distillation. A Study of the Saturated and Unsaturated Oils from Shale, C. W. Botkin. Chem. & Metallurgical Eng., vol. 24, no. 20, May 18, 1921, pp. 876–880. Investigation of amount and causes of unsaturates in shale oils. Cracking during retorting and distillation accompanied by increase in saturation. Unsaturates vary with nature of shale and methods of pyrolysis.

OIL WELLS

Oil Production. Some principles Governing the Production of Oil Wells, Carl H. Beal and J. O. Lewis. U. S. Dept. of Interior, Bur. of Mines, Bull. 194, 1921, 58 pp., 7 figs. Conditions affecting amount of oil in oil sand. Factors that control rate of production in oil wells. Effect of production of one well on that of another.

OPEN-HEARTH FURNACES

Control Valve. New Oil Fuel Control Valve for Open Hearth Furnaces. Iron Age, vol. 107, no. 18, May 5, 1921, p. 1163. Combination Three-way and proportional discharge valve designed by S. A. Gabriel & Co., Cleveland.

Heat Transfer. Heat Transfer in Open Hearth Furnaces, Henry William Seldon. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 299–304. Survey of experimental studies made by various investigators in different countries.

OXY-ACETYLENE WELDING

Refrigerating Apparatus. Oxy-Acetylene Welding on Refrigerating Apparatus, Fred E. Rogers. Acetylene Jl., vol. 22, no. 11, May 1921, 599–606, 27 figs. Examples illustrating practice. Paper read before Am. Soc. of Refrigerating Engrs.

Tests. An Investigation of Oxy-Acetylene Welding and Cutting Blow-pipes, R. S. Johnston. Mech. Eng., vol. 43, no. 5, May 1921, pp 305–310 and 359, 8 figs. Tests carried out by Bur. of Standards for War Department on commercial apparatus for cutting and welding by oxy-acetylene welding process. Photomicrographs.

[See also AUTOGENOUS WELDING.]

P

PAPER MANUFACTURE

Laboratory Tests. An Outline of Laboratory Tests Used in Pulp aud Paper Making, A. Le Chatelier. Paper, vol. 28, no. 8, April 27, 1921, pp. 17–21. Translated from Chimie et Industrie.

PARACHUTES

German Types. Tests on New Types of Parachute. Aeronautics, vol. 20, no. 392, April 21, 1921, pp. 277, 1 fig. Parachutes designed with view to lessening shock on opening. Device submitted in contest organized by German Air Sport Committee under auspices of Sci. Soc. for Aeronautics.

PATTERN MAKING

Shop Organization. A Model Pattern Shop and Storage Building, Gilbert L. Lacher. Iron Age, vol. 107, no. 18, May 5, 1921, pp. 1165–1168, 7 figs. Pattern storage of Whiting Corporation, Harvey, Ill.

PEAT

Distillation. The Distillation of Peat and Wood (Die Entgasung von Torf und Holz), B. Waeser. Zeit. für angewandte Chemie, vol. 34, no. 13, Feb. 15, 1921, pp. 51–54, 2 figs. Discussion of different processes and plants.

Utilization. Peat Power Plants in Germany. Engr., vol. 131, no. 3408, April 22, 1921, pp. 422–423, 1 fig. Scheme involving construction of 7 power plants, 5 operated with peat and lignite and 2 hydroelectric plants. Plants are to be interconnected and will deliver power to country at 150,000 volts.

PHOSPHOR BRONZE

Tests. Note on Phosphor Bronze Bars, John Arnott. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 474, 2 figs. Tensile tests. (Abstract.) Paper read before Faraday Soc.

PIG IRON

Foundry. Some Defects in Foundry Pig Irons, Y. A. Dyer. Iron Age, vol. 107, no. 17, April 28, 1921, pp. 1093–1094. Examples of bad effect of iron oxide.

PIPE BENDS

Design. The Design of Pipe Bends for Expansion in Pipe Lines, J. G. Stewart. Power, vol. 53, no. 19, May 10, 1921, pp. 742–743, 4 figs. Chart for computing expansion of U-bends of commercial steel pipe with nominal diameters 2 in.–12 in. inclusive.

PIPE, CAST-IRON

Centrifugal Process. Cast Iron Pipe Made by the de Lavaud Process, Peter Gillespie. Can. Engr., vol. 40, no. 19, May 12, 1921, pp. 454–455, 4 figs. Comparative weights of pipe made by centrifugal process and sand mold pipe.

PIPE, CONCRETE

Pressure. New Type Concrete Pressure Pipe Successful in Severe Test. Concrete Products, vol. 20, no. 4, April 1921, pp. 15–20, 9 figs. Steel cylinder encased in concrete the latter being reinforced by wire mesh or bars on both sides of steel cylinder.

Tests. New Concrete Pressure Pipe Tested. Concrete, vol. 18, no. 5, May 1921, pp. 242–244, 4 figs. Pipe consisting of steel cylinder and lap horizontal joint welded on outside only, the whole being encased in concrete.

PIPING

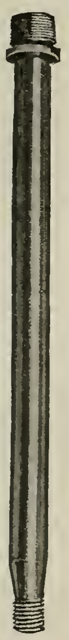
Calculation Chart. A Chart for the Calculation of Steam and Air Piping (Tafel für die Berechnung von Dampf- und Luftleitungen), Alexander Fisher. Zeit. des. Vereines deutscher Ingenieure, vol. 65, no. 18, Apr. 30, 1921, pp. 469–470, 1 fig. Alignment chart is developed which permits a rapid graphic determination of pressure drop, diameter of pipe and flow per second.

PISTONS

Aluminum. Aluminum Pistons, Frank Jardine and Ferdinand Jehle. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 397–403, 9 figs. Survey of recent developments in construction of aluminum pistons, and suggestions in regard to their design.

Aluminum Pistons, Frank Jardine and Ferdinand Jehle. Aerial Age, vol. 13, no. 11, May 23, 1921, pp.

The Best Production Methods Are the Most Economical



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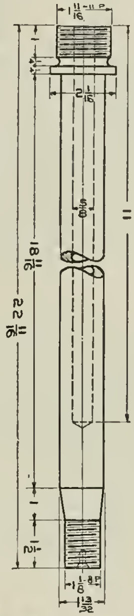

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Andersen, Meyer & Company, Ltd., Shanghai.
Brossard-Mopin & Company, Saigon, Singapore, Haiphong.

ENGINEERING INDEX (Continued)

250–253, 8 figs. Tests conducted to measure operating temperatures of pistons on Liberty engines. (Concluded.)

Machining Methods. Machining Motor Pistons, C. H. Dengler. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 878–879, 3 figs. Successive steps and equipment employed in machining pistons for high-grade automobile.

PLANING

Production Systems. Production Planing in Machine Tool Plants. Machy. (N. Y.), vol. 27, no. 9, May 1921, pp. 833–837, 4 figs. Efficiency factors in production planing. Points to observe in obtaining maximum output from planers.

POLES, WOODEN

Preservative Treatment. The Impregnation of Wooden Poles for Long-Distance Stations (Aufgaben und Ziele der Imprägnierung von Holzmasten für Ueberland-Zentralen), Friedrich Moll. Zeit. für angewandte Chemie, vol. 34, no. 19, Mar. 8, 1921, pp. 81–84, 7 figs. Notes on nature of wood impregnation and experiences in recent years.

The Impregnation of Wooden Poles from an Economic Standpoint (Die Wirtschaftlichkeit der Imprägnierung hölzerner Leitungsmasten), Friedrich Moll. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 6, Mar. 24, 1921, pp. 61–63, 3 figs. Four different impregnation processes are recommended.

PORTS

Dunkirk. The Port of Dunkirk. Bulletin Technique du Bureau Veritas, vol. 3, no. 4, April 1921, pp. 91–93, 2 figs. Mechanical equipment for handling cargo.

POWER GENERATION

Victoria, Australia. Power for Victorian Industries. Supp. to Indus. Australian & Min. Standard, Mar. 17, 1921, 79 pp., 77 figs. Electric power scheme authorized and initiated by state government of Victoria and being carried out effect by Victorian commission. Scheme involves development of water power and utilization of brown-coal deposits.

PROPELLERS, SHIP

Manufacture. Propellers Cast in British Shop, Wesley J. Lambert. Foundry, vol. 49, nos. 9 and 10, May 1 and 15, 1921, pp. 351–355, 9 figs., and 391–396, 6 figs. Physical properties of several bronzes used for propellers given. Details of pattern equipment including striking board illustrated and methods of securing correct pitch described. Method of making cope. Melting methods and pyrometric control.

The Manufacture of High-Class Marine Propellers, Wesley J. Lambert. Trans. Inst. of Mar. Engrs., vol. 32, Mar. 1921, pp. 419–457 and (discussion) pp. 457–470, 12 figs. Practice at works of Deptford & Charlton, England.

PULVERIZED COAL

Dust Explosions. How to Protect Pulverized-Coal Plants From Dust Explosions and Fires. Coal Age, vol. 19, no. 17, April 28, 1921, pp. 746–749. Vacuum system should remove dust from air in building; driers should not be heated excessively; air supply for burning coal should be kept from forcing its way into coal supply line.

[See also BOILER FIRING, Pulverized Coal; BOILERS, WATER-TUBE, Tests.]

PUMPING STATIONS

Air-Lift. A Modern Air-Lift Pumping Plant, John Oliphant. Ry. Maintenance Engr., vol. 17, no. 5, May 1921, pp. 172–174, 5 figs. Installation of Philadelphia & Reading Railway at Telford, Pa. 100 gal. are pumped per min. from well 350 ft. deep, 10 in. in diameter.

PUMPS

Exeter Rotary. By Movement of a Rotor Three Spaces Enlarge and Contract, Thus Drawing and Expelling Water. Coal Age, vol. 19, no. 18, May 5, 1921, pp. 805–806, 2 figs.

New Type Exeter Rotary Pump Works on Novel Principle and Wears But Little, S. H. Farkas. Nautical Gaz., vol. 101, no. 19, May 7, 1921, pp. 597–609, 4 figs. Underlying principle of operation is variant of square-hole drilling device in which triangular bit functions inside restraining square former of equal size. Irregular spaces, increasing and diminishing in volume as two rotate together, admit and eject fluid.

Mercury Vapor. A Mercury Vapor Pump (Quecksilberdampfpumpe nach W. Friedrichs). Zeit. fur angewandte Chemie, vol. 34, no. 11, Feb. 8, 1921, p. 46, 1 fig. Details of pumps constructed by Greiner & Friedrichs Glass Works, Stützerbach.

Submersible. Submersible Electric Pumps. Iron & Coal Trades Rev., vol. 102, no. 2771, April 8, 1921, pp. 493, 3 figs. Pumps manufactured by Submersible Motors, Ltd., Middlesex, England.

Vacuum. Dry-Vacuum Pump Capacity Tests, Snowden B. Redfield. Mech. Eng., vol. 43, no. 5, May 1921, pp. 315–318, 4 figs. Method employing low-pressure nozzle for air measurements. Typical volumetric-efficiency curves.

PUMPS, CENTRIFUGAL

Pullen. A New Low Lift Centrifugal Pump. Machy. Market, no. 1067, April 15, 1921, p. 29, 2 figs. Pullen low-lift pump. Impeller member has vanes shrouded both sides, also impeller member and casing are fitted with renewable wearing rings.

PYROMETRY

Industrial Applications. Pyrometric Practice, Paul D. Foote, C. O. Fairchild and T. R. Harrison. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 170, Feb. 16, 1921, 326 pp., 185 figs. Survey of practical methods in use in industries in 1920.

R

RADIOMETALLOGRAPHY

Developments. X-Rays and Their Industrial Applications. Engineering, vol. 111, no. 2884, April 8, 1921, pp. 412–415, 10 figs. Developments in radiometallographic examination of materials.

RAILS

Electric Welding. See ELECTRIC WELDING, Rails.

Fractures. Internal Fractures in Steel Rails, Henry S. Rawdon. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 470–471, 2 figs. Microscopic examinations of "transverse fissures." (Abstract.) Paper read before Faraday Soc.

Standardization. New Standard Rail Sections for French Roads. Ry. Age, vol. 70, no. 19, pp. 1129. Four sections adopted are 26-kg. section for narrow-gage tracks, 36-kg. section for light traffic, standard-gage lines, 46-kg. section for light traffic, standard-gage lines and 55-kg. section for use in tunnels where action of moisture and smoke results in rapid loss of metal.

RAILWAY ELECTRIFICATION

Economics. Economic Aspect of Railway Electrification, A. H. Armstrong. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 405–413, 26 figs. Electrification advocated as means for solving national transportation problem.

Electrification of Steam Roads an Economic Necessity, A. H. Armstrong. Elec. Rev., (Chicago) vol. 78, no. 19, May 7, 1921, pp. 723–727, 2 figs. Economies in fuel and labor effected by change to electric motive power.

Rational Electrification of Steam Railroads, George R. Henderson. Ry. Age, vol. 70, no. 17, April 29, 1921, pp. 1037–1038, 1 fig. Method for determining what values of profile and traffic density make electric operation desirable.

Switzerland. Electrification of St. Gotthard Line, Switzerland, Hans W. Schuler. Ry. Age, vol. 70, no. 19, May 13, 1921, pp. 1107–1112, 13 figs. Line extends from Lucerne to Chiasso on Italian border, distance of 180 miles. There is average grade of 2.5 per cent for 30 miles. Current at 15,000 volts is supplied to locomotives.

RAILWAY MAINTENANCE

Methods. Developing Thoroughness and Permanency. Ry. Maintenance Engr., vol. 17, no. 5, May 1921, pp. 160–164, 4 figs. Engineering and maintenance methods of Lackawanna Railroad.

RAILWAY MOTOR CARS

Diesel-Electric. Diesel-Electric Cars (Les automotrices, Diesel-électriques), Lucien Pahin. Industrie Électrique, vol. 30, no. 692, April 25, 1921, pp. 145–150, 5 figs. Motor cars used in Swedish railways.

RAILWAY OPERATION

Cost Accounting. The earnings of Individual Passenger Trains, T. W. Mathews. Ry. Age, vol. 70, no. 16, April 22, 1921, pp. 981–983, 4 figs. Method for determining whether selected trains pay out of pocket or other costs.

Freight Trains. Effect of Train Speed on Energy Consumption, G. S. Chiles and R. G. Kelley. Ry. Age, vol. 70, no. 18, May 6, 1921, pp. 1083–1084, 2 figs. Charts showing relation between resistance and speed for various average weights per car.

Train Control. Train Operation and Automatic Train Control, J. B. Latimer. Ry. Age, vol. 70, no. 16, April 22, 1921, pp. 977–979. Caution signals, property located with audible signals suggested as means of remedying collision problem.

Train Despatching. A Complete Train Despatching System. Ry. Signal Engr., vol. 14, no. 5, May 1921, pp. 184–187, 4 figs. Practice of Lancashire & Yorkshire Ry., England. All train movements are controlled from one center office. From Modern Transport, Lond.

RAILWAY REPAIR SHOPS

Electric Welding. Railroad Shop Notes, S. Ashton Hand. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 773–777, 19 figs. Repairs on broken cylinders by electric welding. Gage for setting half-cranks on Walschaerts valve gears.

RAILWAY SIGNALING

Overrunning Signals. Means for Preventing Overrunning Signals Standing at Danger, H. Mollering. Bul. Int. Ry. Assn., vol. 3, no. 4, April 1921, pp. 419–430, 1 fig. Signaling systems used by German Railways. Paper read before Electrotechnical Soc. of Dresden.

RAILWAY SWITCHES

Control. Outlying Switch Control Facilities Train Movements, C. C. Anthony. Ry. Age, vol. 70, no. 18, May 6, 1921, pp. 1077–1079. Development of low-voltage mechanisms controlled from central point.

Interlocking. New Interlocking on the Boston Elevated, W. C. Smith. Ry. Signal Engr., vol. 14, no. 5, May 1921, pp. 173–178, 10 figs. Electropneumatic plant with A. C. control and color light signals gives speed-signaling indications.

RAILWAY TIES

Reinforced-Concrete. The Ickes Railway Tie. Concrete, vol. 18, no. 5, May 1921, pp. 252–253, 10 figs. Main feature consists of lateral enlargements immediately under rail, making longitudinal support of rail at this point 21 in. instead of 8 in. for wooden tie. Tie is made in three parts, which are connected and drawn together by means of 3 8-in. by 2-in. steel bar.

Steel vs. Wood. Steel Sleepers Compared with Wood Indian Eng., vol. 69, no. 15, April 9, 1921, p. 203. Empirical formula for computing relative economy of using steel or wooden ties, obtained from records of service of both of these types of ties in the Baden Ry., Germany.

RAILWAY TRACK

Standardization of Material. The Standardization of Material in France and in Germany (Die Normalisierung des Oberbaumaterials in Frankreich und in Deutschland), P. Müller. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 6, Mar. 24, 1921, pp. 63–65. Comparison of relative merits of both systems. Whereas in Germany the standardization committee is a voluntary organization and no one is compelled to adopt the established standards, in France the standardization commission is appointed by Bureau of Public Works and Bureau of Trade.

Tie Plates. Service Stresses in Tie Plates, E. P. Gowing. Ry. Rev., vol. 68, no. 17, April 23, 1921, pp. 644–645 and 650–651, 4 figs. Graphs showing distribution of pressure. From Indian Engineering.

Weed Burners. Southern Road Develops High Power Weed Burner. Ry. Age, vol. 70, no. 17, April 29, 1921, pp. 1033–1034. Apparatus developed in shops of Texas & Pacific. Heat at temperature of 1400 to 1500 deg. fahr. is blown upon vegetation beneath hood 38 ft. long suspended over track, giving length of contact sufficient to destroy vegetation while burner is moving five miles per hour.

REFRIGERATING PLANTS

Operation. Refrigerating Plant Economies and Capacities, I. L. Kentish-Rankin. Power Plant Eng., vol. 25, no. 9, May 1, 1921, pp. 471–477, 8 figs. Methods for increasing economy and capacity of plant.

RESEARCH

Industrial. A Modern Research Laboratory. Automobile Eng., vol 11, no. 150, May 1921, pp. 176–177, 7 figs. Devices which have been evolved at industrial research laboratories operated by Rudge-Whitworth, England.

The Central Research Laboratory of the General Motors Company, J. Edward Schipper. Automotive Industries, vol. 44, no. 17, April 28, 1921, pp. 900–901, 1 fig. Occupies building 1000 ft. long by 270 ft. wide in Moraine City, suburb of Dayton, and is operated as independent unit of G. M. C. but in coöperation with various automobile and parts plants of company, under direction of C. F. Kettering and staff of specialists.

The Conduction of Research, F. H. Norton. Sci. Monthly, vol. 12, no. 5, May 1921, pp. 424–433. Economical advantages of industrial research. Procedure in carrying out research.

The Products of a Works Laboratory. Engr., vol. 131, no. 3408, April 22, 1921, pp. 430–431, 10 figs. Apparatus used in work done at research laboratory in Conventry works of Rudge-Whitworth, England.

Government-Conducted. Scientific and Engineering Work of the Government, Its Cost and Its Value, E. B. Rosa. Eng. & Contracting, vol. 55, no. 20, May 18, 1921, pp. 487–490. Activities of scientific and engineering branches of national Government, with figures relating to economic value of such work. Paper read before Washington Section, The American Society of Mechanical Engineers.

RIVETS

Design. Rivet-Head Shapes (Nietkopfformen) W. Schulz. Elektrotechnische Rundschau, vol. 38, no. 4, Feb. 21, 1921, pp. 21–24, 18 figs. Determination of weight of rivet heads, and of length of radii of arcs forming contour of sections of round-head rivets.

ROCK DRILLS

Rotary Electric. The New Pillar Drill of the Siemens-Schuckert Works (Die neue Säulendrehbohrmaschine der Siemens-Schuckertwerke), H. Baumer. Kali, vol 15, no. 6, Mar. 15, 1921, pp. 94–100, 11 figs. Details of latest improved type of Siemens-Schuckert drill, the GBD 3000, with 3-phase motor requiring 1.65 kw. Advantages and useful possibilities.

ROLLING MILLS

Electrically Driven. Some Methods of Obtaining Adjustable Speed with Electrically Driven Rolling Mills, K. A. Pauly. Gen Elec. Rev., vol. 24, no. 5, May 1921, pp. 422–432, 15 figs. Discussion of Merits of Scherbius system of speed control, both single range and double range in which slip energy of main motor is returned to system as electric energy. Comparison is made with Kraemer or synchronous converter system in which slip energy is returned to main motor shaft.

Rerolling Rails. Rerolling Rails at Sweet's Steel Co., Sidney G. Koon. Iron Age, vol. 107, no. 19, May 12, 1921, pp. 1227–1232, 8 figs. Recovery of 80 per cent of old tonnage. Rails split for rolling angles and flats for fence posts and bedsteads.

Roll Design. Foreign Methods of Roll Design, H. R. Ronnebeck. Iron & Coal Trades Rev., vol. 102, no. 2771, April 8, 1921, pp. 490–492, 18 figs. Comparison of German and American practices. Paper read before Cleveland Insto. Engrs.

MAKING EFFECTIVE USE OF RADIANT ENERGY

The importance of Radiant Energy in boiler and stoker practice is strongly emphasized by Prof. A. G. Christie of Johns Hopkins University in an article in "Power" for April 12.

The conclusions reached are:

> "First, that direct radiation is an important source of heat in boiler furnaces which should be carefully considered in both design and operation.
>
> Second, that the highest possible furnace and fuel-bed surface temperatures should be maintained, so as to emit the greatest amount of radiant energy; and that furnace design and operation should be studied to insure *continuous removal of ash and cinder from this hot surface.*
>
> Third, that the greatest possible amount of dull metallic boiler surface should be arranged *to "see" the fire:* that is, to receive this radiant energy directly, and that these surfaces must be kept free of dust and cinders by effective cleaning devices."

The Riley Stoker with its continuous automatic ash discharge insures the continuous removal of ash and cinder from the fuel bed so that high surface temperature can be constantly maintained.

With the Riley Stoker no arches are required for combustion purposes, therefore the boiler tubes can "see" *all* of the fuel bed. Note the illustration below.

The Riley Stoker is designed to most effectively use all the available radiant energy.

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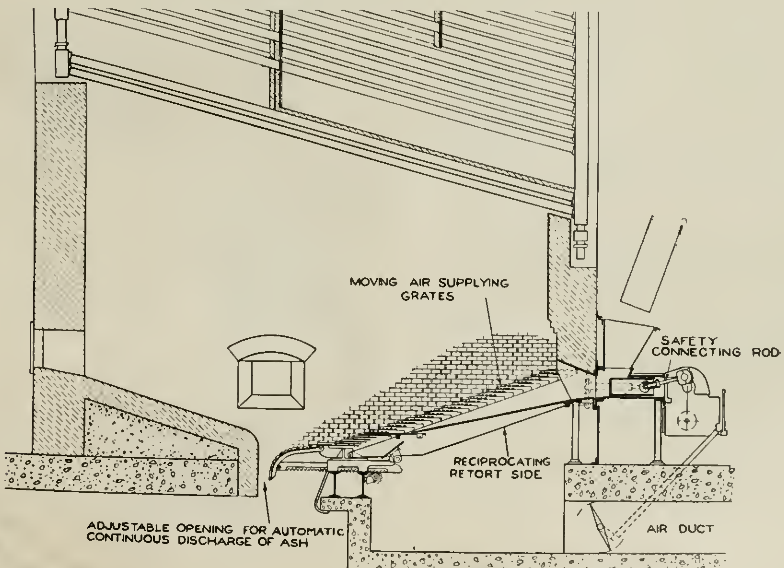

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MURPHY AUTOMATIC FURNACES
BUFFALO CLEVELAND DENVER

ENGINEERING INDEX (Continued)

S

SCRAPING MACHINES

Compressed-Air. The Use of Scrapers in Metal Mines, Lucien Eaton. Compressed Air Mag., vol. 26, no. 5, May 1921, pp. 10065–10075. Structural characteristics of typical scraping machines.

SCREW THREADS

Methods of Producing. Various Methods of Producing Threads, J. H. Moore. Can. Machy., vol. 25, no. 17, April 28, 1921, pp. 25–31, 23 figs. Threading locomotive set screws. Steel axles. Special nuts. Tractor axles; worms; lead screws; fine pitch threads and internal threads.

SCREWS

Gaging. Gauging and Fine Measurements—I, A. C. Wickman. Machy. (Lond.), vol. 18, no. 446, April 14, 1921, pp. 52–55, 8 figs. Application to production of screws.

SLAG

Utilization and Agriculture. Basic Slags: Their Production and Utilization in Agriculture. Trans. Faraday Soc., vol. 16, no. 2, Dec. 1920, pp. 261–335. Symposium. Papers presented were: The Utilization of Basic Slag; The Physical Chemistry of Basic Slags; The National Aspects of the Case for Increasing Supplies of Basic Slag; The Demand for Basic Slag; Basic Slag and Its Place in the Development of Agriculture; A Comparison of the Effect of Various Types of Open Hearth Basic Slags on Grassland; Solubility of Basic Slags; The Improvement of Low Grade Basic Slag; Formation of Basic Slag in the Manufacture of Steel.

SPRINGS

Design. Formulas for Spring Design, Edward Jacobi. Machy. (N.Y.), vol. 27, no. 9, May 1921, pp. 882–884, 4 figs. Empirical formulas tried out in designing plants of Milwaukee manufacturers.

Helical. Design of Helical Springs, Joseph Kaye Wood. Am. Mach., vol. 54, no. 18, May 5, 1921, pp. 780–784, 3 figs. Importance of and factors entering into "material index." Determination of torsional modulus of elasticity. Control of unit fiber stress.

Leaf. Design and Heat Treatment of Leaf Springs, H. E. Hemstreet. Forging & Heat Treating, vol. 7, no. 4, April 1921, pp. 240–242. Times and temperature for hardening and drawing.

Testing. Magnetic Spring Testing, T. Spooner and I. F. Kinnard. Am. Soc. for Testing Matls., advance paper, 8 pp. 3 figs. Apparatus used and results obtained in magnetic tests on helical steel springs. Hysteresis method of testing is believed to furnish ready commercial method of checking quality and heat treatment of finished springs.

Spring Testing. Automobile Engr., vol. 11, no. 149, April 1921, pp. 142–144, 5 figs. Amsler universal machine for testing springs under pressure of from 2 to 100 tons.

STACKS

Steel, Cement-Gun Lining. The Conservation of Steel Stacks Weakened by Corrosion, John V. Schaefer. Eng. World, vol. 18, no. 5, May 1921, pp. 321–323, 5 figs. Reconstruction of corroded steel stack by cement-gun lining.

STAMPING

Typical Operations. The Economics of Drawing and Forming Metals, Robert Holmes. Raw Material, vol. 4, no. 4, April 1921, pp. 124–128, 13 figs. Typical stamping operations. Records of costs.

STANDARDIZATION

Economics. Standardization of Products, Melvin T. Copeland. Bul. Taylor Soc., vol. 6, no. 2, April 1921, pp. 55–64 and (discussion) pp. 64–76. Economical advantages of standardization.

Fillets for Revolving Parts. Standard Fillets for Revolving Parts (Normale Abrundungen an Drehteilen), K. Schenck. Der praktische Maschinen-Konstrukteur, vol. 53, no. 51, Dec. 23, 1920, pp. 436–438, 3 figs. Suggestions for carrying out a standardization system for filleting shoulders of shafts and rounding off the corresponding portion of brasses or bearings in which they revolve.

Machinery. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 15, Apr. 25, 1921, pp. 207–219, 16 figs. Proposals of Board of Directors for plug gages, limit gages, holders, measuring disks and holders, and end gages. Proposed new standards for circular dies, die caps and holders.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 187–199, 20 figs. Proposal of Board of Directors for holes, keyways and arbors for cutters, reamers and countersinks; hand screw taps for Whitworth, metric and pipe threads; nut taps; screw die taps; hand jaw and machine jaw taps. Proposed standard for molded pieces for drain pipes.

The Interdependence of Standards with Special Regard to Preferential Dimensions (Die Abhängigkeit der Normen voneinander unter besonderer Berücksichtigung der Vorzugsmasse), R. Koch. Betrieb, vol. 3, nos. 13 and 14, Mar. 25 and Apr. 10, 1921, pp. 94–101 and 106–108, 10 figs. Presents table containing series of preferential dimensions developed by working committee for standard numerals and explains their practical application. Report of Federation of German Works Engrs.

STEAM

Superheated, Specific Heat of. The Determination of the Specific Heat of Superheated Steam from Throttling Tests (Ueber die Bestimmung der spezifischen Wärme des überhitzten Wasserdampfes aus Drosselversuchen) Karl Hencky. Zeit. des Bayerischen Revisions-Vereins, vol. 25, nos. 6 and 7, Mar. 31 and Apr. 15, 1921, pp. 41–43 and 52–54, 2 figs. Critical discussion of tests by Grindley and Griessmann; notes on accuracy obtainable with throttling tests. Recommendations based on experiences with the throttling calorimeter.

STEAM-ELECTRIC PLANTS

France. French Electric Plant, Carroll F. Merriam. Nat. Engr., vol. 25, no. 5, May 1921, pp. 214–217, 3 figs. Steam-electric plant of gas company of Lyons.

Philadelphia. Compact Reinforced-Concrete Generating Station at Philadelphia. Elec. World, vol. 77, no. 21, May 21, 1921, pp. 1145–1151, 18 figs. Steam-electric station with generating capacity of 180,000 kw. Attention is directed to coal-handling facilities and furnace construction.

STEAM METERS

New Types. Power Consumption and Steam Meters (Ueber Betriebskontrolle und Dampfmesser), Anton Gramberg. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 15, Apr. 9, 1921, pp. 391–393, 4 figs. Suggestions for equipment and superintendence of factories operating with waste heat. Experiences with different types of steam meters and description of two new types.

STEAM POWER PLANTS

New Plant. A Plant Built for Service. Power Plant Eng., vol. 25, no. 9, May 1, 1921, pp. 449–454, 11 figs. Plant supplying steam for power and heating purposes.

STEAM SHOVELS

Loading Slag with. Operations of the Birmingham Slag Company. Excavating Engr., vol. 15, no. 5, May 1921, pp. 151–154, 6 figs. Company is operating eight steam shovels in and around Birmingham, loading slag. Description of plants at Ensley and Alabama City, Ala.

STEAM TURBINES

Developments. Some Recent Developments in Large Steam Turbine Practice, K. Baumann. Eng., vol. 111, nos. 2884, 2885, 2886, 2887, 2888 and 2889, Apr. 8, 15, 22, 29, May 6 and 13, 1921, pp. 435–439, 449–453, 501–504, 532–535, 567–571 and 597–600. 38 figs. Apr. 8: Outline of turbine practice from 1912 to 1921 based on published records and other information, indicating circumstances which have resulted in "race for maximum output at highest possible speed." Apr. 15: Factors affecting development of large turbines Apr. 22: Basis of calculations for improvement in heat consumption possible with improved steam conditions. Apr. 29: Economical rating of given turbine frame. May 6: Comparison of different types of turbo machines. May 13: Tests on steam consumption of large turbines. Paper read before Instn. Elec. Engrs.

Lubrication. Keeping Steam Turbine Lubricating Oil in Good Condition, Charles H. Bromley. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 414–421, 7 figs. Various processes employed, including batch system, continuous filtration, and continuous by-pass are described, and list of requirements of efficient oil filtration system is given.

STEEL

Alloy. See ALLOY STEELS.

Automobile. Further Notes on Automobile Steels, W. H. Hatfield. Automobile Engr., vol. 11, no. 149, April 1921, pp. 153–158, 4 figs. Experiments at Brown-Firth Research Laboratories to establish actual fatigue range of different steels.

Carbon Determination. Electrolytic Resistance Method for Determining Carbon in Steel, J. R. Cain, L. C. Maxwell. U. S. Dept. of Commerce, Technologic Papers, Bur. of Standards, no. 141, Dec. 6, 1919, 21 pp. 6 figs. Method for determining carbon dioxide by absorbing it in barium hydroxide solution and measuring resistance change of solution in relation to its concentration. Suitable absorption vessel with electrolytic resistance cell incorporated.

Intercrystalline Fracture. Inter-Crystalline Fracture in Steel, D. Hanson. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 467–469, 7 figs. Examination of photomicrographs. It is concluded that there is no essential difference between iron and steel and non-ferrous metals in regard to season cracking. (Abstract.) Paper read before Faraday Soc.

Inter-Crystalline Cracking of Mild Steel in Salt Solutions, J. A. Jones. Engineering, vol. 121, no. 2885, April 15, 1921, pp. 469–470, 7 figs. Photomicrographic and chemical analyses. It is believed one of determining factors in production of cracks is presence of internal or applied tensile stress, and fracture occurs only when these stresses are above certain value. Condition of slightly elevated temperature alone was not found to be responsible for producing cracks in internally stressed steel. (Abstract.) Paper read before Faraday Soc.

Piping and Segregation. Shrinkage-Hole Formation and Segregations in Steel Ingots (Ueber Lunkerbildung und Seigerungserscheinungen in silizierten Stahlblöcken), A. Brüninghaus and Fr. Heinrich. Stahl u. Eisen, vol. 41, no. 15, Apr. 14, 1921, pp. 497–510, 17 figs. Marked difference in casting methods employed with steel with silicon added were not observed. Results of investigations and conclusi Discussion.

Rock-Drill. Breakage and Heat Treatment of Ro Drill, Benjamin Tillson. Min. & Metallurgy, 173, May 1921, pp. 38–39 and 42–43, 4 figs Serv tests on 7 brands of rock drill steel. 246 pieces of 271 were broken during tests; 25 pieces avera 114 ft. without breaking.

Shipbuilding. Steel and Iron for Shipbuild Purposes, Horace Holden Thayer. Mar. E vol. 26, no. 5, May 1921, pp. 370–375. Notes practice, requirements, specifications, methods ordering shipments, etc.

Tests. Impact Tests on Cast Steel, F. C. Langenb Am. Soc. for Testing Matls., advance paper, 11 4 figs. Tests made to determine effect of phosph upon physical properties of cast steel, also effec heat treatment upon acid open-hearth cast st

Tool. Action of Internal Stress on Tool Steel Neil Greenwood. Engineering, vol. 111, no. 2 April 29, 1921, pp. 535–537, 1 fig. Origin of inte stresses in pure metals and alloys are grouped in main classes: those due to distortion by cold worl and those resulting from suppression of phase cha by rapid cooling. Conditions governing harde of steel are set out in detail and volume cha causing internal stresses are analyzed. Phenom of spontaneous change are examined in light of sults published by Matsushita. Paper read at j meeting of Faraday Soc. with other instituti

Tungsten. Structure of Tungsten Steels. Ch & Metallurgical Eng., vol. 24, no. 17, April 27, 1 pp. 745–748, 18 figs. Review of Honda and M kami's work, presenting their principal conclus as to structure and constitution of tungsten iron bon alloys. Reactions between iron tungstide iron and tungsten carbides.

STEEL, HEAT TREATMENT OF

Hardening. The Hardening of Steel (Ueber Härten des Stahls), B. Strauss. Betrieb, vol no. 14, Apr. 10, 1921, pp. 400–405, 18 figs. cusses theory of hardness of steel based on result most recent researches, and its dependence on c position, temperature and speed of cooling Origin of pressure cracks and the close relation between volume and hardness of steel.

Quenching Cracks. On Cause of Quenching Cr Kotaro Honda, Tokujiro Matsushita and Sakae I Engineering, vol. 111, no. 2889, May 13, 1921, 595–597, 9 figs. It is concluded from tests tha quenched steel a certain amount of austenite is erally present intermingled in martensite. Amo of austenite increases as quenching tempera increases. Quenching cracks occur in small piece steel when hardness in central portion is much gre than in periphery. Cracking is attributed to st caused by difference in specific volumes of auste and martensite. Paper read before Iron and S Inst.

Screw Stock. Heat Treatment of Screw St A. A. Blue. Forging & Heat Treating, vol. 7, n May 1921, pp. 265–267, 7 figs. Prolonged treatn at high temperatures is necessary to refine llan structure caused by cold rolling. Greatest p bilities lie in case carbonizing.

STEEL MANUFACTURE

Chart. Development of Iron Ore Into Iron and S S. C. Dickerhoff, Jr. Blast Furnace & Steel Pl vol. 9, no. 5, May 1921, pp. 318–319, 1 fig. C illustrating processes of steel manufacture.

Converters. Calculation of the Additions in S Converters (Berechnung der Zusätze beim Kl konverter), Bernhard Osaan. Giesserei-Zeit vol. 18, no. 5, Mar. 1, 1921, pp. 69–71, 1 fig. Met of determining manganese and silicon conten additions to steel.

Direct Process. Another Direct Process for S Making, Herbert Lang. Iron Age, vol. 107, no. May 12, 1921, pp. 1237–1238. Mixture conta in retort and charged into reverberatory furn Steel produced in melting compartment. Metho Direct Steel Process Co. Inc.

STEEL MILLS

Czecho-Slovakia. The Steel Works of Czecho-vakia. Am. Mach., vol. 54, no. 19, May 12, 1 pp. 826–829, 9 figs. Steel mills have melting pacity of 8000 tons per month. Electric furn are used.

Electric Drive. A New Balanced Sheet Mill D Josef Hirschmann. Blast Furnace & Steel Pl vol. 9, no. 5, May 1921, pp. 328–329, 1 fig. D consists of 25-hp. motor running at 750 r.p.m. dir connected to speed reducing gear transmission means of flexible coupling.

Handling Materials. Mechanical Handling of S Mill Material, C. F. Poppleton. Blast Furnace Steel Plant, vol. 9, no. 5, May 1921, pp. 291– 12 figs. Methods at Midland plant of Pittsb Crucible Steel Co.

Lorraine. The Thyssen Works, Hagondange, Dahl. Iron & Coal Trades Rev., vol. 102, no. 2 April 29, 1921, pp. 589–595, 10 figs. Descriptio steel works. Translated from Stahl und Ei

Russia. The Donetz Region of the Bolshevic Gov ment—II, M. Ullrich. Blast Furnace & Steel Pl vol. 9, no. 5, May 1921, pp. 314–316. Notes iron and steel industry in Russia.

STOKERS

Underfeed. Development and Application of Un feed Stoker, Edward Rahm, Jr. Proc. Engrs. of Western Pa., vol. 37, no. 1, Feb. 1921, pp. 2 and (discussion) pp. 53–68, 16 figs. History developments in U. S.

ENGINEERING INDEX (Continued)

STRESSES

Buckling and Bending. Buckling and Bending (Knickung und Biegung), H. Ellerbeck. Zentralblatt der Bauverwaltung, vol. 41, no. 25, Mar. 26, 1921, 3 figs. Discussion of approximate formulas for buckling resistance and bending stress.

Determination with Polarized Light. The Determination of Stresses in Stressed Bodies with the Aid of Polarized Light (Die Bestimmung der Spannungen in beanspruchten Körpern mit Hilfe polarisierten Lichtes), H. Schulz. Betrieb, vol. 3, no. 14, Apr. 10, 1921, pp. 405–412, 12 figs. Discusses laws of propagation of light in anisotropic bodies and apparatus for observation of double refraction caused by stress. Examples of different cases of stressed bodies, such as influence of external pressure or tensile forces, irregularities of structure, and temperature influence.

Photoelastic Analysis. Photo-Elasticity for Engineers—V, E. G. Coker. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 455–466, 14 figs. Stress-strain properties of nitro-cellulose and law of its optical behavior.

SUBMARINES

Detection. The Nash Fish for Submarine Locating. Elec. Times, vol. 59, no. 1541, April 28, 1921, pp. 403–404, 2 figs. Measurements by rotating transmitters.

SUPERHEATERS

Design. Modern Practice with Steam Superheaters and Their Fields of Use, H B. Oatley. Jl. Eng. Inst. of Canada, vol. 4, no. 5, May 1921, pp. 289–300, 17 figs. Notes on design of superheaters, including detailed study of types of installations, application and use, also comparative tables of performance with saturated and superheated steam.

Flue Tubes. The Manufacture of Flue Tube Superheaters. Engr., vol. 131, no. 3408, April 22, 1921, pp. 438–440, 10 figs. Procedure at works of Marine and Locomotive Superheaters, Westminster, England.

T

TERMINALS, LOCOMOTIVE

Mallet Locomotives. Improving Terminals for Mallet Operation. Ry. Age, vol. 70, no. 18, May 6, 1921, pp. 1063–1068, 11 figs. Locomotive terminal of Norfolk & Western Railroad at Roanoke, Va.

Operation. Intensive Operation of Locomotive Terminals, L. G. Plant. Ry. Rev., vol. 68, no. 17, April 23, 1921, pp. 641–644, 2 figs. Urges standardization of terminal equipment and statistical control of terminal operation.

TERMINALS, MARINE

Mechanical Equipment. The Handling of Goods at the Port of Manchester Warehouses. Engineering, vol. 111, nos. 2888, and 2889, May 6, and 13, 1921, pp. 541–544, 23 figs., and 576–577, 12 figs., partly on suppl. plate. There are 44 distinct warehouses which can accommodate about 500,000 tons of perishable goods under cover, besides unlimited quantity in open storage. Methods of handling wool, material in bags, cotton, etc., are described. Cold stores with capacity of 1,000,000 cu. ft.

TERMINALS, RAILWAY

New York. An Automatic Terminal Railway for New York. Eng. & Contracting, vol. 55, no. 20, May 18, 1921, pp. 491–495. Plan of steam and electric yard in New Jersey for joint use of New Jersey railroads and automatic-electric system. Scheme developed by New York, New Jersey Port and Harbor Development Commission.

TESTING MACHINES

Bradley-Richards. A New Metal Testing Machine. Eng. Production, vol. 2, no. 29, April 21, 1921, pp. 512, 2 figs. Bradley-Richards hydraulic testing machine.

Brinell Hardness Testing. Modern Testing Machines (Neuere Prüfmaschinen), E. Irion. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 13, Mar. 26, 1921, pp. 315–320, 21 figs. Deals with hardness-testing machines. Notes on importance of the Brinell test and the Brinell testing machines of the Dusseldorf Machine Corp.; measuring devices; testing machines for large and heavy pieces; relation between degree of hardness and tensile strength degree of hardness with different loads. Recommendation for a standard ball with diameter of 6.35 mm.

Compression. 500-Ton Compression Testing Machine. Engineering, vol. 111, no. 2886, April 22, 1921, pp. 488–490, 5 figs. Installed in engineering department of British Nat. Physical Laboratory. Machine is intended for making compression tests on stone and concrete and embodies unique application of Amsler principle of load measurement.

TESTS AND TESTING

Brinell Hardness Testing. Ball Testing of Materials for Hardness, Brinell Test (Etude sur l'essai de dureté à la bille. Essai Brinell) R. Guillery. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 1–110, 12 figs. Researches on elimination of time influence Testing for hardness with ball receiving pressure by impact.

Impact. Tests Under Repeated Impact (Quelques Essais aux chocs répétés), Leon Guillet. Revue de Métallurgie, vol. 18, no. 2, Feb. 1921, pp. 96–100. It was established that rupture produced by repeated impact takes place by progressive fissuration.

TEXTILE MACHINERY

Machine Running Recorder. Machine Running Recorder. Engineering, vol. 111, no. 2889, May 13, 1921, pp. 580–582, 9 figs. Machines constructed for controlling operation of textile machines. Each machine is connected with instrument in such a way that an electric circuit is completed when machine stops and blank line is started on record sheet.

TEXTILES

Microscopy. The Microscopy of Textiles, F. J. Hoxie. Textile World, vol. 59, no. 16, April 16, 1921, pp. 59 and 61, 3 figs. Recommends coöperative study for needed development. Paper read before Textile Division, Am. Soc.Mech. Engrs.

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Pneumatic. Design and Manufacture of Pneumatic Motor Tires, Colin Macbeth. Practical Engr., vol. 63, no. 1781, April 14, 1921, pp. 228–232, 12 figs. Outline of manufacturing systems. Paper read before Instn. Automobile Engrs.

Truck, Pneumatic. Use of Pneumatics Limited on Trucks of More Than 3½-Ton Capacity. Automotive Industries, vol. 44, no. 18, May 5, 1921, pp. 960–961. Opinions expressed by truck and tire builders in reply to questionnaire.

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Caterpillar. Caterpillar Farm Tractors (Raupenschlepper für landwirtschaftliche Zwecke). Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 14, Apr. 2, 1921, p. 348, 1 fig. New Büssing tractor with slow-speed engine of 55 hp. and capable of traveling up to 6 km. per hr.

Gear for Snow Riding. Cars for Mountains (Chars de montagne), L. Périssé. Nature (Paris), no. 2451, Mar. 26, 1921, pp. 193–195, 5 figs. Typical tractors with running gear adopted for travel on snow-covered road.

Tests. Data on Illinois Tractors. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 487–488. Survey made by Division of Farm Mechanics, University of Illinois, comprising records kept by farmers on 68 tractors.

Nebraska Tractor Tests, Oscar W. Sjogren. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 391–395, 6 figs. Nebraska tractor law provides that stock tractor of each model and type sold in State shall be tested and passed upon by board of three engineers under State University management.

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Brass. Internal Stresses in Brass Tubes, H. N. Vaudrey and W. E. Ballard. Metal Industry (Lond.), vol. 18, no. 15, April 15, 1921, pp. 290–292, 6 figs. Experimental investigation of circular tubes containing 70 per cent copper.

Design. Design of a Tube Supporting a High Internal Pressure (Calcul d'un tube supportant une forte pression intérieur), E. Sinard. Arts et Métiers, vol. 1, no. 1, Oct. 1920, pp. 18–20, 8 figs. Formulas for computing stresses.

Seamless. Finishing Process for Seamless Tubes. Iron Age, vol. 107, no. 17, April 28, 1921, pp. 1114–1118, 11 figs. Details of Pilgrim-step finishing process. Working hollow ingot on mandrel, between rolls, in such manner that at each revolution of rolls small portion of ingot is rolled to tube, is principle. Translated from Stahl und Eisen.

On the Manufacture of Seamless Tubes—III, Karl Gruber. Blast Furnace & Steel Plant, vol. 9, no. 5, May 1921, pp. 320–323, 9 figs. Processes of rolling seamless tube in Germany with special consideration of Mannesmann oblique rolling process. Translated from Stahl und Eisen.

TUNNELS

Vehicular. Shield vs. Trench Method for Hudson Vehicle Tubes, C. M. Holland. Eng. News-Rec., vol. 86, no. 18, May 5, 1921, pp. 764–766. Why shield method has been selected in preference to trench method for construction of Hudson River vehicular tunnels between New York and New Jersey.

V

VACUUM

Methods of Production. Methods for the Production and Measurement of High Vacua—VIII, Saul Dushman. Gen. Elec. Rev., vol. 24, no. 5, May 1921, pp. 436–443, 2 figs. Physico-chemical methods.

VALUATION

Railways. An Analysis of the Current Valuation Report on the Kansas City Southern Properties, Samuel W. Moore. Eng. News-Rec., vol. 86, no. 19, May 12, 1921, pp. 818–821. Status of investigation of date. Present announcement of Interstate Commerce Commission includes single sums as "value" but no statement of method. Land acquisition costs apparently disallowed.

VENTILATION

Office Building. Ventilation of the Home Office Building of the Travelers Insurance Company, Hartford, Conn. Am. Architect, vol. 119, no. 2364, April 13, 1921, pp. 459–462, 4 figs. System is composed of two parts, (1) blower section which includes distributing apparatus, and (2) exhaust section which consists of apparatus by means of which used or vitiated air is removed from building. In each of these sections air is propelled through metal ducts and chambers by fans operated by individual electric motors.

VOCATIONAL EDUCATION

Disabled Soldiers. Making Mining Engineers from Disabled Soldiers, W. A. Clark. Eng. & Min. Jl., vol. 111, no. 17, April 23, 1921, pp. 706–708, 3 figs. Project of Federal Board of Vocational Education, Washington, D. C.

The Re-Education of the Disabled, J. Manclark Hollis. Jl. Royal Soc. of Arts, vol. 69, no. 3568, April 8, 1921, pp. 318–324, 5 figs. Work being carried out by Village Centers Council, England.

VOCATIONAL TRAINING

Disabled Workmen. Industrial Rehabilitation—General Administration and Case Procedure. Federal Board for Vocational Education, Bul. no. 64, Mar. 1921, 52 pp. Rehabilitation is considered from point of view of State administrations.

Pennsylvania Bureau of Rehabilitation. Bureau of Rehabilitation Pennsylvania Department of Labor and Industry Report of Activities to January 1, 1921, Bul. Dept. of Labor & Industry, vol. 8, no. 2, Jan. 1, 1921, 30 pp.

W

WAGES

Changes in Industry. Wage Changes in Industry. Nat. Indus. Conference Board, no. 35, Mar. 1921, 52 pp. Survey of wage changes in major manufacturing industries in U. S. from Sept. 1914 to end of 1920.

WATER POWER

Argentina. Hydroelectric Power in Argentina, Leonard Matters. Sci. Am., vol. 124, no. 17, April 23, 1921, pp. 330 and 340, 2 figs. Scheme for generating 125,000 kw. from Eguazu Falls.

Japan. Regulations Governing Development of Water Power in Japan. Elec. World, vol. 77, no. 20, May 14, 1921, pp. 1101–1104, 3 figs. State governors have power to alter designs and rescind concessions. Basis of calculations required. Electric companies have right of eminent domain.

WELDING

Steel. The Welding of Steel, H. Brearley. Engineering, vol. 111, no. 2888, May 6, 1921, pp. 551–554, 12 figs. Welding of steel in relation to occurrence of pipe, blow-holes and segregates in ingots. (Abstract). Paper read before Iron & Steel Inst.

[See also AUTOGENOUS WELDING; ELECTRIC WELDING; ELECTRIC WELDING, ARC; OXY-ACETYLENE WELDING; RAILWAY REPAIR SHOPS, Electric Welding.]

WELDS

Heat Treatment. Effect of Heat Treatment on Metal Arc Welds, James W. Owens, J. H. Ramage and J. A. Watts. Ry. Elec. Engr., vol. 12, no. 5, May 1921, pp. 189–193, 10 figs. Metallographic studies made at U. S. Navy Yard, Norfolk, Va.

Testing. The Desirability of Standardization in the Testing of Welds, F. M. Farmer. Jl. Instn. Mech. Engrs., no. 3, April 1921, pp. 225–240, 5 figs. Standards for evaluating welds are suggested and certain standard procedures are proposed for various mechanical tests.

WELFARE WORK

Restaurants. The Factory Restaurant as a Service Nucleus, Sanford DeHart. Indus. Management, vol. 41, no. 9, May 1, 1921, pp. 338–340. Experience of R. K. LeBlond Machine Tool Co., Cincinnati, O.

WIND TUNNELS

Design. National Advisory Committee's 5-ft. Wind Tunnel, F. H. Norton. Jl. Soc. Automotive Engrs., vol. 8, no. 5, May 1921, pp. 489–495, 16 figs. Tunnel is of venturi type with continuous throat of circular section and there is airtight experimental chamber built about working section in order that small holes may be opened into tunnel while it is running without disturbing airflow.

Intake Bell. Experiments on the Design of Intake Bell for a Wind Tunnel. U. S. War Dept., Air Service Information Circular, vol. 3, no. 217, April 30, 1921, 8 pp. 5 figs. Object was to investigate effect of intake bell on smoothness of flow in wind tunnel. Conclusion reached was that Grimes type intake bell gives best velocity distribution.

McCook Field. Description of the McCook Field Wind Tunnel. U. S. War Dept., Air Service Information Circular, vol. 2, no. 196, April 30, 1921, 8 pp. 6 figs. McCook field wind tunnel is used for high-speed investigations of instruments, aerofoils, etc. Speeds up to 525 m.p.h. are attained.

WOMEN WORKERS

Two-Shift Systems. The Two-Shift System for English Working Women. Monthly Labor Rev., vol. 12, no. 4, April 1921, pp. 92–95. Approval by parliament of bill permitting under certain conditions employment of women in workshops at any time between 6 A.M. and 10 P.M. in shifts averaging not more than 8 hr. for each shift.

WOOD PRESERVATION

Treatment. Modern Wood Impregnation Methods, Friedrich Moll. Eng. Progress, vol. 2, no. 3, Mar. 1921, pp. 55–56, 4 figs. Rüping economic process. Part of oil is forced out again.

MECHANICAL ENGINEERING

Volume 43 August, 1921 Number 8

General Education and the Engineering Profession

By H. E. Miles,[1] New York, N. Y.

POSSIBLY no consequence of the Great War is more portentous than the decision of all the people of civilized nations that hereafter every man shall think for himself, and that no Prussian militarist or other group, however wise, shall think for the rest of society.

With this decision comes the requirement, not that we concern ourselves less with higher education, but more with the common schools and with new avenues of educational advancement, fitted to his circumstances, whereby the average man of whatever age, and the less favored, shall be trained to sound thinking upon social and economic subjects and for better accomplishment than heretofore.

Education is the development of the powers of mind and body, and public education, the taking of the money of all for the education of the children of all, is especially for the development of the social and economic understanding of all.

An idea of the present educational foundation of the American social structure may be gained from the chart of Fig. 1, which includes the total population of the United States under fifty years of age. The irregular line to the left of the chart may be called the death line as it indicates our diminishing population as life advances.

The inner curved line indicates the total school population, and the numbers in the first 6 grades, in the 7th and 8th, in high school, and in college.

It is commonly said that there is nothing of education in the first six grades where only the tools of education, the "Three R's," are acquired with which education is secured later if at all. As nearly half the children leave school at about 14 (in the mill towns of Massachusetts 70 per cent leave by the end of the 5th grade), it may be said that half leave school forever without any real education. There is, moreover, substantially nothing of formal education in "live civics" or in economics taught in the 7th and 8th grades. We may therefore say that education begins in this sense with the dotted line at the 16th year after 70 per cent of the children have left and therefore that our social structure with its great adult population in the large area *A* of the chart has an educational foundation in one corner only, that of the college and high school, rapidly diminishing from this little corner along the curved line from *C* to nothing before reaching *D*, with 43,000,000 wage earners and 20,000,000 of their wives and sisters of the same status in the area *A* who left school by the end of the 6th grade with never an hour of formal instruction in those things which make for understanding of our social institutions, of economics or the means of livelihood.

The inestimable value of this neglected 80 per cent of our citizenship is indicated by the careful testing of some 1,500,000 enlisted men in the recent war, showing that only one-tenth of the genius of our country is college bred, the other nine-tenths running all the way from high school to illiteracy, with 24.9 per cent of our people unable to read an English newspaper and write a letter home. We have been miners finding only one nugget in ten and missing the other nine.

Prof. Irving Fisher estimated, some years ago, the mere money value of the brain and muscle of our working people at $250,000,000,000 to $300,000,000,000, or five times the value of all other natural resources of the country combined. This equals in today's values and population not less than half a trillion dollars, an inconceivable sum. What a chance for engineering is this development of our human resources!

The following quotation from a chart hung on the bulletin board of a great high school, shows the insistence everywhere expressed that there is no chance for the American boy unless he goes to college:

DISTINGUISHED MEN OF AMERICA AND THEIR EDUCATION

With no schooling, of *5 million* only *31* attained distinction.
With elementary schooling, of *33 million* only *808* attained distinction.
With high-school education of *2 million*, *1245* attained distinction.
With college education, of *1 million*, *5768* attained distinction.

WHAT IS YOUR CHANCE?

With us it is "go to college or go to the devil" educationally. Rather, with reasonable encouragement of colleges, we should make equal provision for those who cannot go, by the setting up for wage earners and others in connection with their employment and otherwise, of the equivalent of high schools and colleges adapted to their circumstances, not unmindful of the findings above referred to, that only 30 per cent of our youth have the natural ability that will permit them to go through the present high school however much they try, and that presumably much less than half of this 30 per cent could by any chance go through college.

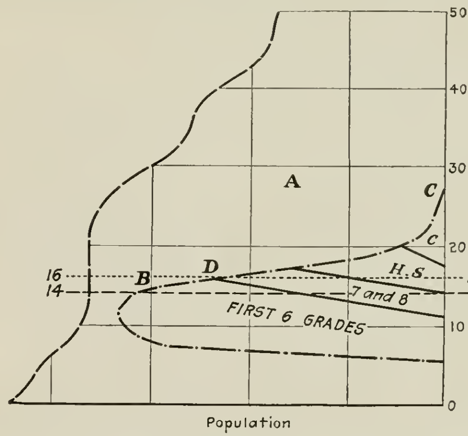

Fig. 1 Total Population and School Attendance, Russell Sage Foundation

Our Lack of Vocational Schools

Is it not an indictment of our intelligence that we provide no opportunities for the education in this wise of the 38,000,000 noted in the first two items of the chart just referred to? Several countries, with Germany leading, have shown the way. By a survey of 105 of Germany's greatest industries, 65 per cent of the men in foremost places in managerial and technical departments were little working boys who quit school at 14, grew up with the right sort of compulsory continuation schools, and later, selectively, enjoyed special technical training with the assistance of their employers and otherwise. Most of the graduates of her technical colleges served under these leaders from work schools and higher vocational schools, of which there are practically none in democratic America. This statement is not an endorsement of the German policy of

[1] Formerly President of Wisconsin State Board of Vocational Education. Address delivered at the session on Training for the Industries, of the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers.

class distinction in education, nor of her terrible sin against her common people in withholding instruction in citizenship and inculcating instead blind obedience to authority. It is for us to give the best possible education to those who will not, and to those who should not, go into our present high schools so as to inculcate in them principles of good citizenship and of economic understanding. England prepared to do this recently in the Act of August 1918, the most comprehensive educational legislation ever enacted at one time by any nation.

As a major part of this program England is developing compul-

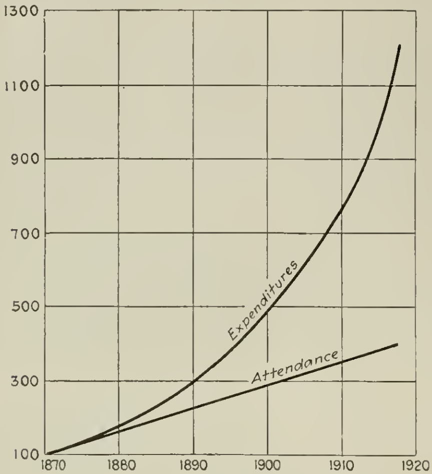

Fig. 2 School Attendance and Expenditures

Trend of average daily attendance and expenditures in public schools in the U. S. from 1870 to 1918 in percentages of the figures of 1870—W. R. Burgess, Russell Sage Foundation.

sory continuation schools for all workers under 18, and similar schools for adults up to instruction of college grade for labor leaders and others. Educators commonly agree that this training can be given in the grades. Remarkable success is secured from informal, well-directed instruction in these subjects in our army training stations, noticeably at Camp Grant near Chicago with enlisted men, including the illiterates.

The Mounting Cost of School Facilities

Not satisfied with the results of public education, America is resorting to her old makeshift, increased money expenditures, as indicated in Fig. 2 which starts with 1870 as 100 per cent and shows the relative increase in expenditures to the increase in hours of school attendance in the succeeding decades. In 1880 the two lines are not far apart. For increased expenditures we got proportional returns. In the decade 1880–90 the line of expenditures rises more than twice as fast as that of attendance. In the next decade over four times faster. In the next decade, long before the war, seven or more times faster, while in 1914, still prewar, the expenditure line has gone into the clouds with little improvement in total schooling received. A few years ago we spent $400,000,000 for public schools; last year $750,000,000; this year about $1,000-000,000; and the retiring Federal Commissioner of Education says we should spend $3,400,000,000 all told, which I judge includes some quarter of a billion for colleges. And he has substantially no suggestion for a change in the old policy of "go to college, or go to the devil."

Having exhausted the means of increasing school funds by the present methods of taxation, our school people are seeking new methods, new state and federal appropriations, and new powers to school boards enabling them to levy taxes independently and without regard to other local needs. Must not industry and the citizenship at large seriously consider where additional income is to come from, and see how far present expenditures can be made to yield better returns? Let us try for economy and improvement and not for increased levies only. Let us remember that not over 30 per cent of American youth have the natural qualification that permit them to complete a high-school course; that the mortality in the high schools supports this finding, half or more dropping out at the end of the first and second years. Let us develop collateral facilities equivalent to high schools at a fraction of the per capita cost and more effective for certain types than the present high school which educators declare to be still in the experimental stage—to be cherished but supplemented and modified.

What is the solution? The following suggestions have been approved in their general features by all prominent educators to whom they have been submitted;

I Elementary schools must be made more effective with the best possible instruction in citizenship and economics for every child before he leaves, and afterward in the continuation schools which have recently been established in 25 states, but very poorly developed. It is said that most of the instruction in the seventh and eighth grades is repetitional and waste, and can be replaced with citizenship and economics for those who go to work early, with a year saved to those who will study them in high school and college.

The Need for a Longer School Year

2 There must be more schooling per pupil per year. One-fourth of all enrolled pupils on the average are absent each school year, due to lax attendance and public indifference. Mr. Leonard Ayres says we have "the shortest school day, the shortest school week and the shortest school year of any first class nation in the world." See Fig. 3.

And what is all this for? For the child, who, as shown in the seventh bar, gets only an average of 605 hours of schooling per year, a year of 4500 waking hours, allowing ten hours for sleep. Remembering that 85 per cent of the children in our cities do not go to the seashore or the country in vacation time, but stay in the

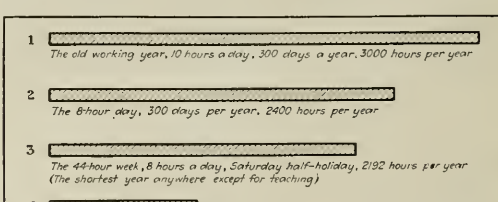

Fig. 3 What is a Year's Work for a Healthy Adult?

Bars 5 and 6 show only the fixed school hours. In addition, many high-school teachers in good schools average about two preparatory hours daily. Little outside work is commonly done by elementary-grade teachers.

city streets, and that almost all leave school at 14 or 15 years of age with a sixth-grade education or worse, it is a sin of the first magnitude that they are not given all the education they can take rightly each day and year. With book learning they should have training in health, the use of leisure time and regulated play, to make them sturdy, masterful little citizens measurably ready for life's cares and opportunities.

With open minds the school authorities must find for themselves what hours in each situation a teacher should work and require no less. Some educators approve of Amarillo, Texas, which recently employed one-third less than her usual number of teachers and increased the school year to 46 weeks; with 50 per cent in-

crease in teachers' salaries, but no increase in the total salary budget. The Federal Commissioner of Education inclines toward a six- or seven-hour school day and a 46-week compulsory school year. Our long summer vacation is said to be a relic of agricultural days when all children helped to raise the crops.

3 Teachers' salaries must be carefully determined that they be commensurate with those paid in other comparable occupations, and that rating and promotion be dependent not upon period of service only, as now, but also upon personal and professional and qualifications. There is a spirit of rebellion on the part of many because merit counts for so little, and consequently there is less inclination than heretofore for superior people to enter the profession.

Results of Adult Education Shown in Increased Industrial Efficiency

4 Facilities for adult education must be immeasurably extended. Education must not stop with the 14th year, the 16th year or any other year. As in some other countries there must be provision in day and night and part-time schools, in factories and elsewhere, for every one of whatever age who desires to enlarge his understanding as a citizen or to improve his economic condition. The extent to which this can be done has been demonstrated and shown to be profitable to employers as well as workers. The chart of Fig. 4 was prepared by one of the best production experts in America and published by the Federal Department of Labor. It presents a cross-section of American industry. It is a composite of several charts, some by Mr. H. L. Gantt, and includes such different types of production as power tools in a great factory of international reputation and the making of brushes, all showing substantially the same condition.

It shows all these workers averaging only 46 per cent efficient, with 59 per cent of them 38 per cent efficient. Post-war charts are similar but the percentages somewhat better. The wonder is, as has been often disclosed, that many of the workers in the 59

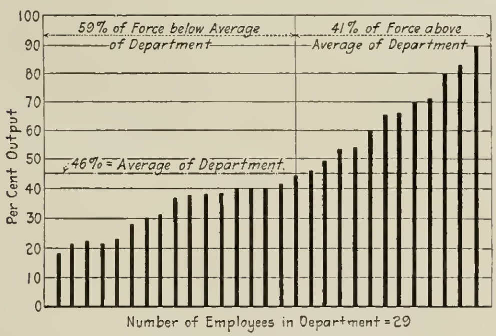

Fig. 4 Relative Efficiency of a Typical Factory Group

per cent group are as bright as the average in the 41 per cent of the best workers. They were put to work with no one to show them how. Those who, after proof in the best factories in America, have declared that the production of many workers can be doubled, have been criticized as exaggerating; but this chart shows how easy it may be to train an intelligent worker, man or woman, who is 38 per cent efficient, to be 75 per cent efficient. France by a general order required every considerable factory during the war to introduce these training departments; England also, but by clauses in her war contracts. If they increase production 20 per cent, which is easy, they effect a saving of $1,000,000,000 in payrolls, in wholesale prices of $2,000,000,000 and to the consumers $3,000,000,000. The aid to foreign trade with its keen competition is evident from this economy. But the greater accomplishment lies in the heightened intelligence, the happiness and the improved social attitude of the workers thus lifted in self-respect and capacity. What applies to factory workers in all these ways applies to all others.

The middle-aged man in a factory noted for its efficiency, whose production was increased 93.7 per cent by three weeks in the training department as shown in Fig. 5, looked upon his instructor as the best friend he ever had. He had been unable to support his family properly on his former earnings and considered himself a failure until so trained.

One of the largest producers of fine hardware in America tested the value of their training by the upgrading process in their special training room by comparing two men originally of equal capacity. The first man made no improvement in the 23 days of observation, while the other man doubled his production after 21 days of intensive instruction at absurdly little cost because the instructor was caring for other men at the same time.

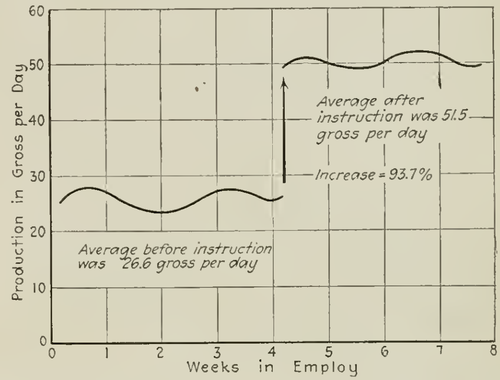

Fig. 5 Increasing Daily Production by Proper Training Methods

Fig. 6 shows how a group of 43 women long employed in one department increased their production 152 per cent in three weeks in the training department. In this case the training department was made a laboratory on methods, i.e., the methods of operation were improved at the same time as the skill of the operatives. As should always be the case, the teacher was a production expert who could also instruct effectively, giving him the twofold qualifications required in the trainer for production.

Fig. 7 shows, in the solid line, how a group of 50 women on power sewing machines were brought to full production in five weeks as against the 10 weeks (dotted line) required by old methods.

Apprenticeship Does Not Solve the Problem

We have greatly misunderstood apprenticeship in respect to its general applicability. It is desirable for the development of leaders who will cease to be wage earners as soon as trained. It is for one in a hundred. In three American factories famous for their highly developed apprenticeship courses it averages one in ninety. Most of our workers are doing work impossible of apprenticeship instruction of the old sort. The factory training department when rightly developed with what I call "intermittent apprenticeship" offers a substitute. A distinguished member of your association searches constantly throughout his force for average and superior men who want to advance, trains them for one limited field after another in his training departments and in regular shop work, and gradually lifts them higher and higher at good wages at almost negligible cost. He thus fills his best positions from the ranks, his master mechanic being of this class. The effect of this method upon the morale of the shop is evident.

To appreciate modern requirements and opportunities for trade training we must free our minds of traditional beliefs regarding apprenticeship. The so-called "halcyon days of apprenticeship" never were. There were halcyon days of guild monopoly with fathers paying large sums for their sons' indenture in these trades and their subsequent enjoyment of monopoly privileges, and there were apprenticeships of lesser value. I have diligently searched the authorities and, strange as it may seem, I cannot find that there ever was a time in England, the cradle of apprenticeship, when men entered apprenticeship much more readily than now because inspired by a desire to master a trade.

All through the middle ages from about 1261, the earliest mention of apprenticeship, to 1700, the time of its rapid decline, it was a

penal offense in England for any one except the eldest son of a master who "inherited apprenticeship," to buy or sell merchandise or to create any article embodying skill, except after apprenticeship which began anywhere from the eight to the seventeenth year, and ended about the twenty-fourth year. In about 1700, however, after two centuries of what we may call the "boot-legging" of those days, when men had persisted in acquiring skill in hidden places, in farm houses, "in aleys & upon steyers, and houses in corners," and in selling their products covertly, until finally the right to exercise one's faculties freely in production had come to be recognized, apprenticeship rapidly and greatly declined. Incidentally, it may be noted that during the long apprenticeship period of those days, little of mathematics or other book learning was taught and there was complaint as in our days that so far as the acquirement of skill was concerned the apprenticeship period might have been much shorter. It was made long that production might be cheaper.

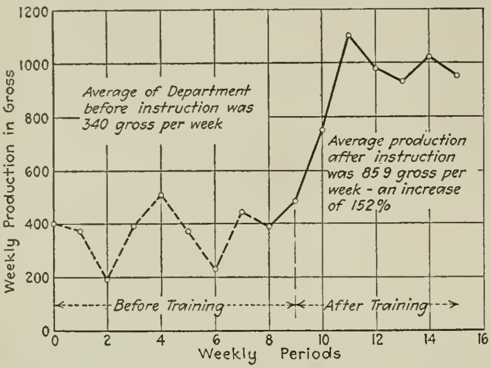

Fig. 6 Increasing Production of a Department by Correct Training Methods

During all these centuries England, by fixed policy and legislation, made low wages and this sort of apprenticeship the basis of her foreign trade and her commercial prosperity. She made herself supreme in skill and commerce, but her workmen paid the price.

It will comfort and inspire some of us to know that we need not attempt broadly and generally "to revive apprenticeship" by a return to the past, and that we have developed in considerable measure our own better way as shown in many factories, large and small.

Continuation Schools

The compulsory continuation schools now in operation in about 28 states are a modern substitute for the initial years of ancient apprenticeship. Where best developed, as in Boston and Milwaukee they are, with such extensions as will come naturally, the least expensive and most effective agency for the education of that 70 per cent of all our children who cannot or will not continue in the regular schools and have been entering the occupations at the rate of over 1,000,000 a year, unfitted therefor and without hope educationally.

Vocational education is essentially different from general education. The aim is vocation and education. The aim being different, the administration and methods must be different. Having, however, no system of vocational education in the United States we commonly think of it as something to be tacked on to the existing system.

Vocational schools, including continuation schools, must be directed and controlled by boards or committees representative of the vocations to be taught. Not because these representatives are better or worse than others; but because there are men in the vocations of as broad social vision and sound judgment as elsewhere, and because only men who have spent their lives successfully in the occupations know what the requirements are and can wisely select experts to meet these requirements.

The aim in vocational schools is production, the mastery of some one calling that leads ever upwards to higher places. Production is not merely the operation o˘ a machine and the making of things. It includes knowledge of the latest scientific methods as well as accuracy and speed. The Racine, Bridgeport and New Haven schools make commercial products for the market with the approval of labor leaders and all others. So do other good schools.

In Racine and Bridgeport the so-called "high-school manual training" is merged in the continuation and apprentice schools, thereby improving qualities, giving the favored high-school children desirable contact under superior conditions with their less fortunate fellows and saving the cost of separate high-school equipment and operation.

All-day vocational schools should operate 8 hours per day with Saturday half-holiday and 46 or 48 weeks per year, thus giving their working children, whose parents think they can ill afford to lose their children's time, the same hours they would have if in employment. This gives 10 per cent more hours of schooling in two years than the ordinary high school gives in four years, and gives a trade in addition.

5 Continuing the consideration of improvements, we may require, as a group of educators recently declared, that taxation be better safeguarded "to the end that a dollar's worth of education is received for every dollar spent."

The Training of Teachers

6 There must be great improvement in the quality and amount of teacher training in normal schools and in continuation and extension classes. Says the Commission on National Program of the National Education Association:

> The majority of the 600,000 teachers of the public schools represent in general a low level of maturity, general education and professional preparation.
>
> Of the twenty million boys and girls in our public schools today, it may be conservatively estimated that—
>
> 1,000,000 are being taught by teachers whose education has been limited to seven or eight years in the elementary schools;
>
> 7,000,000 are being taught by teachers who are scarcely more than boys and girls themselves;
>
> 10,000,000 are being taught by teachers who have had no special preparation for their work and whose general education is quite inadequate.

Support of Best Educational Leadership Essential

7 As a condition precedent to these attainments there must be an intelligent support of the best educational leadership, of which America has much that is as good as anywhere in the world. Also in the hundreds of thousands of devoted, aspiring members of the rank and file is a potential leadership hungry for opportunity.

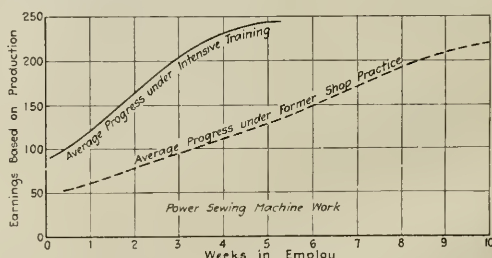

Fig. 7 Showing Saving in Time Effected by Intensive Training in Attaining Full Production

Collateral to this support of professional leadership must be developed a lay leadership, not more devoted nor high-minded than most of the present leadership, but thoroughly informed and therefore courageous; not getting in the way of the professional; not, as frequently now and to as bad effect, unintelligently supporting the wrong type of professional leadership, selected from personal appearance, political or other pressure, on letters of recommendation the general value of which none know better than employers.

Public education is not alone a professional matter. Education must be linked with life continuously and the forces of society should unite with the professional forces of education for a joint accomplishment. To this end there should be a central agency or clearing house for the collection and dissemination of facts in the

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The National Metal Trades Association and Industrial Education

An Outline of Its Activities in the Training of New Workers, with the Opinions of Its Committee on Industrial Education Regarding Apprenticeship, Trade and Continuation Schools, Instruction by Foremen, Training in Plant, and Vestibule Schools

By HAROLD C. SMITH,[1] CHICAGO, ILL.

REALIZING the need for national concerted action in handling labor problems with which they were constantly confronted, a small group of manufacturers engaged in the metal trades industry, in the spring of 1899, formed an organization for this purpose. After twenty-two years of steady growth this organization, the National Metal Trades Association, stands out preëminently for fair dealing, strength, and efficiency. Its primary object, as tersely stated in its constitution, is "to secure and preserve equitable conditions in the workshops of its members for the protection of both employer and employee."

The fact that our country has occupied for so many years a leading position as a world commercial power has been due in a large measure to its unrestricted productive facilities afforded by the maintenance of American principles. Realizing this, the organization adopted early in its career as a vital policy in dealings between its members and their employees, the open-shop, or American Plan, principle.

In addition to being a stanch advocate of the open-shop principle as the only sound basis in dealings between employer and employee, the Association has also been mindful of the necessity for, and the far-reaching benefits incident to, other constructive activities. Consequently its field has become widened from time to time until now it is a potent factor in the furtherance of industrial training, safety, sanitation, Americanization, and kindred subjects. It actively coöperates with other national organizations of a constructive character, and is affiliated with the National Industrial Conference Board, a federation of national associations of manufacturers in the principal branches of American industry, which it aided in organizing.

For a number of years the Association has endeavored to point out to its members the necessity for training in industry and the importance of their assuming an active part in this work by the establishment of training units in their own plants and by coöperating with both public and private institutions organized for this purpose, realizing that this question will have a far-reaching effect upon the future of our industries.

Clearly nothing will tend more to the stabilization of labor conditions than an adequate supply of competent workers, the need for which until a comparatively recent time has been most keenly felt, and a shortage of which exists even today for normal production. From the worker's point of view training offers an opportunity to increase his efficiency and thereby greatly enhance his earning capacity.

A Brief Survey of the Educational Work of the Association

One of the Association's early efforts in educational work was the equipping with machinery certain buildings in the Winona Technical Institute, of Indianapolis, and the furnishing of scholarships, worth $100 each, for prospective students, the contributions of equipment and scholarships being made by individual members of the Association to the Institute. Later the Association, in conjunction with the Indianapolis members, voted financial support to the Institute for the maintenance of a Metal Trades Department, and appointed a committee to coöperate with the officers of the Institution in the management of that department. Subsequently, when the school system of Indianapolis took over the Institute and started the present Arsenal Technical High Schools, the equipment was given to the "School City," from which nucleus its present extensive system of shops for vocational and technical education has grown.

In coöperation with the University of Cincinnati, under Prof. Herman Schneider, members of the National Metal Trades Association opened their shops in 1906 to the students in the University's "Coöperative Course in Engineering," with the result that young men there are now getting a practical and technical training which was impossible under the old order.

Realizing the spread of industrial and vocational education and appreciating the work of the National Association for the Promotion of Industrial Education, the National Metal Trades Association, at its annual convention in 1911, made an appropriation to be used at the discretion of its Administrative Council for advancing the work undertaken by the former. Similar contributions were again made in 1914 and 1915. The passage of the Smith-Hughes Bill, granting federal aid for vocational education, it is believed was largely due to the efforts of that organization, aided by individuals and associations.

Immediately upon its appointment in the summer of 1918, in order to meet the serious labor shortage created by the war, the Association's Committee on Industrial Education entered upon a plan which had as its object the breaking in of unskilled workers and increasing the efficiency of those already in industry. As the result of a conference with Mr. H. E. Miles, Chairman of the Section on Industrial Training for the War Emergency, Advisory Commission, Council of National Defense, Washington, D. C., it was decided to make a study of the so-called "vestibule schools," which had for their object practically the plan just outlined, i.e., the instructing of new help and upgrading those already in the plants.

Accordingly, the Committee began its activities by visiting Cincinnati and Dayton during the month of September 1918, and plans were made to inspect plants in the East that were operating similar schools. While the signing of the armistice seemed for the moment to have removed the urgent necessity for this particular kind of intensive training, it soon became evident that industry could not afford to ignore the continued need for industrial training in the competitive days of peace. The Committee was so strongly of this opinion that, following a tour of inspection of a number of plants in Worcester, New Haven, Bridgeport, Stamford and Buffalo, it unanimously recommended to the Executive Committee of the Association the employment of a man especially qualified to carry on this work, whose sole duty would be to visit each individual member of the Association for the purpose of making a study of the plant called upon and offering recommendations based upon such inspection. This recommendation was adopted by the Executive Committee, in July 1919, and after careful consideration, Mr. Philip C. Milter was selected for the position.

Various Plans Employed in the Training of Workers

As a result of its studies the Committee has found that the training of workers is now being carried on under five general plans, each of which has its place in industry; and the Association recommends each and all of them to its members, depending upon the special case under investigation. These five plans may be designated as follows:

1. Apprenticeship
2. Trade and Continuation Schools
3. Instruction by Foreman
4. Special Training in Plant
5. Vestibule Schools.

[1] Illinois Tool Works; Chairman of Committee on Industrial Education, National Metal Trades Association. Mem. Am.Soc.M.E.

Paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

Apprenticeship is particularly designed to take care of young men who wish to learn a trade in all of its branches, but is not generally adaptable to the instruction and upgrading of unskilled workers. The Committee feels that while there has been a lessening interest in apprenticeship as the result of conditions brought about by the war, this was nevertheless also due in a large measure to the unattractive conditions of the indentures. It hopes, therefore, to develop during the coming year some plan which it can recommend to the Association that will be sufficiently attractive to boys and the better grade of young men to hold them throughout the full course. Too much emphasis cannot be laid upon the desirability of each company's training apprentices in proportion to the needs of the industry, as regards growth and labor turnover.

Trade and Continuation Schools have for their object the manual and technical training of boys and young men in a particular craft or trade which they may select. By this form of education the boy is able to earn money throughout his school course, and if mechanically inclined obtain an education, whereas without such an opportunity many of them would be compelled to quit school entirely. This form of education is carried on in a number of cities, notably in Cincinnati, Ohio, and in Fitchburg, Mass. It has a further advantage in that it requires no additional expenditure or teaching force, with the exception of one supervisor to see that the industries and the public schools properly coöperate. Compulsory attendance at continuation schools by permit workers has also made rapid strides, twenty-five states now having legislation making education and training for these young people mandatory. The Committee recommends this form of education as being most desirable and most earnestly asks the interest of engineers and manufacturers in such schools where it is in existence, in order that they may be made most practicable and kept free from politics. There is a possible objection to the trade and continuation schools as the Committee sees it, and that is, they cannot be expected, no matter how efficient, to give to the minds of the workers that touch of confidence in the good intentions of a particular corporation in the same way that it can be given by the representatives of the plant itself, provided those who govern industry can be awakened to their duties.

This is the system most universally employed and it consists of putting the workmen directly into the department and under the supervision of the foreman in charge, who is entirely responsible for their success or failure.

The Committee found that the particular objection to this method was that the foreman, being responsible for the success of his department, in a great many instances had neither the time nor the patience to properly instruct the worker, nor in many cases the ability to impart his own knowledge.

There is also the possibility that prejudice on the part of the foreman may prevent him from properly instructing the worker in the performance of the required operations, the result being a lack of efficiency, causing a loss to both the employer and worker.

While the Committee admits that poor foremanship brings about many industrial faults, yet it does not believe that the foreman should be charged with conditions where the employers themselves have taken no definite steps to train him as to his particular duties. Foremen can be taught the fundamental principles of foremanship and department management from books and by teachers who are not themselves owners of industries, but, after all, the real policies that the foreman should live up to must be laid down for him by the manager of the plant in which he works.

Hitherto the foremen have had to build up their own policies from hearsay, deduction, or actual experience with each case as it came up. Different foremen translate management policies thus acquired in different ways, which means that the quality of foremanship varies from one department to another in a given plant. In the author's opinion, the only way a corporation can obtain a uniform dispensation of justice to its workers is for the management to see to it that its foremen are taught the policies of the corporation directly by the management or through authorized agents.

The proper course of instruction to the foreman should, in the opinion of the Committee, include:

1 The policies of the company as interpreted by its officers
2 The teaching of sound economic principles and their effect upon industry
3 The proper methods of manufacture
4 Proper instruction as to the best method to impart the above above knowledge to the workers under their supervision.

Special Training in Plant. This system, which consists of training in the department by a general instructor, has some of the advantages of the vestibule school and, it is believed, is preferable to instruction by foremen. It is particularly applicable in shops whose equipment consists mostly of large tools which cannot be isolated, and removes some of the objectionable features of training by foremen.

The Vestibule School. This plan came into prominence during the war. As the name implies, it is intended as the worker's entrance to the factory; and while by no means supplanting apprenticeship, is adaptable in some form to almost all shops, and, properly managed, goes far toward relieving the shortage of skilled labor. It has been applied very successfully to the intensive training of workers for repetition work, and has also been used to train specialists such as operators of particular types of machine tools. To this school should be sent all accepted applicants, where their fitness or unfitness is readily determined. The length of time spent in the school depends upon the skill possessed at the start, the aptness of the student, and the character of the work he is to be taught. The Committee found in the schools visited that the training time varied from three days to three months.

Since entering the service of the National Metal Trades Association, Mr. Molter has worked in eight districts, visited 130 shops, and has made a large number of formal surveys and a greater number of informal recommendations. His reports show that almost without exception the members visited have displayed much interest, and the Committee feels that worth-while work has been done. As a result of Mr. Molter's visits, a number of companies have installed definite training methods, while a greater number have signified their intention of doing so as soon as conditions warrant. In addition thereto it has been very gratifying to learn that a number of members, whose interest in industrial education has been stimulated by the publicity work carried on by the Association, have, of their own volition, set up complete training shops.

It is worthy of mention that the National Metal Trades Association is the only country-wide organization in the United States that is prepared to undertake the work of industrial training in a practical way, it being the opinion of its officers that the duty of furnishing industrial education to our young people will devolve sooner or later upon industry itself.

Among the reasons for believing that industry must assume much of the task of education is the fact that a great number of young people leave school at the earliest "permit age" in order to go to work. It is unnecessary to discuss the reasons for this phenomenon, but the facts as shown in the 1917 report of the Commissioner of Education show that out of a total school population between the ages of 10 and 14 of 9,939,532, only 145,891 or 1.47 per cent are not in school, while in the next group, ranging from 15 to 17 years of age and 5,823,160 in number, 2,463,458 or 42.30 per cent are not in school. The next group, ranging from 18 to 20, shows 82.87 per cent out, and of those from 21 to 24, 95.17 per cent no longer attend any sort of school.

Another table in this same report shows that the group which started school in the first grade in 1906 dropped from 4,066,091 at that time to 1,244,098 in the eighth grade, and of these only 629,432 entered high school in 1914–15, and it is estimated that only 117 out of each 1000 entering the first grade in 1906–07 would be graduated from the high school in 1918. Need we elaborate on this condition to show that we have a duty to perform?

Findings of Committee on Existing Industrial Conditions

As a result of its studies during the year, the Committee on Industrial Education of the National Metal Trades reported to the annual convention in April that they found the following conditions to exist:

1 A shortage of efficient workers for normal production
2 Too few companies train workers

(Continued on page 550)

Future Power Development in the Middle West

By C. W. Place,[1] Chicago, Ill.

In this paper the author outlines a system in which it is proposed that the fairly efficient steam power plants in the 100-odd cities of over 25,000 population in the 14 middle-western states be interconnected, not by heavy high-voltage lines, but by lines running from each which will pick up the small-town and village load to the point where its next larger neighbor will take its share; hydroelectric plants are to be installed on the streams near the towns and villages, each with a small pondage; the steam stations are to carry the steady continuous load above the maximum stream flow, the hydroelectric plants automatically coming on to carry the peaks. On the off-peak period the hydroelectric plants will restore the pondage and carry local load. The quickness with which the latter can get on the line (12 to 30 seconds) will enable the steam stations always to work at maximum efficiency. The advantages of the system are pointed out in the paper, as well as the procedure necessary to bring about its development.

Up TO a certain point in the growth of a country or under abnormal conditions, the growth and development are the important things: the means to the end or the cost are not of great consequence. Economy and the conservation of natural resources cannot be allowed to interfere with this early expansion, but there is nevertheless some stage of development and concentration of population where early methods must be changed.

Present Sources of Power in the Middle West

At present the sources of power for the supply of light, heat and energy for the mechanical operations necessary for the life and continued development of the Middle West are coal-, oil-, and gas-fired steam equipment, internal-combustion and heat engines, and water-driven equipment. Wind and solar-heat sources need not be considered.

Fig. 1 is a map of the Middle West showing the coal fields it draws from, as well as the rivers and larger streams. Table 1 gives the coal production of this region according to Government estimates for the period 1917–1920, and Table 2 data on the potential and developed water of the fourteen states it includes. Table 3 shows the oil production of the United States in 1920, that of the Middle West being 15 per cent of the total.

It will be noticed in Fig. 1 that the coal fields are not located conveniently as regards water supply for condensing purposes and are not particularly convenient to the load concentrations as at present arranged. A recent news report indicates that the Federal investigators on power conditions of the Atlantic Coast states have concluded that the solution of the problem does not lie in enormous production at the mines on account of condensing-water conditions. On the basis of our conditions and economical production, every 100,000 kw. produced in a day would probably require 380 million gallons of water, or a flow corresponding to 588 sec-ft., for condensing purposes. It would therefore seem that the demand for power in the Middle West cannot be taken care of at the mines as these are not situated near streams of the proper size. The rivers and streams are in better relation to the load, as the cities and towns have grown up along these streams.

Power Potentialities of the Rivers and Streams

The production of power thus far by steam has been practically always at the load concentration. A start has been made transmitting from steam stations to less heavy load centers. A moving of load to cheap power has been successful in a number of cases, but this has caused unnatural conditions in other respects and has not necessarily been for the greatest good of the country as a whole. We have no great sources of hydraulic power conveniently available which can be profitably developed at present money rates and material costs. We must therefore lay our plans on our real conditions and not on some imaginary combination as regards power supply or regrouping the load arrangement. Large blocks of power have been developed at centers of load by large steam stations. These large centers are, however, not close together but each has its tributary country with low load density. This

Fig. 1 Map of the Middle West, Showing its Rivers and Larger Streams and the Location of its Coal Fields (Shaded Areas)

territory is made up of towns and villages surrounded by farming country drained by innumerable streams.

Most of these streams have comparatively low banks, have bottom lands which are good farming land and have extreme flood and low-water periods. As one travels along these streams any number of small dams may be seen that are either partly washed out or are still serving to drive some mill and making a more or less efficient use of the water going down the stream. From his observations the author would say that these streams would be

[1] General Electric Company.

Paper presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

able to supply the necessary power for all the towns and villages near them of 25,000 population or less; that during a good part of the year they could assist even in these towns during the peak if properly connected and manipulated. In these fourteen central states there are but 102 cities of over 25,000 people, and cities of this size have already established quite efficient steam plants.

Proposed Interconnected System of City Steam Plants and Village Hydroelectric Plants

Suppose now that the power houses of all these 102 cities were connected together, not by heavy high-voltage lines, but by lines running from each which would pick up the small-town and village load up to the point where its next large neighbor would take its share, and that the streams near these towns and villages had hydroelectric stations of a size proportionate to the size of their respective streams. These 102 steam stations must work on a fair load to get their best efficiency both from a steam-economy and a maintenance basis, and when the units are operating at good efficiency a sudden increase in load cannot be handled properly until other units are brought on and steam conditions have been restored. During this period of adjustment the voltage goes down and the frequency droops, and would droop more if the voltage were brought back to normal.

TABLE 1 GOVERNMENT ESTIMATE OF BITUMINOUS COAL PRODUCTION IN 1000 TONS

	1917	Per cent[1]	1918	Per cent	1919	Per cent	1920	Per cent
Total U. S.	551,790	100	579,385	100	458,063	100	556,563	100
Arkansas	2,143	1.0	2,227	1.0	1,680	1.0	2,310	1.0
Illinois	86,199	41.6	89,291	40.0	64,600	38.5	90,050	40.6
Indiana	26,539	12.8	30,678	13.7	20,500	12.2	30,420	13.7
Iowa	8,965	4.3	8,192	3.6	6,300	3.7	9,170	4.1
Kansas	7,185	3.5	7,562	3.4	5,750	3.4	6,700	3.0
Kentucky	27,807	13.5	31,612	14.2	28,500	17.0	31,000	14.0
Michigan	1,374	0.6	1,464	0.6	930	0.5	1,440	0.6
Minnesota	......	....	....	....	.....	....	....	....
Missouri	5,670	2.7	5,667	2.5	4,060	2.4	5,750	2.6
Nebraska	......	....	....	....	.....	....	....	....
N. Dakota	,790	0.4	,719	0.3	750	0.4	,770	0.3
Ohio	40,748	19.6	45,812	20.5	35,050	20.8	45,000	20.2
S. Dakota	......	....	....	....	.....	....	....	....
Wisconsin	......	....	....	....	.....	....	....	....
Total, 14 states	207,520	37.6	223,224	38.6	168,120	36.7	222,610	40.0

[1] Percentage opposite each state is percentage of production of the 14 states listed. 207,520,000 tons of 11500-B.t.u. coal will produce 249,000,000,000 kw-hr of energy at present efficiency, or at the rate of 28,000,000 kw. continuously. The total output of electrical energy in 1919 in U. S. was 3,215,552,000 kw-hr.

TABLE 2 WATER POWER IN THE MIDDLE WEST
(Extract from *Electrical World* Estimate, Jan. 1, 1920.)

State	Potential Maximum	—Developed— Hp.	Per cent of Max.	Undeveloped Maximum	Growth of Industrial Hp. req. in 1930 in Excess of Present Station Rating
Arkansas	75,000	13,400	17.9	61,600	7,000
Illinois	410,000	191,000	46.7	219,000	1,302,000
Indiana	140,000	123,000	130.0	....	558,000
Iowa	450,000	423,000	94.2	27,000	78,000
Kansas	320,000	105,000	32.8	215,000	7,000
Kentucky	250,000	61,400	24.6	188,600	62,000
Michigan	350,000	357,000	102.0	....	1,535,000
Minnesota	600,000	233,000	38.8	367,000	261,000
Missouri	200,000	39,500	19.8	160,500	49,000
Nebraska	280,000	65,200	23.3	214,800	....
N. Dakota	150,000	1,000	0.7	149,000	10,000
Ohio	215,000	200,000	93.0	15,000	1,150,000
S. Dakota	90,000	11,900	13.2	78,100	
Wisconsin	1,150,000	237,000	20.8	913,000	298,000
	4,680,000	2,121,400		2,608,600	5,317,000

Thirteen applications for Federal permits were made up to April 5, 1921, in the Middle West, and 205 applications in the entire United States and Alaska.

TABLE 3 GOVERNMENT ESTIMATE OF CRUDE-OIL PRODUCTION IN 1920

	1000 Bbl.	Per Cent Total of 14 States
Total United States	443,402	....
Arkansas	....	....
Illinois	10,772	16.2
Indiana	932	1.3
Iowa	....	....
Kansas	38,501	58.2
Kentucky	8,679	13.1
Michigan	....	....
Minnesota	....	....
Missouri	....	....
Nebraska	....	....
N. Dakota	....	....
Ohio	7,412	11.2
S. Dakota	....	....
Wisconsin	....	....
Total for 14 states	66,296	15.0

During 1920 about thirteen million barrels of crude oil were used by public utilities for power production. Of this California and Texas used 8,500,000 bbl. and Missouri and Kansas the greater share of the remainder. Crude oil is therefore of relatively little importance as regards the total power requirements.

Due to these conditions extra machines are now carried either under part load, or ready to put on at once. Suppose the interconnection mentioned above has now been made, and a goodly number of these hydraulic stations installed. These hydraulic stations are large enough to take a little more than the average stream flow, i.e., are overdeveloped. Each has a small pondage and is automatically controlled so that it will come on on a drop of frequency of the system and in sequence with other plants, depending on the proportion of its working head available at the instant. That is, the plant with the best water conditions will get on the line the quickest. It will drop off the line on a decrease of its water supply or a dropping off of load. The steam stations are operating efficiently and have a sudden increase in load.

These various hydraulic stations are operating, using up the natural stream flow and sending but a very small proportion of their load toward the city. With the droop in frequency the several water-wheel generators installed for the flow above the average begin to come in and to draw on the ponds. Enough come in to bring the frequency back to normal. In the meantime the steam stations are back to normal. The operators have not let the voltage stay down to save the speed, but have restored it at once and the service has been maintained. With this automatically started reserve there is an opportunity to decide whether the load is going to continue, and if so, to get on extra boilers and machines. It is known that the hydraulic helpers are going to begin to drop out as they exhaust their pondage, so the steam operation can be governed accordingly.

Again, suppose that each of these streams had the low swampy ground and the willow thickets made into ponds even where there was insufficient head for power development, which could release when the ponds with hydroelectric stations were drawn down by this sudden drain, and close when the station pond was restored. This would mean perfect flood control for normal rises, and, by holding out the steam stations, very good control during extreme floods.

These smaller streams lead to the larger rivers and with an approach at flood control on the tributaries there would be a greater number of locations for hydroelectric development on a larger scale along these larger rivers, each to be controlled in the same way. Each development would help the flood conditions below and make feasible developments not now economically practical.

Very closely resembling this hypothetical case is the arrangement for taking care of the peak load of New York City suggested by F. O. Blackwell at a meeting of the New York Section of the American Society of Civil Engineers, February 9, 1921. Mr. Blackwell stated that water if pumped up to an area on the Palisades during the peak, would develop the peak power more economically than it could be done by any other method of reserve. He further stated that this is being done in several installations in Switzerland, the water being pumped into reservoirs when the load is light. Prof. R. A. Fessenden in April published an article suggesting that such storage be made underground, the hole being dug near the load.

Our conditions do not perhaps lend themselves to this arrangement as readily as the combination mentioned previously. There are, however, cases where these schemes would probably work out. Along certain parts of the Mississippi River there are high bluffs and in some places the land is not particularly good on top of the bluff. A transmission line along the bluff might obtain the reserve capacity in this manner if at the same time the pondage could act as a reserve reservoir for city filter beds or some such purpose. There are high valleys in the Ozarks where there is no natural large water supply and where the land is of little value which could act as such a reserve if properly arranged and if in conjunction with the natural water-power supply in the same region. This might even make some of the powers with greatest water fluctuations economically feasible.

As regards Chicago, there is quite a large reserve at the east in Lake Michigan. On the way to Lockport there are large areas of worked-out stone pits and ground where it might be possible to get short-time storage so that the drainage canal could be upon for such peak service without unduly drawing down the lake level. Excess capacity would have to be installed at Lockport.

The State deep-waterway project could be overdeveloped and operate along this line if properly connected and operated.

All this sounds highly imaginary, but it is being done on a small scale in Saline and Seward Counties, Nebraska, along the Big Blue River, with manually operated and automatic stations, except that as yet there is no steam reserve. This system is being extended by the addition of more stations, and from present indications the entire river will soon have increasingly larger stations installed, the dam of each being at the point where the ordinary backwater from the dam farther down the river runs out. Other systems are also doing something along this line.

Advantages of the Proposed System

Suppose this idea were carried to its ultimate conclusion. The steam station would then carry the steady continuous load above the minimum stream flow, and the hydraulic equipment would carry the peaks, and on off-peak periods restore the pondage and carry local load. The quickness with which the hydraulic stations can get on the line (12 to 30 seconds) will allow the steam stations to work always at maximum efficiency.

All of these developments must be made at a cost that will show

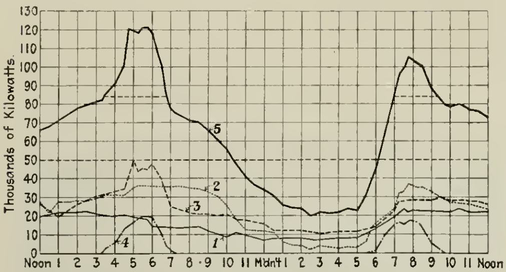

Fig. 2 Daily Load Curve of a City Having Steam and Water-Driven Power Supply for Lighting, Power and Railway Service

Curves	Kw. Peak	Kw-hr.	Load Factor, per cent
1—25-cycle steam generators..	24,000	362,150	62.8
2—60-cycle steam generators..	36,600	552,490	62.9
3—25-cycle hydroelectric generators............	50,000	528,000	44.0
4—Railway Co. steam generators	20,180	79,610	16.4
5—Total....................	121,500	1,522,250	52.5

a reasonable profit. In order to arrive at the correct profit, however, all the advantages must be weighed. A small automatic station tied to the line has a stabilizing effect on voltage which should be worth something. It should receive a credit equivalent to the transmission losses and another on the basis of the investment in coal storage of the steam station which it relieves; it should also receive some credit due to absence of labor trouble.

A multitude of these small stations will, by means of legitimate interconnections, do more actual work than the same installed capacity in one station. The small station made automatic can usually be installed on a much more satisfactory basis than the large plant. It can usually be financed locally, and a good share of the money will remain near the site. A large amount of land will not be taken out of production, so there will not be a large overhead, and the land taken will be of small value. If the development is forced beyond a certain point under middle-western conditions, this land becomes the most valuable corn land in that section, i.e., the second bottom land. The dam which before was an easy proposition on a more or less soft bottom, now becomes a difficult one, and the development will not show a profit. It is therefore necessary to multiply the number of stations instead of increasing the size if we wish to get total capacity. If these smaller stations are first installed it would seem that the larger streams could be used if developed on the same general plan and money made by the development.

Fig. 2 shows the daily load curve of a city having steam-and water-driven power supply, and having lighting, power and railway load served. If the water could be called to carry the sudden rise and the extreme of the peak it can be seen what an advantage it would be. It is evident that this could not be done with a single source of water power with any storage available in the river valley, but only with a number of such reserves acting for a territory rather than for one city.

What, now, are the things that we should do? In the opinion of the author—

1 The stream conditions and their possibilities should be studied with the above-described or some similar method of utilization in view.

2 Public opinion should be guided in the proper direction so that it will not obstruct such development.

3 Rivers which are technically navigable but are not really so should either be released or made navigable and the flow used for power development, and the engineer's influence should be used to bring this about.

4 In the permanent-highway-improvement campaign, influence should be used to have these permanent highways diverted from sites capable of future development or their natural ponds.

5 The relative importance of railway transportation and power development may change, so that any readjustments of railway roadbeds up river valleys should be along lines that will not interfere with the possible stream development. It may easily prove that the railway may be the first and most important benefactor in its electrification. Public sentiment might very easily assist in this.

6 Existing power sites in the form of mill dams should be developed and tied into the nearest transmission, and the possibilities in this direction should be investigated and taken advantage of in every locality.

7 The investing public should be instructed regarding developments in their vicinity. They should be shown that our water-power possibilities are not gold mines for the owners and are of little value if not tied in with existing systems; but that when they are so tied in they increase the value of the system and make its securities much better from the investment standpoint.

Germany Developing Water Power

Quite an extensive hydroelectric project is being undertaken in Germany in the development of the Neckar River. Capital requirements during the next few years are estimated at 950 million marks, while the total capital required for the completion of the scheme will amount to from 1900 to 2000 million marks.

While the ultimate object of the whole enterprise is the canalization of the Neckar and the linking of that river with the Danube, its immediate purpose should be seen in the harnessing of the Neckar and the generating of hydroelectric energy with a calculated output of 70,000 hp., equal to 300,000,000 to 400,000,000 kw-hr. The whole scheme represents a bold attempt to render large industrial districts in the south of Germany less dependent on outside coal supplies, and its success from a revenue-paying point of view will, in a measure, be linked with the future development of the South-German coal market and, above all, inland coal prices and coal taxes.

The entire project, covering the section of the Neckar from Mannheim to Plochingen—a distance of about 210 km.—provides for 25 to 28 dams. It is intended to start building operations at the five best-suited barrages without further loss of time and the first 700 million marks' worth of obligations will shortly be issued. Completion of the scheme in its present form will take from 10 to 13 years. Concessions have been granted for a period of 100 years.

Another big hydroelectric scheme is planned by the Prussian government in the form of a supplement to the state hydroelectric plants on the Weser and the Main, comprising four new plants to be erected on the Fulda at Cuxhaven, Freienhagen, Wahnhausen and Munden, of which only the Eder Valley power station is in operation as yet. Plants already erected and in course of construction on the Weser and Main will yield an aggregate of 66 million kilowatt-hours per year after completion, and the output of the projected Fulda plants is estimated at 69 million kilowatt-hours annually.—*Power*, July 26, 1921, p. 133.

Some Technical Problems in Aeronautics

Aluminum Cylinder Castings, Air-Cooled Airplane Engines, Airplane Carburetors and Radiators, Aerial Photography, Machine-Gun Synchronizers, etc., as Discussed on Occasion of A.S.M.E. and S.A.E. Joint Visit to McCook Field, May 21

IN connection with the joint visit of the Aeronautic Division of The American Society of Mechanical Engineers and the Socety of Automotive Engineers to the Air Service Station at McCook Field, May 21, a very interesting technical program was presented by the members of the Field's staff. Joseph A. Steinmetz, Chairman of the A.S.M.E. Aeronautic Division presided. Brief summaries of the eight papers read immediately follow.

Aluminum Cylinder Castings

DISCUSSING this subject, E. H. Dix stated that a satisfactory bond between the steel cylinder and the cast aluminum head was formed with either sherardized or tinned steel cylinders.

FIG. 1 BOND BETWEEN ALUMINUM CAP AND SHERARDIZED STEEL CYLINDER Unetched; Magnification × 200. A—Steel cylinder; B—Sherardized coating; C—Zinc-aluminum alloy; D—Copper-aluminum alloy.

Sherardizing was decided upon because of the higher melting point of zinc. A micrograph showing the bond is given in Fig. 1.

The problem of an alloy for valve-seat inserts and spark-plug bushings was solved by the adoption of a rolled phosphor bronze containing $3^1/_2$ per cent tin—chosen because its coefficient of expansion approximated that of aluminum.

The next step after these preliminary experiments was to make the actual casting. Fig. 2 shows the open mold with steel cylinder, cores, valve-seat inserts and spark-plug bushings in place. The job was made up using dry sand cores inside and outside. The method of gating is evident from the view of the cope. Three overflow risers were placed to allow for the pouring of metal through the mold.

Metal was poured through the mold so as to heat the cylinder and prevent the cracking of the aluminum casting if possible. However, the first casting showed a serious axial crack just over the steel ring. It was therefore decided to put a heating coil inside of the cylinder. This was done and a second casting poured. In this case, however, the cores were thoroughly heated before pouring, and the whole mold was placed in a core oven at 500 deg. fahr. immediately after pouring and allowed to anneal for a day and a half. This eliminated the cracking around the steel cylinder, but a crack developed in another place, that is, between two of the valve-seat inserts. It is believed that these difficulties can be overcome by slight changes in the method outlined, although preheating the mold and the subsequent annealing would make a rather expensive production job.

It has therefore been decided to endeavor to find an alloy which is less liable to crack than the one previously used which was 7 per cent copper, 1 per cent tin, and the remainder aluminum, this being recommended from the experience gained in England on a similar proposition. To guide in this selection, a hot-shortness test was devised. This consists in casting a test bar around steel lugs fixed 12 in. apart as shown in Fig. 3. The first three bars shown in this figure are aluminum alloys containing 8 per cent copper, 10 per cent copper, and 7 per cent copper + 1 per cent tin, respectively, and it will be seen that all cracked. The fourth bar is a silicon-aluminum alloy on which the Material Section is experimenting at this time. This bar showed no crack when cast in this manner. Arrangements are being made at the Bureau of Standards to have coefficient-of-expansion tests made on this alloy.

Mr. Dix pointed out that he had summarized very briefly a problem now of very vital interest to the Air Service and of which no more than the surface had been scratched, and he hoped by so

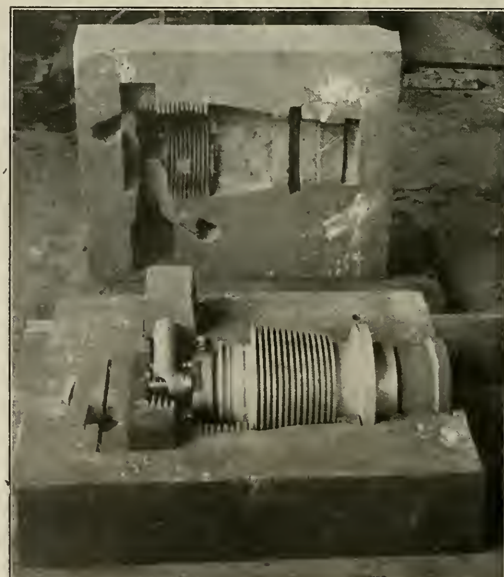

FIG. 2 MOLD FOR CASTING ALUMINUM HEAD ON STEEL CYLINDER OF AIR-COOLED AIRPLANE ENGINE. DRY SAND CORES USED INSIDE AND OUTSIDE

doing an interest might be stimulated among the engineers present which would result in valuable suggestions for future work at the Field in this connection.

Air-Cooled Airplane Engines

IN his treatment of this subject, S. D. Heron pointed out that the advantages of an air-cooled engine for military purposes were that it is less vulnerable to fire, freezing does not occur during long drives, and overheating due to a steep climb is temporary. The air-cooled engine however, has not reached the finality of design of the best water-cooled engines, although cylinders up to

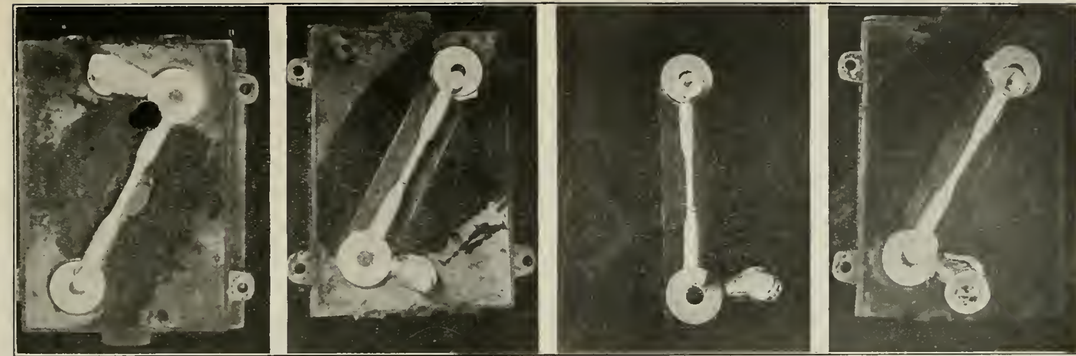

Fig. 3 Hot-Shortness Tests of Aluminum Alloys

150 cu. in. of swept volume have equaled the best water-cooled practice in power, brake mean effective pressure, and exhaust-valve reliability. Fuel economy with maximum power mixture is from 5 to 15 per cent less than in the best water-cooled engines. The advantages of the air-cooled engine have been shown in service when receiving a minimum of skilled attention. They have given good results in the Egyptian desert and in Mesopotamia.

In most designs of a cylinder for the radial engine, a compro-

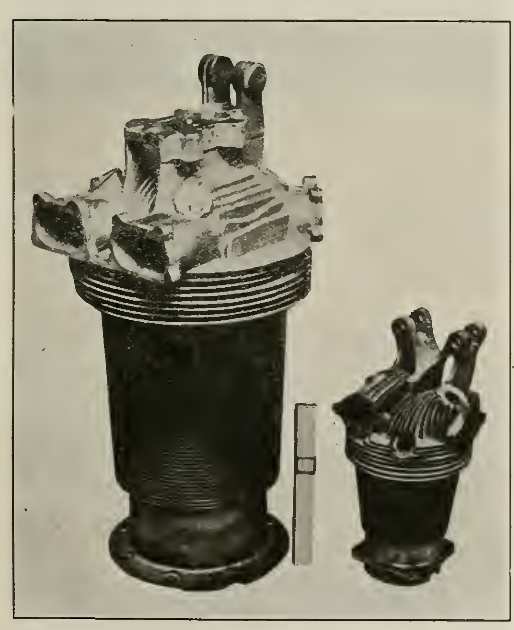

Fig. 4 Probably the Largest and Most Powerful Air-Cooled Airplane Cylinder Yet Made (8 in. Bore by 10 in. Stroke)
(Cylinder at the right is 4½ in. by 6 in.)

mise between cooling efficiency and proper valve operation is evident. The speaker pointed out that in the air-cooled cylinder cheapness and lightness have been overemphasized, with the result that cooling features have suffered. The resulting designs would not be tolerated in a high-class water-cooled motor.

As to V-engines, twelve-cylinder types up to 240 hp. have been constructed satisfactorily and have given good service. The valve operation of this type is complicated because of the location of the exhaust side of the cylinder relative to the air blast.

Dealing with the question of cylinder design, Mr. Heron described the results secured by the British with the spherical aluminum head cast or screwed to an integral fined steel barrel. He presented data from a number of tests of air-cooled engine cylinders which show that the highly efficient cylinder has not a low weight per cubic inch of swept volume. Fig. 4 shows probably the largest and most powerful air-cooled cylinder yet made—the R.A.E. 19 T., with 8 in. bore and 10 in. stroke and developing 129 b.hp. The cylinder on the right is a $4^1/_2$- by 6-in. R.A.E. 22 T.W.

Carburetors for Aircraft

THE carburetor problems of aircraft engines were outlined by C. Fayette Taylor in his remarks. A more simple type of carburetor can be utilized in airplanes than in automobiles, the open-tube type with some form of accelerating well being the most

Fig. 5 Airplane Models, Showing Systems of Camouflage for Upper Surfaces. Dark Areas are Models Covered with Standard Varnish

common. Most aircraft engines carry from two to six carburetors, which constitutes a problem in obtaining uniform adjustment and synchronization. This precludes the ordinary needle-valve fuel adjustment, and fixed fuel orifices are therefore the rule. The necessity for operating under extreme variations of temperature and pressure requires that the fuel-metering orifices must be large enough to take care of the highest density at which the engine will operate. A manual control is therefore provided.

Extreme variation from the horizontal position brings about a severe condition for the aircraft carburetor. This condition is met by carefully locating the float chamber in relation to the fuel nozzles amd metering orifices.

In order to reduce the fire hazard, the carburetor air intake must project outside the engine cowling. This means that the aircraft carburetor must take its air from a slip stream traveling from 100 to 200 m.p.h.

Airplane Camouflage

THE purpose of color camouflage for airplanes as stated by Gerald P. Young, is to break up the outline of the plane. The coloring of the upper surfaces is a combination of tan, blue green and mauve purple. The general scheme followed is to divide the surface into three irregular areas of large curving boundaries, applying these three colors both to the upper surface of the top wing and the upper surface of the lower wing. The same colors are brought back along the top of the fuselage and tail surfaces. The idea is to make the plane less visible when observed from above, and a tan section, blending with tan earth colors, causes it to become practically invisible, leaving only the darker colors which, being arranged irregularly, throw the eye off from the general outline of the plane and cause the observer to lose the plane in the background beneath.

This system is of value for planes left in the open at flying fields or when parked in the field at night, and also for concealing bombers flying at low altitudes and observed by pursuit planes from above.

The under surfaces of planes are camouflaged to give a light reflecting surface and the coloring scheme is burnished aluminum, light blue, light purple and white. This system makes it possible for an airplane regularly finished in dope and varnish having a light yellowish cast and visible at altitudes up to 17,000 ft., to become invisible at an altitude considerably under 10,000 ft.

Radio Communication

DEALING with this subject, O. E. Marvel described the characteristics of continuous wave transmission and the vacuum tube, the one thing that made the radio telephone possible. He explained that all airplanes radio sets are now designed for telephoning and continuous wave telegraphy. He emphasized the importance of radio communication, especially in military movements such as artillery fire control, infantry contact work and reconnoissance. He also emphasized the importance of wireless in direction finding—used during the war to locate enemy radio stations and to navigate aircraft.

Fig. 6 Airplane Model Against Sky Background, Showing Comparison of Standard Varnish with Camouflage Scheme

Airplane Radiators

LIEUT. Bayard Johnson spoke on the subject of airplane radiators. He pointed out the fundamental differences between the problems of radiators on an airplane and on an automobile engine, emphasizing the large quantity of water which must be forced through the airplane radiator and the need for unrestricted flow. The standard radiator core adopted by the Air Service is made of seamless round copper tubes with hexagonal ends. It gives small resistance to water flow, has no internal soldered joints, can be easily installed, is light and is most effective for air speeds of 80 miles per hour and over. In discussing the location of a radiator he emphasized the necessity for a support as free from vibration as possible. Comparing relative values of frontal, wing, landing-gear and side radiators, the advantages of the side radiator were shown, as they are protected from damage and have high air speeds available. Although the piping is long, it is accessible and warms the pilot hands. He also emphasized the need for accurate information as to the performance of different types of radiators and stated that the Engineering Division of the Air Service was progressing favorably in obtaining this information.

Aerial Photography

IN discussing aerial photography, Capt. G. W. Stevens described different types of films and plates and showed that film in rolls permitting 100 exposures, which does not require bulky, heavy magazines and is not subject to chipping or breakage, is more desirable for aerial photography. With suitable ray filters to eliminate haze it is possible to get good negatives from heights of three to four miles. A camera specially designed by Major Bagley of the Corps of Engineers has three lenses, making one vertical and two oblique negatives at the same time. At an elevation of 15,000 ft. it takes in an area 8 miles wide. With this mechanism artillery fire control can be carried into the enemy country with an error of but 200 ft. in 15 miles. The use of the camera in mapping was explained by the speaker, who showed a slide of a mosaic of the city of Rochester made up of 83 negatives.

Fig. 7 Oblique View of Washington from 4007 Feet, Taken by the Air Service

Fig. 8 New York Skyline from 1000 Feet, Taken by the Air Service

(Continued on page 562)

The Influence Exerted by the Automobile on the Machine-Tool Industry[1]

A Group of Papers Dealing with the Changes Brought About by the Automobile in Machine-Tool Design, Construction and Operation, Together with a Discussion of the Fundamentals of Interchangeable Manufacture

The session of the Spring Meeting of The American Society of Mechanical Engineers held under the auspices of its Machine Shop Practice Division was devoted to a consideration of the influence of the automobile on machine-tool design and operation during the past decade, with special reference to gear cutting, lathe practice, and the stamping and forming of sheet metals; and to the subject of interchangeable manufacture. Five papers in all were presented, abstracts of which follow, together with a brief account of the ensuing discussion.

THE INFLUENCE OF THE AUTOMOBILE ON THE MACHINE-TOOL INDUSTRY IN GENERAL

By F. K. Hendrickson,[2] Worcester, Mass.

During the years 1910 to 1913 the automobile industry began to exert a great deal of pressure on machine-tool manufacture and design, and about this time several concerns found it necessary to make extensive and very expensive changes in their systems of production to meet the rapidly increasing demand for cars. To arrive at the best conclusions and in order to secure the most modern installations, they invited many of the best engineers and machine-tool manufacturers in the country into conference with them. Each individual piece was considered separately and at times in the presence of two or more representatives from different firms, with the result that highly specialized machines were rapidly developed.

A brief study of the developments in machine-tool building attributable to the demands of the automotive industry therefore seems desirable at this time, taking up in their order the following elements which go to make a successful machine:

1 Materials and their proper distribution
2 Precision and Specialization
3 Power
4 Manipulation
5 Speed
6 Lubrication
7 Safety Devices.

Materials. Every mechanic is fully aware of the extremely rigid construction which has been demanded, due to the ever-increasing strains to which machines are subjected. In addition to the extra weight thus entailed, materials of high tensile and torsional capacity have been substituted. A few examples will suffice to indicate the trend.

Lathe spindles originally 30- to 40-point carbon steel, are now made of 15- to 20-point steel, being carbonized and hardened to produce glass-hard surfaces. The diameters also have been greatly increased.

Lathe centers formerly quite small, unhardened and of low-grade tool steel, are considerably increased in size and hardened at the point on both head and tail stocks.

High-speed cutting tools generally supported in special rigid holders are replacing almost entirely carbon-steel lathe and planer tools, twist drills, reamers, milling cutters, taps and dies.

Babbitted journals or bearings are rapidly being replaced by the best-quality bronze metals, and the tendency is toward the application of ball bearings. Certain types of machines have already been forced to incorporate them on their main spindles and with success, which indicates that the same conditions will ultimately obtain in other machines.

Cast-iron gears for speed and feed changes have been discarded in favor of the hardened steel gears, except in a few machines where the speed changes are accomplished by the engagement of friction clutches, thereby permitting the gears themselves to remain constantly in mesh their full depth and width of tooth, and leiminating the shock that otherwise results.

Clash gears, either of the sliding or tumbler type, have proved absolute failures when made of cast iron or soft steel, but are satisfactory when made of the proper steel and subjected to suitable heat treatment.

In addition to producing gears of wear-resisting qualities, it has also been necessary to develop their efficiency and to produce much quieter running. To accomplish these conditions, several machines are today equipped with helical or herringbone gears to produce smooth action and silent running under high speed and strain. New forms of spur gears are also being developed which are claimed to successfully meet the requirements.

Precision and Specialization. Grinding machines have been brought to a high state of perfection and produce a truer and finer quality of work on all revolving and sliding parts much more rapidly than ever before. Closer limits and tolerances have been demanded, with the result that the one-time all-around mechanic has been replaced by the present specialized expert, in order to obtain the highest grade of precision in quantity.

Power. Along with the added strength and rigidity of the machines must necessarily be considered their power. The automotive industry has accomplished much in the direction of insisting that the drive shall be either of the geared or silent-chain type to prevent slippage, usually prevalent when machines are belt-driven. The individual motor installation has also come into common use, and at the same time the horsepower of the motor has been increased sufficiently to care for the extreme loads.

For example, a few years ago a 14-in. geared-head lathe was equipped with a $^3/_4$-hp. motor, while today the machine must be provided with a motor of 2 hp. at least and preferably 3 hp. This proportion may not be general for all classes of machines, but is a fair criterion of the present condition.

Manipulation. One of the very essential features demanded in present-day machines by the automotive industry is easy manipulation and the convenient location of the operating levers, handwheels and cranks. Speed- and feed-changing mechanisms must be located within easy reach of the operator and must not cause him any undue exertion or unnecessary delay.

Where there is a sufficient quantity of pieces and the parts lend themselves to magazine or hopper feed, these must be included in order to assist in the handling of work. If the parts are heavy or bulky, mechanical or electrical handling devices must be provided in order to secure high production.

Speed. Several years ago speed bosses were practically unknown, but with the advent of the automobile era has come this type of functional foreman and with him a demand for readily obtaining in a given machine the proper speed and feed for the work. To meet this ever-increasing demand machine-tool manufacturers have in general incorporated mechanical speed-change heads and quick-change gear boxes for feed variations in their machines. Motors of the variable-speed type are used when mechanical changes are not available.

It is interesting however, to note certain specific conditions which, although contrary to the general demands, have worked out in the most gratifying manner. During 1912 and 1913, in a well-established automobile plant in Detroit, the production of

[1] Abstracts of papers presented at the Spring Meeting, Chicago, May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[2] Chief Engineer and Designer, Reed-Prentice Co., Mem. Am.Soc.M.E.

transmission parts was receiving the most careful consideration as to the best method to adopt to materially increase their already heavy production. It was finally decided to adopt a single-purpose lathe having one speed and one feed, properly calculated to obtain a maximum production for each individual piece.

The Reed-Prentice Company, of Worcester, Mass., placed the first of these single-process automatic lathes into actual operation, and much to the satisfaction of all concerned the production was increased from 25 to 50 per cent. Additional machines of the same type were then installed in larger batteries and in each case the production was increased proportionately.

The theory of establishing a single speed and single feed was to eliminate the judgment of the operator and to predetermine the day's output. If this was not obtained the cause was readily detected and almost as readily remedied.

In the machine referred to certain features were introduced which permitted the increase in production. The spindles were much shorter than in a standard lathe, while the bearings and journals themselves were longer than ordinary and much larger in diameter, with the journal bearings of the spindle carbonized, producing glass-hard surfaces.

The driving gears were extremely wide and of the herringbone type to permit smooth action under high speed without any perceptible vibration. The rack and pinion were hardened, as it was discovered that under actual production conditions the severe strains to which these parts were submitted finally bent the teeth very perceptibly and caused them to wear out rapidly.

The handwheel type of tailstock was replaced by a cam attachment for quick approach and withdrawal of the spindle, permitting a travel of from one to three inches according to the requirements of the work.

In order to obtain the squaring of the shoulders during the actual process of turning, a back-arm attachment was incorporated, actuated by the travel of the carriage so that when the longitudinal turning was completed the shoulders were simultaneously finished, thus producing the squaring operation at practically no additional cost. This, however, was not an absolutely new feature, having been previously employed.

To further assist in speeding up production multiple tools are used, and when the pieces are in sufficient quantity and adapt themselves to multiple operations, single-purpose machines of special design are brought out.

A very simple but most efficient method for securing quantity production is to use several arbors, some for loading while the others are working. Also, when applicable, a punch press is used for an arbor press, simultaneously loading one arbor and unloading another, this of course being used only where a battery of machines are operating on the same kind of work and call for a number of arbors of the same size, and where a conveyor is used to carry the work from the press to the lathes and return.

Air cylinders and quick-action, mechanically operated chucking or gripping devices are used wherever possible. Magnetic chucks and plates are also in extensive operation.

Lubrication. The seriousness of having 25 to 100 separate oil holes spread out promiscuously all over a machine is beginning to be realized. The neglect of any one oil hole invariably causes a hold up of production and may mean the entire dismantling of the machine. Therefore it becomes obvious that to control the lubrication from one point is decidedly advantageous. This is accomplished either by supplying a reservoir having gravity feed, by gear pumps delivering lubrication to the various bearings, by the use of the splash system, or by use of force-feed oilers. In fact, there are several methods, all of which are worthy of consideration.

Safety Devices. The working forces of automobile factories comprise many who never saw a machine tool prior to their employment, and it is this class of help that has made it necessary to safeguard every moving part of a machine to prevent them from getting injured. Years ago gears were left exposed and shafts allowed to run in the open, but the machines of today must include guards over every part that is in the least dangerous. Projecting shafts must be guarded, and where it is impossible to supply guards as part of the machine, rails or nettings must be secured around the machine to prevent any possibility of injury.

INFLUENCE OF THE AUTOMOBILE ON GEAR CUTTING AND GEAR-CUTTING MACHINERY

By Henry J. Eberhardt,[1] Newark, N. J.

During the past 20 years the interest of many of our engineers has been especially centered on the successful production and operation of automobiles and particularly automobile gearing.

To produce perfect and noiseless gearing, the trend of effort in gear making has been to produce accurate and rigid machines and cutters. The evolution of these elements divides into periods of great activity. The first period is that of the use of forms, and cutters made to the tooth form, nearly all of the industrial spur and heavy bevel gearing being cut by these means at the present time. Many early gear-cutting machine designs have become obsolete—the 1899 catalog of a prominent international machine-tool dealer illustrated thirteen gear-cutting machines, only three of which are being made today. Machines of this type have been redesigned to use the new alloy high-speed-steel cutters, and are, in the main, rugged examples of specialized automatic machines for the production of gears. As a rule, however, these machines will stand more punishment than the high-speed-steel cutters they use.

The second period is that of the use of gear-tooth generating machinery designed to generate tooth curves from the basic mechanical elements, the straight edge and the circle.

Great credit for early leadership in this period of gear-tooth generation is due to Edward Sang, who in 1827 read a paper before the Royal Scottish Society of Arts, the principles of which he finally crystallized in a treatise published in 1850 and entitled A New General Theory of the Teeth of Wheels.

In this work Professor Sang described a gear-generating machine using a rack-shaped cutter for generating all numbers of teeth; and also a generating machine using a pinion-shaped cutter for the same purpose. All successful gear-generating machines of today are but modification of one or the other of these two types.

The larger proportion of automotive gearing has been made by machines in this second group. However, the exacting requirements of very high-speed gears are not altogether satisfied. Many deviations from theoretical tooth curves have been made, and many changes in the proportions of gear-tooth sizing have been tried, with varying degrees of quiet running at critical speeds.

The third, or present, period of gear making is that in which the cutters are ground after hardening, and which is very prominently exemplified in the recent production of hobs with teeth ground on the top and sides; and also in which the gear tooth is ground after having been hardened. It appears that we are at the very threshold of this period. Several factories are rough-forming their gears on machines of the first and second groups and finishing by grinding.

With finish-grinding of the teeth it is becoming apparent that theoretical generating processes are not essential for the first cutting operation in the soft material. This has led to the production of simple specialized roughing machines, several having multiple spindle features for operating upon more than one blank at a time.

As high-speed-steel cutters are subjected to a melting-point heat in the hardening process, their surfaces become somewhat roughened and oxidized; therefore the value of grinding these cutters, even for roughing purposes, is clearly appreciated by the manufacturers of large quantities of high-grade gearing in a keen competitive market. Grinding such cutters on the top and sides, as well as on the front face of their cutting teeth, removes the roughened layer of oxidized steel and leaves the cutting edges smooth and keen, giving them cutting and wearing qualities much superior to those of an unground cutter.

These refinements of accurate gear making have brought gears to a more advanced state of perfection than the bearings of the shafts carrying them. In the general industrial field, machinery is designed relatively heavy—up to the point of clumsiness—and toothed gearing is given a large factor of safety. Considering

[1] Secretary, Newark Gear Cutting Machine Co., Mem. Am.Soc.M.E.

the automobile as a machine, it is designed relatively light—down to the breaking point—and yet is surprisingly efficient and lasting. Light gear bearings mounted on a flexible foundation will throw the gears out of position for the correct operation of exact tooth curves.

There is also a doubt in the minds of many engineers as to the desirability or mechanical value of adhering to theoretically correct tooth curves. Mr. Hugo Bilgram, in his U. S. patents granted in 1904 on a process and a machine for modifying the shape of gear teeth, refers to the humming noise of theoretical-form gears when running at high speed in the following words:

This may be accounted for as follows: The teeth of wheels, when properly constructed, are made so that one pair of teeth make contact before the exit of the preceding pair, and for a sensible space of time two pairs of teeth remain in simultaneous contact. When the teeth are formed theoretically correct, the pressure to be transmitted will be uniformly shared between the two points of contact while two pairs are in contact, and upon the exit of the receding pair will suddenly fall upon the one pair still remaining in contact. As the succeeding pair come into contact the pressure is again suddenly divided between the two points of contact. This sudden change of pressure and especially the fact that the entering tooth will be expected to instantaneously take one half of the full pressure, readily accounts for the series of shocks manifesting themselves in the humming noises. This noise may be materially reduced if the teeth are so formed that each tooth shall at first take only a small fraction of the pressure to be transmitted and that, as the movement proceeds, the pressure upon the approaching pair shall be gradually increased, while that of the receding pair shall be correspondingly reduced, so that the pressure shall be transferred gradually instead of suddenly from one tooth to the following one. This can be obtained by slightly relieving either at the point or near the base, or both, the surface of the otherwise correctly formed tooth.

In 1902 the author used a gear-generating hob to obtain a similar result. Various successful modifications of tooth forms are being used today. One of the most prominent to be rapidly accepted is a spiral bevel gear, the bearing surface of which is relieved at the large and small ends of the teeth, giving smooth operation even under slight shaft and bearing deflections. The straight-tooth bevel gear is being made with tooth lengths of one-quarter the cone distance, whereas formerly the lengths were from one-third to one-half of the cone distance. Many other variations and special forms are being advocated.

RELATION OF POWER PRESSES AND DIES TO THE AUTOMOBILE INDUSTRY

By Henry J. Hinde,[1] Toledo, Ohio

The art of producing sheet-metal stampings from a flat sheet while cold has made marked progress in recent years, and many articles are now made of sheet metal which were formerly produced by casting or forging, or in a lathe, milling machine, drill press or at the bench.

Forming and stamping operations especially have in many classes of work become very complex, and the art of drawing sheet metals, stimulated by the enormous demand of the automobile industry in particular, calling for most intricate shapes, has reached a state of perfection hardly imagined possible a few years ago. The results achieved by the ingenuity of the present-day press and die designers, and to no small degree also by the metallurgist, who comes into consideration through his improvements of the physical qualities of the metals used, are indeed revelations in economy of production, strength of stamped articles and the absolute interchangeability and beauty of appearance of the finished products.

The development of power presses, together with that of dies and special tools, has been so marked in the last twelve years, principally because of the demand for intricate stampings for the automobile trade, that it is believed a far greater advance has been made than at any other period in the history of the business. This development has not wholly been confined to the working of sheet metal, for, as previously stated, the demand for accurate duplication of parts and the great quantities in which they are desired has resulted in power presses being used for sizing forged-steel parts which were formerly finished by means of saddle milling and similar operations. It has been found that manufacturers can produce greater quantities with much greater accuracy and with such a reduction in machine-shop production expense by the use of what is known as knuckle-joint or cold-swaging presses in sizing the finished working surfaces on these forgings, that a number of equipments have been installed for work on steering knuckles, brake levers, connecting rods and other similar forgings and castings. These presses are built in sizes capable of exerting a pressure up to 2000 tons and over, and it is claimed that size limits of 0.001 in. can be successfully maintained in operations of this character.

Although this marked advance is due to the automobile industry more than to any other one factor in recent years, at the same time the economical production of motor cars was made possible solely on account of the ability of the press and die manufacturers to successfully control the flow of the cold sheet metal into certain forms and shapes, by means of properly constructed dies and presses of such power and design that wonderful results have been obtained. As an illustration of this a wire-wheel hub is shown in Fig. 1.

This hub requires a blank $16\,{}^1/_2$ in. diameter and ${}^5/_{32}$ in. thick. Attention is called in particular to the numerous niches or pockets successfully formed into the circular shape, and also to the fact that the stamping was first drawn to a considerable depth at the narrow neck. The end of the neck or bottom of the stamping was then removed and this metal was made to flow back and expand to a considerable degree beyond its former small diameter without even stretching or thinning the metal in the reforming operations,

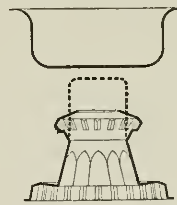

Fig. 1 Pressed-Steel Wire-Wheel Hub Formed from Blank $16\,{}^1/_2$ in in Diameter and ${}^5/_{32}$ in. Thick

thus proving conclusively how successfully the metal was controlled and forced to flow back into its larger diameter with an opening in the bottom much smaller than the former small diameter of the neck of the stamping.

In the production of brake drums, front and rear hubs and spoke flanges the conditions that have to be fulfilled by the dies are that the product shall be absolutely interchangeable; that no machine work shall be performed upon the stampings when coming from the press, excepting some reaming and thread cutting; and that the strength of the material shall remain unimpaired. In addition it is imperative that all cylindrical parts be smooth and true and of standard diameter, allowing less than the commercial tolerance of variation. The work involves a most careful planning of the interrelation of the several operations, so that at no time the material shall be overstrained or reduced in thickness, and that the dies shall not be subjected to excessive wear in order to maintain uniformity of size.

A straight-column press has been developed especially for such work by the Toledo Machine and Tool Company which is of unusually rugged proportions and weighs about 145,000 lb. It is double-geared with a ratio of 40:1 and fitted with a very powerful friction clutch in combination with an effective brake and hand-lever control, so that the machine may be started or stopped at any part of the stroke of the slide up or down. The frame consists of four pieces—the bed, the two uprights and the crown—which are held together by four massive tie rods passing through the said crown, uprights and bed. When the frame is assembled these tie rods are heated. The nuts are then screwed home and the rods permitted to cool. In this manner, through the tendency of the rods to shrink, an enormous pressure is exerted by the rods upon the frame that renders the entire structure practically an integral one and brings all the working stress upon the tie rods.

Axle housings are made of steel plate up to ${}^5/_{32}$ in. in thickness, and the requirements are that the stampings be perfectly straight and flat so that when the two halves of a housing are joined

[1] President and General Manager, The Toledo Machine and Tool Company.

together by welding they form a perfect casing without warp. A powerful double-crank press developed for this purpose weighs about 95,000 lb. and is capable of forming and stamping cold at one blow axle-housing halves about 40 in. in length of steel plate up to $^5/_{32}$ in. in thickness, the blank having been cut previously to proper shape.

One modern form of toggle drawing and deep-stamping press, such as is used for making engine pans, radiators and other similar articles of the comparatively lighter gages of metal, has two slides, an outer slide for clamping the blank and holding it while the work is being drawn, and an inner slide for doing the drawing, stamping and forming operation. Presses of this character are also made in the double-crank type with a considerable distance between the uprights and weighing as much as 600,000 lb. Such presses are used for body forming, for making cowls, dashes, fenders, etc.

The forming of channels and side rails for automobile frames and similar requirements has resulted in the designing and building of special presses particularly adapted for this work. The side rails, for instance, are preferably first blanked in a double-crank press as much as 218 in. between the uprights. The largest sizes of these presses weigh in the neighborhood of 500,000 lb.

The forming operations are performed in a specially designed press, the outstanding feature of which is that the operation is diametrically opposite that of the ordinary toggle drawing or deep-stamping double-action presses. The channel-forming press has a movement entirely mechanical that brings the tools down and at rest on a flat blank, or sheet, by means of a toggle motion, and in this position the machine is capable of a resistance pressure upward of 2000 tons. While this first toggle movement is at rest, another movement is brought into play, forming up the sides of the channel or frame. The machine in its operation completes the one cycle when the stamping lies on the face of the dies completely formed, with the result that the web, or bottom of the stamping, remains as flat as it was in the original sheet. In other words, the bottom or web of the channel is held perfectly flat during the operation. Several of these presses have been built and are in most successful operation. They weigh upward of 600,000 lb. each. One of these presses with five men will do the work of three hydraulic presses with fifteen men, to say nothing of the large force required to straighten the rails when hydraulic presses are used.

Still another interesting feature that the automobile trade has developed is the smoothing-out process for certain of its stampings, more particularly the tapered, stamped-steel radiator front or casing. Because of its slightly tapering form it was found difficult to produce a stamping for this piece so free from waves, or buckles, that it would show smooth over the finally enameled and varnished surface. The requirements were successfully met by developing a set of tools to receive the finished stamping and allow an exceedingly small space for water to flow just inside of the stamping around the steel form supporting the stamping. It was necessary to exert a pressure of some 2000 tons on the outer surface of the stamping to prevent seepage or leaking, and to supply water to the die through a $^3/_4$-in. pipe by means of an accumulator with sufficient force to smooth and iron out all of the unevenness and waves in the original stamping.

THE INFLUENCE OF THE AUTOMOBILE ON LATHE PRACTICE

By Ralph E. Flanders,[1] Springfield, Vt.

Within the memory of the author, the design of machine tools has been deeply affected by a number of influences. The first of these was the bicycle craze of the 90's. An important result was the development of the hand screw machine in the direction of heavier drive and feeds and stiffer structure to meet the demands of work like hub forming. Another line of improvement lay in the design of highly specialized machinery for the making of a single part. Such machinery had been almost unknown up to that time, as the bicycle gave the first opportunity since Civil War days for continuous production on work of moderate size. Machines of this new type were applied to spoke and nipple making, hub drilling, chain-link manufacture, sprocket and gear cutting, etc.

The second great influence was the invention and development of high-speed steel by Mr. Taylor and his associates. The effect of this invention began to be strongly felt in the first five years of this century, and was the chief factor in a continuous policy of redesigning for cutting power and rigidity which has been going on until the present time.

Meantime the high-speed tools themselves have been improved, while the ability to treat them and, still more, the courage to use them to the limit, have been steadily developing. As a consequence there has been a contest between the machine and the high-speed cutting tool much like the classic rivalry between the projectile and the armor plate. As soon as a machine was designed to use high-speed tools to the limit, better tools were provided and speeds and feeds were demanded which were beyond the capacity of any known machine.

The last important influence was that of the automobile. This statement is made advisedly, as the war, so far-reaching in its effect on human life and history, made really little lasting impression on machine-tool practice. A few special processes were fostered, such as thread milling and form grinding. A really revolutionary advance was made in gaging, inspection, and interchangeability in general. This was induced by the necessity for assembling together parts made in widely scattered factories. But the effect on machine tools themselves and their actual operation now appears to have been negligible.

If we study the influence of the automobile on machine-shop practice, we can see why this is so. The industry, long before the war, developed to the point where parts were made in such quantities that most of the operations could be made continuous, one machine or many being set up and tooled for a single operation on a single piece, remaining on this operation hour after hour, day after day, and month after month. In spite of the immense amount of machine-shop work involved in the activities of the war, only a minor percentage attained to this standard condition of automobile manufacture. For the most part it was ammunition and small arms only that were made in continuous production.

Now this condition of continuous production is the ultimate goal of manufacturing development. It demands and employs every last possibility in cutting qualities of steel, power and accuracy in machines; and particularly in skill in the design of fixtures, tool outfits, and methods of machining. The fact that this goal was reached so early in American automobile manufacture explains why the war did not stimulate new developments in machine-tool practice, but rather acted as a retarding factor on the whole.

The influences just described have affected all varieties of machine tools, but this paper is limited to a discussion of lathe practice as affected by the automobile. By lathe practice is meant not only engine lathes, but turret lathes, automatic lathes, automatic screw machines, and other machines in which cutting tools act on rotating work.

For the moment, at least, machines of the best design are more than adequate to the demands of the best high-speed steel now available. Development has therefore taken entirely new directions, and the present is a most favorable moment to examine its progress.

Present progress in lathe practice is in two radically different and, to some extent at least, opposed directions. The one relates to the expanding of the machine by giving it a number of spindles with a corresponding number of tool positions. This is best seen in the multiple-spindle automatic screw machine, now used almost exclusively for standard bolts, screws and studs, and for other parts made in large quantities. It is more costly than the single-spindle automatic, but not much more complicated, the cost arising principally from the extreme accuracy necessary in the indexing and spacing of the spindles. The difficulty of obtaining this accuracy is the limiting feature of the machine, but its scope is constantly increasing.

As applied to larger machines for chuck work on castings, forgings, etc., the machine becomes more elaborate, approaching the conditions of a number of separate machines united on one base. This results in considerable complication and cost, but spectacular producing capacity in many cases. There is the further advantage

[1] Manager, Jones & Lamson Machine Co., Mem. Am.Soc.M.E.

that the tooling—being spread broadly over the different positions—is simple, open, and easily adjusted.

The second line of progress is in the direction of providing machines having a large surplus of driving and feeding power and of rigidity. The limitation on output and accuracy now becomes an entirely new one. Instead of asking, "What will the machine stand?" or "What will the tool stand?" we ask "What will the work stand without springing, breaking, chattering, or tearing from the chuck?" The engineering problem thus becomes one of operation sequence, support for the work, tool design, and—in some cases—design of the work itself.

FUNDAMENTALS OF INTERCHANGEABLE MANUFACTURE

By Chester B. Lord,[1] Battle Creek, Mich.

In dealing with so broad a subject as interchangeable manufacture, it is well to remember that in the course of time many false traditions and pseudo-scientific conditions are built around a process or system, either glorifying it unduly or condemning it beyond its deserts. This makes it necessary to be iconoclastic and tear down that we may build upon a firmer foundation, sometimes rearranging the former material and sometimes rejecting it. Likewise, it is well to start out with certain fundamentals plainly stated, and any discussion or theory that contravenes these fundamentals is useless for our purpose.

The first fundamental is that no two things are alike; the second, that the difficulty of maintaining accuracy increases in geometric ratio with each added accurate dimension on the same piece; the third, that no machine or tool under stress can be accurate; the fourth, that the manufacture of interchangeable parts in quantity is a matter of percentage; and the fifth, that irrespective of the method used, quality is a matter of insistence.

The nearest approach to mechanical perfection that we know of is found in the Johansson gages, or was until the advent of the Hoke gages; but within their limits these are by no means interchangeable and the interferometer shows not only a variation in size but a difference in parallelism of the same piece.

Securing one very accurate dimension on a piece is a comparatively simple matter. The ease of securing two accurate dimensions, however, depends upon the relation of the second to the first. The figures given in the following table are based upon practice and general impressions, but the author believes them accurate enough to justify their publication for the purpose of showing the high cost of unnecessary accuracy:

No. of Dimensions on One Piece	Probable Number of Perfect Pieces	Per Cent Estimated Increase in Ratio of Cost per Operation
1	100	0
2	90	30
3	50	75
4	15	100
5	5	200
6	0	500

In making the foregoing statements the author has in mind automatic and other machines where the close-dimension work is done at one setting and in manufacturing quantities. Some will dispute the figures given in the table and will declare that it is not good practice to attempt finishing pieces in the automatic, but that they should be roughed out there and finished on a shaving lathe or elsewhere. This brings us to our third fundamental and we may ask, Why should they not be finished complete when a good automatic must, in the nature of things, be (and is) as accurate as a single-purpose machine *on a single accurate dimension?* It is not accurate on several close ones, however, and accepted practice confirms this statement; and the reason why it is not and cannot be accurate is because of conflicting stresses.

There are many firms the engineering departments of which really believe they are producing an interchangeable product of close dimensions, but their inspection and manufacturing departments could tell a different story. It is not bad workmanship or lax inspection that is responsible for their failure to produce such work, but the—ofttimes—unnecessarily close tolerances specified on unimportant dimensions, or the insistence of close ones on several dimensions of the same piece, and it is well to stop and consider what may happen, say, to a piece of apparatus after it has been in service for some time when initially it required the centers of two shafts to be held within one-half thousandth of an inch.

Interchangeable manufacture requires both *relative tolerance* and *specific tolerance.* Relative tolerance has to do with its relation to the part to which it assembles and does not necessarily affect the tolerance of the specific dimension. Specific tolerance is that tolerance on a specific dimension required to render a particular part easy to manufacture, or to take care of the wear on tools. Any part increases in cost with each succeeding operation, and the probability of loss should decrease in the ratio of its added value. This result should be obtained, first, by a design having in view its relation to subsequent machining operations, and, second, through the proper sequence of operations relative to their difficulty, and sufficiently divided. This leads us up to the question of registration. Automobile-engine builders cast lugs on their cylinders to insure parallelism of bore; adding-machine and phonograph castings sometimes have bosses cast on, to take the pressure of milling or drilling operations. It is also true that sometimes we insert a pin in a drilled hole to guard against movement, but we do it only at times and usually as a matter of convenience, whereas it is a matter of necessity; and it will usually cost less to drill special holes or machine special lugs for registration and resetting than to attempt to do the work in fewer complex operations.

And nearly as important as registration is the question of clamping. One of the fundamentals laid down was that a machine under stress could not be accurate. This is just as true of a piece being machined, and unless a part is designed with its subsequent machining operations in view; unless it is supported sufficiently near its pressure centers; unless it has a three-point support with the holding or clamping pieces immediately over them (and in the case of a drill jig, independent of the part that carries the bushings), then that piece cannot be accurate. This is true of drilling always, of milling generally, and of turning sometimes.

How tolerances shall be indicated; whether they shall be identical, independent, or overlapping; what the law of probability and what actual trial demonstrate as the probability of overlapping or identical tolerances interfering; the percentage that may be expected at different parts of the tolerance, and the lessons to be learned therefrom are subjects calling for extended treatment by themselves. The same is true of inspection, of machining methods, of analysis of product.

The automatic screw machine will, of course, always be with us, for in that we meet ideal manufacturing conditions as nearly as they may be met. But the fact that the single-spindle screw machine persists and is even exclusive in the small-part field, is still further corroboration of the price we must pay for accuracy. The question of accuracy is of course relative, as is the question of rigidity of machine; but it is important in its bearing upon the cheapness of manufacture by determining the number of cuts, retapping, reaming, grinding, etc., that are necessary.

The law of compensation applies to mechanics as well as elsewhere in industry, and when we attempt to work to closer limits at the expense of increased operations, we must pay somehow. This is not to be considered as an argument against such a procedure, but an appeal for common sense in interchangeable manufacture—not to make the work easier, but to reduce the cost—and the firms that are really making a good interchangeable product are those that have analyzed all the different conditions and hold the extremely accurate dimensions at a minimum.

Neither should it be thought from what has been said that close dimensions may not be necessary or desirable. Some companies require them much closer than do others. It then becomes a question of whether the price received for the finished apparatus is commensurate with the close limits imposed. If not, then it is a matter of increasing the tolerances so as to permit manufacture on a cheaper basis. In other words, the percentage of rejections that can be tolerated must be figured out and kept within that limit. For instance, on an apparatus costing $10.00 for which a liberal price is asked and received, an allowance of 50 cents per apparatus for rejections may not be excessive. If, on the other hand, the price is close, 50 cents may mean the difference between profit and

[1] Works Manager, Advance-Rumely Co., Mem. Am.Soc.M.E.

loss. This is a matter of policy to be settled by the administration and not by the shop, although we very often lose sight of this fact.

In the author's opinion there are no such things as close tolerances. All are relative and we only court trouble when we try to take too many steps at once. One-half thousandth is only five per cent of ten thousandths, and the chance of securing that accuracy in quantity in one step is about five per cent multiplied by the extra cost. But one-half thousandth is *fifty per cent* of one thousandth and the probabilities are increased in the same ratio, so we may lay it down as a truism that subdivided operations are a function of accuracy.

Analyzing our fundamentals, we find that there are three ways in which interchangeable parts may be secured:

a By obtaining a percentage of good ones, with close tolerances
b By giving individual attention to each piece
c By employing liberal allowances

The first is wasteful and the second is not manufacturing; the third one means liberal unnecessary allowances and close necessary ones, with the operations so divided that each individual working upon the part has but one thing to do. Thus, on a small shaft with six diameters all ground to a 0.0005-in. limit, there should be six roughing and six finishing operations because different wheels may be used; because less skilled men may be employed with less chance of scrap; because the wheel will be in better condition and will not need dressing so often and the operator will not have to change his sense of proportion, "hog off" material one moment and hardly touch it the next; because the finishing operations may always be done on the most accurate machine; and last, but not least, because as a rule one man can finish more work to close dimensions in four operations than four men can in one operation.

Let us not delude ourselves, however, that interchangeable manufacture or standardization is all profit and has no penalties. The French, even in large business, recoil from the idea of standardization, and this feeling has saved them through the ages from the rigidity of an arrested civilization. I am not competent to say whether the artistic qualities of the French are the result of their fight against standardization or whether it is the cause. Suffice it to say that no country that manufactures on the scale that France does and employs standardized methods, can either duplicate her excellence of manufacture or produce the artistic or scientific results she obtains. We must somehow pay for the repetition we call standardization, specialization, or interchangeability, and as usual the toll is collected from the intellectual.

DISCUSSION AT THE MACHINE SHOP PRACTICE SESSION

THE discussion was opened by Luther D. Burlingame[1] who spoke of the influence of the automobile both on the use of the machine tool in their manufacture and to its use in providing the tool and gage equipment needed for quantity production. In the case of the milling machine, power feeds in all directions had been added, with automatic quick return, with constant-speed drive and gear changes for the feeds and spindle speeds controlled by levers conveniently adjusted; while in the case of gear-cutting machines, the call for gears of a higher degree of accuracy and strength, combined with quiet running, brought new problems. Much study, he said, had been given to the question of the worm drive and to the development of steels and other materials which had reacted on the industry in a way to increase very noticeably the efficiency and durability of machine tools. Machine tools are depended upon in the manufacture of gages and tools and in this field of work alone, he said, there has been a special challenge to increase the degree of accuracy and high grade of workmanship needed for the manufacture of the machines needed for producing this tool equipment.

J. A. Smith[2] spoke of the need for strengthening machine tools, expressing his belief in "lots of iron." Machines could have precision without being specialized, he said, the opportunity for specialization being greater in the larger manufacturing plant having a small variety of products. There should be plenty of power, so distributed in a machine that the place of power application should be the place of failure in case of overloading. He criticized the lubrication of machine tools, which he considered the least up-to-date feature.

Chester B. Lord[3] expressed himself as being dissatisfied with the lubrication of machine tools and criticized the builders in not taking the lead in making improvements along this line. He objected to "specialization" saying that "simplification" was needed. He also objected to the many speeds and feeds.

N. W. Dorman[4] took up the cudgels for the machine-tool builders on the matter of lubrication and spoke of the thought and care with which they had considered this problem.

F. O. Hoagland,[5] chairman of the meeting, then started a discussion of the color which machine tools should be painted. Chester B. Lord said his practice was to enamel all machines upon which girls worked white, while J. A. Smith thought he would like to have machines painted a light gray. C. W. Ripsch[6] said his company's practice was to use a battleship gray, and Roger B. Garvin[7] complained that each customer would want a different color should machine-tool builders commence such a practice.

In discussing punch presses, J. A. Smith again spoke for more material, such as bigger shafts, and for the location of bearings so that they would be accessible.

Forrest E. Cardullo,[8] who presented the paper by Mr. Hendrickson, was asked to close the discussion and spoke of the fact that tools which were not primarily used in automobile manufacture had also been improved. He took sides with the manufacturer on the subject of lubrication, maintaining that it should be the duty of some one to see that machines were properly oiled. He considered the value of weight of metal in machine tools an exaggerated idea; correct design would eliminate useless weight. He was also of the opinion that purchasers of machine tools always expected more of the tool than their original requirements and for this reason were apt to brand it as unsatisfactory.

A. C. Cooke spoke of a number of details of automobile practice and design which had been adopted by machine-tool builders. One of the most valuable outcomes of the relations of the automobile and machine-tool builder, he thought, was the coöperation between them which had resulted in improvements.

Sol Einstein[9] in a written discussion, mentioned many of the improvements to milling machines which had come about through the demands of the automobile industry and of the details of automobile design and practice which had been adopted by machine-tool builders. He summed up his remarks by saying: "The automotive industry asked of the machine-tool designer automatic machines, either through modification of standard designs or machines of entirely special design—quick-acting fixtures, either hand-operated or automatically operated—more powerful and stronger machines occupying a minimum amount of floor space. On the other hand, the automotive industry supplied the machine-tool designer with a vast variety of highly successful mechanisms and constructive details, from which he could draw freely such elements and such ideas as could be adapted to the design of machine tools."

Following the discussion of these papers, Chester B. Lord presented his paper on the Fundamentals of Interchangeable Manufacture. The discussion of the paper turned to the question of tolerances, location surfaces and standards. Those participating in the discussion were Messrs. Smith, Cardullo, Hoagland and Lord.

[1] Industrial Supt., Brown & Sharpe Mfg. Co., Providence, R. I. Mem. Am.Soc.M.E.

[2] Genl. Supt., General Electric Co., Schenectady, N. Y. Mem. Am.Soc.M.E.

[3] Works Manager, Advnce-Rumely Co., Battle Creek, Mich. Mem. Am.Soc.M.E.

[4] Machine Designer, Toledo Machine & Tool Co., Toledo, Ohio. Jun. Am.Soc.M.E.

[5] General Manager, Reed-Prentice Co., Worcester, Mass. Mem. Am. Soc.M.E.

[6] Chief Engr., Joyce Cridland Co., Dayton, Ohio. Mem. Am.Soc.M.E.

[7] Director, The Garvin Machine Co., New York, N. Y. Jun. Am.Soc. M.E.

[8] Chief Engr., The G. A. Gray Co., Cincinnati, Ohio. Mem. Am.Soc. M.E.

[9] Chief Designer, Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio. Mem. Am.Soc.M.E.

Limitations of Stokers Using Mid-West Coals

Two papers dealing with the limitations of stokers using Mid-West coals were presented at the Fuel Session of the A.S.M.E. Spring Meeting in Chicago, and appear below in slightly abridged form.

In the first paper the author, Mr. E. H. Tenney, discusses the limitations imposed on mechanical stokers by the use of Mid-West coals, which are characterized by higher moisture, volatile and ash contents as compared with Eastern coals; the limitations imposed by air supply and by the design of the furnace; and the effect of these various limitations on stoker operation. It is his belief that in general the application of mechanical stoking equipment to the use of Mid-West coals has proved to be eminently successful. Specially designed arrangements for air supply and to facilitate ignition of the fuel have been provided; and furnace volumes and gas passes have been scientifically studied, with the result that the most difficult problems—namely, those incident to operation at high rates of combustion—have been satisfactorily solved.

According to the author of the second paper, Mr. John E. Wilson, less progress has been made in the direction of securing efficient combustion than in any other immediately connected with stoker service. In the case of natural-draft chain-grate stokers the greatest losses are those due to the dry chimney gases and the carbon in the ash, and the possibility of making a material gain in the efficiency lies to a great extent in the ability to reduce these two losses. A certain amount of air admitted over the fire has been found advantageous when high-volatile coals are used, such as those found in the Middle West.

Capacity is governed principally by the available draft and ratio of total boiler heating surface to the grate area. Chain-grate stokers provided with forced draft operate successfully under continuous high rating, respond quickly to load requirements, and will successfully burn coal containing a large percentage of ash which fuses at a comparatively low temperature.

Underfeed forced-draft stokers in the Mid-West districts have a large number of very satisfactory operating records to their credit both from an efficiency and a capacity standpoint. Some types of overfeed stokers have also been used with good success in this section where only a limited capacity was required and suitable coal was available.

The necessity of securing improved refractories as well as improving the furnace design is emphasized by the difficulties encountered with the brickwork when forced firing is employed, and it is possible that these may prove factors governing the capacity which will be obtained in future installations.

LIMITATIONS OF MECHANICAL STOKERS UTILIZING MID-WEST COALS

By Edward H. Tenney,[1] St. Louis, Mo.

A CONSIDERATION of the limitations of mechanical stokers imposed by the use of Mid-West coals is pertinent at this time on account of the increasing application of mechanical-stoker equipment throughout the Middle West, and on account of the tendency on the part of some to overlook the fact that such limitations exist.

Limitations Imposed by the Fuel

Mid-West coals are classed as bituminous or sub-bituminous, and are characterized by the higher percentages of moisture, volatile and ash which they contain as compared with Eastern coals (see Table 1). On account of these characteristics they are inherently difficult to handle satisfactorily on a stoker, but they present possibilities for even greater operating economies than in the case of Eastern coals because of the opportunities provided for even firing, close regulation of air supply, high temperatures, and a continuous and regular elimination of ash.

TABLE 1 COMPARISON OF EASTERN AND MID-WEST COALS

Constituents of Coal	An Eastern Coal[1]	A Mid-West Coal[2]
Moisture, per cent	2.21	11.90
Volatile, per cent	15.78	31.06
Fixed carbon, per cent	71.65	41.62
Ash, per cent	10.36	15.42
	100.00	100.00

[1] Pocahontas. [2] Southern Illinois.

Moisture. The moisture content in Mid-West coals ranges from 6 per cent to 16 per cent, depending largely upon the amount of surface moisture which may be present. This moisture absorbs heat from the furnace for its vaporization and superheating and tends to reduce furnace temperatures, often to such an extent as to be the limiting factor in the obtaining of proper ignition at high rates of combustion.

Volatile. High volatile content is the one redeeming feature of the Mid-West coals, inasmuch as this quality tends to facilitate ignition. With other furnace conditions favorable to the proper combustion of the liberated gases, there is little doubt but that the limit of stoker capacity is increased by the increased percentages of volatile.

Ash. The ash content of these coals varies from 10 per cent to 16 per cent, depending upon the method of mining and storing, and presents one of the most difficult limitations to their use on mechanical stokers. Large quantities of incombustible matter interfere with combustion if allowed to remain in the active fuel bed. This is increasingly true at high ratings, especially so on account of the low fusing temperature of the ash, which results in the formation of clinker and the prevention of proper air supply. The efficiency of the combustion process and the effectiveness of the stoker for burning large quantities of coal at high rates of combustion are seriously limited by this clinkering quality in the Mid-West coals. This characteristic can be closely approximated from an analysis of the ash, although the grouping of elements and the reactions at different temperatures vary to such an extent that no rule can be applied. Table 2, prepared by Mr. Edwin Lundgren,[2] shows the increase toward fusibility as percentages of certain constituents change, more particularly the ferric oxide. Ash from Mid-West coals comes between "clinkering" and "bad" in the table.

TABLE 2 TYPICAL PERCENTAGE ASH ANALYSES

Composition	Non-Clinkering	Fair	Clinkering	Bad
Silica (SiO_2)	54.67	46.23	46.40	43.50
Aluminum (Al_2O_3)	41.95	31.93	16.45	17.10
Ferric Oxide (Fe_2O_3)	Trace	14.54	18.15	28.10
Calcium Oxide (CaO)	1.82	5.04	11.80	5.30
Magnesia (MgO)	1.42	2.26	4.63	0.75
Sulphur	0.55	1.50	3.00	2.70

Limitations Imposed by Air Supply

The subject of air supply to stokers utilizing Mid-West coals is of equal fundamental importance to that of the fuel itself. In the burning of low-grade coals the distribution of air through a fuel bed heavy with ash and clinker is not conducive to its proper mixture with the combustible gases, with the result that combustion is incomplete when the gases have passed from the furnace. Such coals require large quantities of excess air, which, on account of the interference set up by the fuel bed, tend to travel in stratified streams. The mixing, therefore, is incomplete and the combustion slow. Where natural draft is utilized, it is obvious that air supply is one of the important limiting factors as to efficiency in the use of these coals. Where artificial draft is utilized, air supply is seldom a limiting factor. Care must be exercised, however, in the specification of equipment for varying qualities of fuel in order that provision may be made for sufficient capacities when burning low-grade fuels at high ratings. This involves the use of quantities of excess air at high temperatures and may become a serious limiting factor.

Limitations Imposed by the Design of the Furnace

The size of the combustion chamber, in that it determines the length of time during which the mixture of combustible gases and air will remain in the furnace, determines the amount of fuel that can be burned, and hence determines stoker capacity. For high ratings where large quantities of gas are produced and large volumes of air supplied, a limit is reached when the furnace gas and

[1] Chief Engineer of Power Plants, Union Electric Light & Power Co. Mem. Am.Soc.M.E.

Slightly condensed from a paper presented at the Spring Meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers. All papers are subject to revision.

[2] Vice-President and Chief Engineer, Frederick Engineering Co., Frederick, Md., Assoc-Mem. Am.Soc.M.E.

the oxygen in the air supply cannot remain in contact in sufficient time to completely burn the gases. With 50 per cent excess air and burning at the rate of 50 lb. per sq. ft. of grate area per hour, developing to within one-half of one per cent complete combustion of the flue gases, the Bureau of Mines[1] have determined that Illinois coal requires 11.9 cu. ft. of combustion space per sq. ft. of grate area as compared with 4.8 cu. ft. in the case of Pocahontas coal. In other words, to obtain like results at very high ratings the Mid-West coals require about two and one-half times as much furnace volume as the Eastern coals.

For high overratings with Mid-West coals very large volumes of flue gas must be handled. Resistance to the passage of these gases through the setting increases as the square of their velocity. At high ratings, therefore, the drop in pressure through the furnace and boiler increases rapidly, at 200 per cent of rating becoming four times the drop at 100 per cent rating, and at 300 per cent of rating becoming nine times the drop at 100 per cent rating. Draft pressures must therefore be adequate to overcome these high frictional losses or capacity will be limited. Location of baffles to give uniform velocities throughout the path of gas travel is an extremely important phase of boiler and furnace design which, until recently, has had too little serious attention and has been a limiting factor in boiler efficiency.

The problem of ignition offers another limiting factor in the operation of stokers using Mid-West coals, especially at high overratings. Furnace design must permit of the concentration of sufficient heat at the point of entrance of the fuel to accomplish a rapid distillation and strong ignition of the hydrocarbons. The necessity for, and the practice of, installing a properly designed reflecting arch to accomplish this is well known. The high volatile percentage of our Mid-West coals tends to facilitate ignition and is especially favorable when the volatilization may be accomplished rapidly and at comparatively low temperatures. This produces the greatest percentage of methane (CH_4), which is the simplest hydrocarbon and most easily consumed. Successful ignition also depends to some extent upon the size of the coal, smaller sizes igniting more quickly than larger lumps on account of the greater surface displayed to the heat.

Effect of Limitations on Operation

The effect of these various limitations in the case of chain-grate stokers utilizing natural draft is that maximum capacity is limited to the burning of from 40 to 45 lb. of coal per sq. ft. per hour, which may be somewhat increased at a large sacrifice in efficiency. Above this rating, however, the ash-pit loss increases excessively, and it is almost impossible to maintain ignition. In the case of forced-draft chain grates the limits as to rates of combustion are considerably higher, and greater flexibility of operation is also obtained through a more definite control of air supply. However, when the coal rate is increased beyond approximately 60 lb. per sq. ft. per hour, clinkers and slag complications make efficient operation difficult. In addition to this, temperature conditions at high ratings become such as to make furnace and brickwork maintenance a serious problem.

In the case of the overfeed type of stoker, operating under natural draft, a coal consumption somewhat less than that obtainable on the chain grate is generally recognized, this being approximately 30 lb. per sq. ft. per hour. Trouble from the avalanching of the fuel bed is reported beyond this rating resulting in breaks and bare spots within the fuel bed and temporarily limiting both efficiency and capacity. In the application of forced draft to overfeed types of stoker overratings may be somewhat extended. A test by the Bureau of Mines on a Murphy-type stoker developed a combustion rate of 50 lb. per sq. ft. per hour.

In the case of the underfeed stoker, particularly where equipped with multiple retorts and forced draft, a quick response may be had to all changes in load, resulting in an exceedingly flexible control. For continuous operation the maximum amount of coal which can be burned successfully seems to be from 900 to 1000 lb. per retort per hour. For high overratings over short periods a combustion rate of 1400 lb. per retort per hour may be established. The limiting features as to capacity and efficiency in the underfeed stoker utilizing Mid-West coals lie mainly in the high ash content of the fuel and its low fusibility, which at high overratings result in clinker formation and sometimes in the fusing over of the entire surface of the fuel bed adjacent to the dump plates. While such conditions are being rectified combustion is partially suspended, capacity limited, and efficiency low.

In conclusion, it may be generally stated that the application of mechanical-stoking equipment to the use of Mid-West coals has proved to be eminently successful. The peculiar characteristics of the fuel have called for especially designed arrangements for air supply and for ignition. Furnace volumes and gas passes have also had scientific attention, with the result that the most difficult problems, namely those incident to operation at high rates of combustion, have been satisfactorily solved. The particular type of stoking equipment best adapted to these coals may be specified as that one which most fully overcomes the many limitations to capacity and efficiency which have been found to exist.

[1] Bulletin No. 135 (1917).

CAPACITY AND EFFICIENCY LIMITATIONS OF STOKERS USING MID-WEST COALS

By John E. Wilson,[1] Chicago, Ill.

The cost of stoker repairs per ton of coal burned depends to a large extent on the quantity of coal consumed per square foot of grate surface, or its equivalent, rather than on the type of stoker used. The average cost of repairs to a number of chain-grate and underfeed stoker installations has been found to be 3.7 cents and 5.4 cents, respectively, the cost of repairs to the fans and air ducts required by underfeed stokers being included in the latter figure. The chain-grate plants mentioned will burn, on an average, 30 lb. of coal per sq. ft. of grate surface per hour, while the underfeed stoker plants will average 550 lb. per retort per hour.

In considering the repair and operating records from numerous plants, the fact has been brought out that the stoker is one of the most dependable pieces of equipment in the power plant. The stoker, up to the present time, has been primarily a labor-saving device. The importance of this feature has increased with wages, together with the uncertainty and scarcity of labor. The decision to install stokers in many plants has been governed to a large extent, if not entirely, by this factor. The saving in the cost of operation effected by stokers is frequently considered along with the saving made by the coal and ash-handling machinery. In this way the total saving often appears credited to the stokers alone. Since all or part of the coal-handling, and all of the ash-handling, equipment is applicable to a hand-fired plant, care should be taken to make a distinction between these figures. The quantity of steam required for driving stokers, also for draft fans, should in all cases be charged against stoker operation when considering these costs. The quantity of steam required for this purpose will vary from 0.3 per cent on stokers using natural draft to 3 per cent where induced or forced draft is used.

Mechanical Stokers from the Standpoint of Efficient Combustion

Upon considering mechanical stokers from the standpoint of efficient combustion, it is apparent that less progress has been made in this direction than in any other immediately connected with stoker service. The saving due to the increased efficiency obtained with stokers over hand firing will cover only to a small extent the fixed charges on the increased investment required by the stokers.

Chain-grate stokers operating under natural or induced draft have been used extensively through the Middle West for a number of years. In supplying coal to the stoker magazine it is the usual practice to feed it from an overhead bunker through chutes. In gravitating down the chute the various-sized pieces of coal have a tendency to separate from one another. This action causes the coal to be delivered in the magazine with the small coal in the center, increasing in size toward the ends. The result of this is a marked tendency for the fire to burn off unevenly. The use of overhead

[1] Traveling Engineer, Swift & Co. Mem. Am.Soc.M.E.

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lorries for weighing coal to the stoker magazine eliminates this condition to a large extent.

A large percentage of the screenings, or slack coal, used on chain grates will pass a 1/2-in. mesh screen. In some cases this fine coal has found its way to the sieving pit in such quantities as to represent 15 per cent of the total amount of coal fed to the grate. As a rule the sievings are either conveyed back to the main coal bunkers, or returned directly by hand to the stoker magazine. A comparatively small quantity of this coal on the grates will be sufficient to upset conditions in the furnace, resulting in lower capacity and efficiency. Efforts to reduce the amount of sievings by providing air openings running diagonally across the links, also by substituting skids in place of rollers, have been only partly successful.

The design and location of the furnace arch have an important bearing on the operation of a chain grate, both from an efficiency and capacity standpoint. It is highly important that the hydrocarbons driven off from the coal in the distillation zone at the front of the stoker be consumed in the furnace before having an opportunity to come in contact with the heating surface of the boiler. The ignition rate is governed principally by the design of the arch, and this affects the quantity of coal consumed to a large extent.

The following figures are those of a representative heat balance from boilers equipped with natural-draft chain grates burning Illinois coal:

	Per cent
Heat absorbed by water	70.0
Heat loss due to dry chimney gases	14.5
Heat loss due to combustible matter in the ash	5.5
Heat loss due to burning of hydrogen	5.0
Heat loss due to incomplete combustion of carbon	1.5
Heat loss due to moisture in coal	0.5
Heat loss due to moisture in air	0.5
Heat loss due to radiation and unaccounted for	2.5
	100.0

It will be seen from this that the greatest loss from any two combined sources is from the dry chimney gases and carbon in the ash. This indicates that the possibility of making a material gain in the efficiency lies to a great extent in the ability to reduce these two losses. The importance of reducing the excess air is apparent, since some 40 per cent of the loss due to heat carried away by the dry stack gases results from the excess air admitted to the furnace. The most serious fault, perhaps, of the chain-grate stoker is the failure to provide adequate facilities for controlling the air supply to the furnace. Adjustable dampers have been installed on some natural-draft chain grates for this purpose, but the results obtained are only partly satisfactory. If attempt is made to burn the carbon out of the ash, it is found that an increased amount of excess air is admitted through the rear of the grate.

The short-circuiting of air through the well-burnt-out ash, in addition to carrying heat away from the boiler, tends to slow down the ignition and combustion rate on account of reduction in furnace temperature. On the other hand, if the fuel bed is carried well up to the water back, an excessive amount of carbon will be wasted in the ash. On account of the conditions just mentioned, after a certain point is reached the combined loss from stack gases and carbon in the ash remains approximately the same—a gain in one being offset by an additional loss in the other.

The baffle found on chain-grate stokers at the rear of the grate helps to prevent an excessive amount of air from finding its way into the furnace between the water back and grate. The condition which tends to discount the good to be derived from the baffle is the variation in size and nature of the coal, which makes it difficult to maintain a uniform length of fire extending up to the water back at all times. The stoker baffle is necessarily located in a place difficult of access, with the result that it is likely to be neglected.

Various experiments have proved that a certain amount of air admitted over the fire is an advantage where high-volatile coals are used, such as are found in the Middle West. This will be appreciated when consideration is given to the fact that practically no free oxygen passes through an active fuel bed of a uniform thickness which would be available for uniting with the combustible gases driven off of the coal soon after it passes into the furnace. With the present stoker design there is no doubt considerable air leaking in around the ledge plates, coal gate, etc., which furnishes in a more or less uncertain way some of the air required above the fuel bed.

The chain grate disposes of the ash very successfully, even from coals which run high in ash having a comparatively low fusing point. This is a material advantage as it permits the use of high-ash coal, which is practically valueless on account of clinkers when used on other types of grates.

The various factors enumerated in the preceding paragraphs relate primarily to efficiency. Operating records from a large number of plants show that an actual operating overall boiler efficiency of 70 per cent is difficult to maintain. This covers plants where natural draft is used and boilers are not equipped with economizers.

Limitations Governing Capacity of Stokers

The capacity is governed principally by the available draft and ratio of total boiler heating surface to the grate area. With a draft of 0.35 in. over the fire and a ratio of heating surface to grate area of 50 to 1 or less, a capacity of 170 per cent of rating should be obtained without any sacrifice in efficiency. When the ratio of heating surface to grate area is around 60 to 1, a capacity of 140 per cent rating is seldom exceeded. This is based on an available draft of 0.35 to 0.40 in. over the fire.

In many installations where the boilers are equipped for induced draft, ratings of 180 per cent to 190 per cent, and even higher, are obtained with chain grates. It is common practice to use economizers in connection with induced draft.

It has been pointed out in a number of instances that small plants burning from 50 to 150 tons of coal a day operate very economically as compared with larger plants in the same district. This is due in a large measure to the fact that the supply of coal for the small plant is obtained from one source. Under these conditions the furnace design may be changed to suit the coal used, and the most satisfactory method of operating the stokers can be determined and adhered to. The coal for the large plant, on the other hand, is secured from a number of different sources and varies materially in quality and other characteristics. This requires very close attention in order to make the numerous changes necessary in the feed, air supply, etc., to suit the different coals.

Several different makes of forced-draft link or chain-grate stokers have been placed on the market in the past few years. A number of installations of this type of stoker are to be found in the Middle West. In making provisions for furnishing air under pressure below the fuel bed, wind boxes and dampers were installed in such a way as to divide the fuel bed into several zones. The control of the air supply to any zone can be regulated independently of the other sections. This feature makes it possible to admit the air to the fuel bed where it is required, and in the proper quantity. It follows that an increased efficiency is obtained, as the excess air is reduced to a minimum. The quantity of unburned carbon in the coal is also much less than found with other types of stokers. The increased investment required by the forced-draft chain grate, however, together with the increased cost to operate, materially cuts down the saving in money due to the increased efficiency. The satisfactory operation of this type of stoker under continuous high rating and the quickness with which it responds to load requirements form a very important feature. It is possible to use coal containing a large percentage of ash which fuses at comparatively low temperatures without any difficulty on this type of stoker, and at the present time is without doubt better adapted for burning the Mid-West coals economically at high ratings than any other stoker on the market.

Underfeed forced-draft stokers in the Mid-West districts have a large number of very satisfactory operating records to their credit, both from an efficiency and a capacity standpoint. The difficulties experienced with holes burning in the fuel bed, where a thickness of 6 to 7 in. is carried, are eliminated on the underfeed. This type of stoker shares the advantage with other forced-draft stokers of being able to bring a boiler up to 250 to 300 per cent rating in a very short time. The nature and quantity of ash in the coal form probably the most important single item governing the successful operation of underfeed stokers. With a heavy fuel bed the tendency is for the ash to ball up and clinker, preventing the carbon from being burnt out in the furnace. This condition at the same time tends to interfere with the continuous operation of the stoker at

(Continued on page 561)

Organization of an Engineering Society Discussed at A.S.M.E. Spring Meeting

At the Spring Meeting Business Session there was presented a paper by Morris L. Cooke on the Organization of an Engineering Society. As the subject of this paper, which was procured by the Management Division, was of a fundamental management character, the discussion thereon was held at the Management Session.

This paper, with the discussion relating thereto, is of especial importance at this time when the revised constitution and by-laws of the Society are being presented for consideration and discussion by the membership. The draft of the new constitution and by-laws is given in Part Two of this issue in parallel form with the present constitution and also with the notes of discussion presented at the Business Session. The new constitution and by-laws will be discussed at the Annual Meeting Business Session and will be presented to the membership for letter-ballot in March.

The first discussion was presented by R. M. Gates, managing engineer of The Lakewood Engineering Company, Philadelphia,

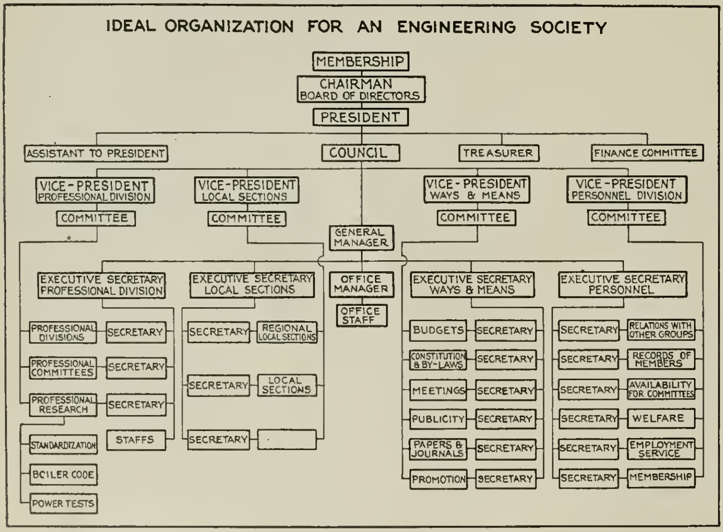


Fig. 1

and H. V. Coes, manager of Ford Bacon & Davis, Philadelphia. These gentlemen defined the engineer as a man whose knowledge of the application of the physical laws and the technic of industries enables him to direct the use of the forces and materials of nature in anticipation of and daily solution of economic needs. Stating the purpose of the engineering society to be the promotion of the technical interest of its members, they gave the following methods of procedure:

1 Technical meetings
2 Intensified technical research
3 Bureau of technical information
4 Public representation of the engineering fraternity at large.

They classified the average society membership into two groups, —those who desire to take part in the technical work of the society, and those who are interested in engineering and in committee work relating to the promotion of engineering. The latter total possibly ten per cent of the Society membership, the balance of ninety per cent being made up of those who desire to keep in contact with their fellow-engineers and those who join under any one of a number of pretenses and who are generally indifferent.

Messrs. Gates and Coes stated the problem of society organization to be (*a*) reorganization of the method by which a society functions, and (*b*) the development of a plan to secure active participation of the indifferent members.

The discussers likened the engineering society to an organization for the production of engineering knowledge and service. They discouraged the committee idea as slow and cumbersome and presented the chart, Fig. 1, showing the proposed organization. In this chart the sales or distributing division is represented by the Local Sections activity; the production department is likened to the Professional Divisions; the administrative department to the Ways and Means Division. The duties of each of the parts of the proposed organization are listed as follows:

Professional Divisions should be required to furnish the programs, papers, discussions, research. Local Sections should advertise the professional work of the Society and arrange for local meetings. The Ways and Means Division should handle the business and operation of the Society, finance, rules, national meetings, publications, etc. Each of the groups should be directed by a vice-president of the Society. Each major sub-division of each of these groups should have a manager or chairman: These would be chairmen of our present Professional Divisions and chairman of each regional Local Section.

The Board of Directors should consist of a president elected by the membership at large, the three preceding past presidents, a vice-president in charge of Professional Divisions elected by the Professional Divisions members, a vice-president in charge of Local Sections elected by the Local Section members, a vice-president in charge of Ways and Means Division elected by the membership at large, a vice-president in charge of Personnel elected by the membership at large, and a treasurer elected by the membership at large.

The Council as now constituted would become an advisory board without power to execute and would consist of the chairmen of the principle sub-divisions under each vice-president.

Because of the magnitude of the responsibilities of the president with the term of office only one year as under the present system, it is recommended that a general manager be employed who would be responsible for the operation of the society to the directorate through the president. This general manager should be virile, broad-gaged, able executive.

To handle the activities of the Society so that the present indifferent members will take active interest, these members should be subdivided into the following:

1 Engineers of confining work that have limited vision and a lack of ability to get acquainted
2 Men in engineering work in isolated territory whose inability to attend meetings makes them indifferent
3 Those who have become displeased over some method used by the Society or some difference of opinion.

To cope with this problem the fourth vice-president should direct membership relations with other groups, welfare, records of membership, employment and men available. His records should contain a complete report of the activities and the ability of each member. Those who are inactive should be approached either personally or through the mails, to impress upon them their responsibility in contributing to the welfare of the engineering profession. This division would afford them an avenue of approach to the professional, local or ways and means divisions of the Society, where they might assist on committees and participate in the carrying out of the Society's ideals. There are innumerable ways in which a department under such a division could be of great value to the membership of the Society.

H. J. Laski, of the School of Economics and Political Science of the University of London, presented a written discussion combining a number of valuable suggestions. Most important of these was the development within the A.S.M.E. of groups to undertake surveys of the regional problems of the country, pooling the results to obtain a catalog of the engineering needs and thus providing a basis for subsequent action. Other suggestions of Mr. Laski's called for representation of younger men on the Council, separation of policy from administration, and a setting up of a

research organization to make expert criticisms on public engineering products and to give advice to public authorities. He also suggested the study by the Society of conditions of appointment and tenure of engineering posts in the public service with constant scrutiny of such appointments and public announcement when they are unsatisfactory.

Dr. F. H. Newell, consulting engineer, Washington, D. C., emphasized two particular points brought out by Mr. Cooke as to the necessity for increasing the activity of the individual member and the need for an engineering organization to develop a method whereby the task of the engineer in an organized group can be kept abreast of the best thought of the profession and the times. In discussing the need for developing individual activity, Dr. Newell compared the activity of engineers in their regular employment and in the Society. In one case the man is impressed with his duty to deliver the goods and in the other case it is rarely brought to his attention that he has a larger duty or that it would be desirable to try to utilize the full man power of his associates, especially of the younger and newer members who may be regarded simply as an audience, or background against which may be displayed the special qualities of some leader in the profession. The traditional attitude of the Society may discourage the interest and activity of the younger men who should be attracted and inspired. Lack of opportunity for individual activity and a tendency to a conservative attitude tending to keep the control of affairs as exclusively as possible in the hands of a few men will repulse the younger man. Dr. Newell pointed out that in the case of the commercial organization the employee's interest is stimulated by compensation either in salary or in satisfaction received. The engineering society compensation must be entirely that of satisfaction received. This satisfaction may be personal contact and acquaintanceship rather than scientific or technical information. However, engineers are not sociably inclined. Dr. Newell stated that after a generation of attending engineering meetings he was not conscious of having enlarged his acquaintanceship in anything like the proportion which should have been possible. He emphasized the importance of making each member responsible for increase in membership, as there is no way of appreciating an organization better than by trying to convince another person of the benefit of belonging to it and taking part in its work. Dr. Newell also emphasized the necessity for direct appreciation of work done by officers and active members. Even though the recognition may be trivial in itself, it should still be a tangible testimonial of service rendered or skill shown.

In developing the idea that the engineering profession should be kept abreast of the times, Dr. Newell stated that papers and discussions have too often been in the nature of an autopsy of a dead issue rather than a diagnosis of real existing conditions. Live, debatable subjects will keep an organization awake and add to its efficiency. Many a responsible officer of an engineering society has urged that it would be impolitic and unwise to discuss such matters in open meeting; such discussions are the very things most needed at the present time. In closing, Dr. Newell emphasized again the necessity for showing proper appreciation of service freely given or offered by individuals or groups of less well-known members.

In an oral discussion S. N. Castle outlined the broadening of the mechanical engineer during the past thirty years with the coördinate development of the Society's organization. He emphasized the point that the Society must receive its impetus for growth from its membership but that this growth should develop effective citizenship by the better use of engineering and technical judgment. He strongly urged an effort to secure the interest of the young man entering upon an engineering career either in school or in an industry, so that his association with an engineering society will date from the time he commences his engineering studies.

Dean Perley F. Walker, of the University of Kansas, in a written discussion stated as important the present sentiment in favor of making our professional societies a more vital counterpart of the engineering profession. The public-service aspect is being broadened and should be reflected in a declaration of principles. Dr. Walker directed his discussion to the consideration of the definite situation in The American Society of Mechanical Engineers and in its connection with other organizations. He outlined briefly the aims of The Federated American Engineering Societies and explained its method of procedure. He stated the aims of our Society to be as follows:

1 To benefit the individual member as a mechanical engineer
2 To develop and perfect the profession in our own field
3 To render public service through (1) and (2), and locally through professional activities and as groups of citizens specially trained and qualified to speak on questions of civic and industrial importance.

The local-section plan seemed to Dr. Walker to be capable of most pronounced development in new lines, inasmuch as local groups are in touch with civic and local enterprises. He suggested the appointment of more local committees to do active and fruitful work in conservation of resources and materials and in the development of local power resources, in the investigation of industrial development, and in coöperation with the Chamber of Commerce. He stressed the conduct of a service publicity program and prophesied a program that would increase immeasurably the public recognition of the engineer.

L. C. Marburg, consulting engineer, New York City, divided his discussion of Mr. Cooke's paper into two parts: First, the improvement in organization and policy of any engineering society; and second, the broad question of organization of the entire profession. Under the first heading, speaking of the A.S.M.E., Mr. Marburg called attention to the small percentage of ballots returned at elections and the small number of members that "ever get into some part of the play." He called attention to the great development of local sections and the future of the professional divisions which would undoubtedly increase many times the percentage of participating members. He seconded Mr. Cooke's suggestion that some professional divisions be limited to members doing active work. Mr. Marburg emphasized the opportunity offered by the local sections for the development of majority rule in the Society. Mr. Marburg also seconded Mr. Cooke's point that the fullest publicity of Society affairs is required.

In discussing the place of the engineering society in the commercial structure, he analyzed the purposes for which engineers are organized as scientific or technical and public. The public aims of the society are the attempts to render the service of the group to the community and incidentally to secure public recognition for the group. To successfully develop these aims, Mr. Marburg stated the need for an all-inclusive organization, as its influence would be in proportion to its size. He sounded a solemn warning that the engineers would lose their influence upon obtaining the reputation of being a set of highbrows. He pictured the difficulty of the adoption of an ideal type of organization because of the impossibility of realizing such a type in view of previous developments. Mr. Marburg reiterated as the most important statement of Mr. Cooke's that no organization of the profession will be satisfactory which does not provide for the greatest coöperation with other groups. Although a number of public problems today are in a large part engineering there are still other public problems which require the services of a group of experts for solution and it is with such groups that engineering coöperation must be played up. In closing Mr. Marburg emphasized again that the great opportunity which the engineering profession has for gaining influence by developing the ideal of service.

Mr. Cooke's Closure to the Discussion

Before the administrative and managerial problems of the profession and of the various organizations through which it functions can be profitably discussed, every effort must be made to visualize the enlarging field of the engineer. If one can get a sense of the desired crop, seed, soil and season become measurably fixed. Method is by no means negligible. But it is of the very first importance to decide on the goal towards which to strive. Otherwise united effort is impossible and even the strong press forward less ably than they would if the common objectives were fully determined.

There are many reasons for believing that as a group we are timorous in acknowledging the high purpose to which we are in-

vited through our education and experience and ability. Somehow we must learn to rise above the weakness inherent in our capacity for specialization. If possible, we must pay even greater tribute to the individual who through painstaking and unremitting toil digs out the true inwardness of a set of baffling facts. But also we must more and more insist that the completed task include the the relating of the result of our research to that whole scheme of living for the betterment of which the engineer is, we hope, becoming the master-architect.

So in all our planning as to method we should not only always have our objectives in mind, but keep them fluid so as to be capable of easy adjustment to meet the rising standards of action within the profession and changing needs without.

Any author would be pleased with the quantity and kind of discussion which this paper has received. Nevertheless it is a bit disappointing that so little of it suggests that to the engineer belongs the task of formulating definite programs "of creation and of construction, of stimulation of human effort and accomplishment." We should abandon the theory that we are assisting some other agency such as government or society. Both the responsibility and opportunity are wholly ours—are being literally forced upon us—almost literally in its totality.

With the task so defined the outstanding change called for is to get a larger number of members of the profession actually at our group work. The suggestion of Messrs. Coes and Gates for a personnel secretary seems altogether convincing. Such an official would only indirectly be interested in projects. His concern would be the maximum number of members making some contribution to the total volume of work. Then all through the formal and informal discussion of the paper has been emphasized the necessity for getting the young men both into the Society and at work as early as possible. If any one doubts how much this is needed and demanded, let him make a trip around the country visiting engineering organizations.

No such study as this can be altogether frank or very helpful without a suggestion as to one major danger which at every turn casts at least a shadow across our path, i.e., the influence of business as contrasted with engineering considerations. Because of this we must constantly make excuses both for things done and things left undone. No other profession in its development is quite so beset. We must constantly study the technique of steering clear of these influences and dangers and so set ourselves free to work at full liberty at our appointed task.

Vernon Kellogg says that while "the biologist does have certain positive knowledge of some conditions or factors that do help to determine the course of human life," it is also true that "the course of human life is partly determined by a set of conditions which are, so far, at least quite outside the special knowledge of the biologist. He can guess and wonder about them, just as other people do, but he has no right to claim that he knows about them." And so we engineers would rarely give people cause for offense if in our discussions we could frankly separate those matters which we have reasonably positive knowledge from those in which our judgment is no better than that of other well-opinioned folk.

In the end the machinery of administration and management will adjust itself to the ambitions and environment of the profession. The largest contributions to a better organization for the group will come from those engineers who, while insisting that as individuals we shall be afforded conditions most advantageous for good work, make effective public service the final test of our success.

Analysis of the positions held by the graduates of engineering colleges shows that only fifteen to eighteen per cent stay in technical work. The major portion enter widely different pursuits, although many seek positions of executive or managerial responsibility. This situation and the need of industry for trained intelligence to direct and operate its complex activities, has caused a number of engineering schools to establish new courses to educate executives. The Society of Industrial Engineers has also planned such a course. Prof. Collins P. Bliss, of New York University, has compared eight of these courses, and in an extended article in the July issue of *Managememt Engineering* shows their make-up and gives the time allotted to each general group of subjects and to each study.

GRAPHICS IN BUSINESS

THAT over 40 per cent of the members of The American Society of Mechanical Engineers are engaged in executive and administrative work is an indication that business requires its leaders to possess qualities which are developed by engineering training and experience. The demand is greater than ever for executives well trained in the analysis and evaluation of forces and influences that affect business. With its growth in complexity business is demanding a better knowledge of its significant facts. Much of the executive's time and effort is spent in the maintenance of a proper balance among the various activities and influencing factors of his enterprise. Stimulation of some and checking of others to meet the ever-changing requirements, call for numerous and frequent comparisons of these factors on which to base judgments and decisions.

The progressive executive realizes the necessity for improved methods for getting at the facts and for performing his own work. To an increasing degree he is seeking the aid of scientific methods to lighten his burden. Accounting and statistical reports have been used extensively to convey to him the facts of his enterprise, but these leave largely to him the burden of interpreting the figures in terms of relative movements of the various factors they represent. This requires him to retain in his memory large quantities of figures or to spend much valuable time in study and reference to tables and detailed data if he is to have a comprehensive knowledge of his intricate undertaking. Frequently he is forced to resort to short-cut formulas, often unsound, as a means of freeing his mind.

The presentation of the facts of the enterprise in vivid picture form, so that the interrelations and movements are quickly grasped and easily retained, is the function of modern business graphics. The relations and movements are the significant things to the executive, much more so than the absolute values of the different factors at any given time. The weakness of accounting and statistical presentations as distinguished from the graphic method lies in their static quality and the difficulty of conveying by figures an adequate conception of movement and interrelation. Considerable mental effort is required to obtain from a table of figures a clear conception of the direction and magnitude of the movement, for example, of the volume of sales of a product over a period of twelve months. A clearer mental picture can be quickly obtained without effort from a properly designed graph based on the same figures. When, however, it is desired to show the relations of these movements to those of similar previous periods or to predetermined quotas, the contrast between the use of tables and of a coördinated series of charts is vastly greater. Contact of executives with the earlier efforts to utilize graphic charts has lead many to view them with skepticism and not without reason. Frequently such charts were designed without any apparent regard for their comparability one with another, and as much study was required for their interpretation as for the corresponding tables. Study of these earlier efforts, from the viewpoint of executive needs with a realization of the importance of comparability of the charts in a given enterprise, has led to the development of a technique of chart construction which has greatly simplified their use. Many progressive concerns have appreciated the time-saving value of coördinated graphs as a management tool for the control of their activities.

Concurrent with the development of standardization in the construction of business charts has come a marked reduction in the cost of their production—an important factor when large numbers are used. While formerly it required men of considerable engineering and statistical ability to prepare reliable and practical business-control charts, it is now possible, by the employment of standard methods, inexpensive equipments and limited instructions, to prepare them with lower-paid clerks and stenographers and with great rapidity.

The "fact" type of mind is responsible for the perfection of this tool of business, and as the engineer becomes more familiar with fields of business and finance into which he is being drawn. there is every prospect that equally satisfactory solutions will be found for the many other problems such activities present.

W. Herman Greul.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Straight-Flow High-Lift Poppet-Valve Steam Engine

By J. Stumpf

Losses in steam engines are due to cylinder condensation, clearance space, throttling, friction, leakage, heat radiation, heat conduction and imperfect expansion. It is claimed that some of these losses are reduced in the engine about to be described.

The most characteristic element in this straight-flow or "uniflow" steam-engine cylinder shown in Fig. 1 is the very small high-lift nozzle-disk valve employed therein. It became possible to give this valve such small dimensions through the employment of a valve-gear shaft running at twice the speed of the main engine shaft. For an average cut-off of 10 per cent the eccentric motion with the camshaft running at a speed of the main shaft will give a maximum valve lift of h', while a valve lift h four times as great is obtained with a double speed of rotation by means of which the central angle α is increased to 2α. Because of this a double-seated valve of 200 mm. (7.87 in.) diameter can be replaced by a disk valve 100 mm. (3.93 in.) in diameter, with a corresponding reduction of clearance space and cylinder condensation area.

The valve motion is regulated from a layshaft running at twice the speed of the engine shaft by means of a cam, of which the lift and lead are regulated by means of a shaft governor, Fig. 3. The

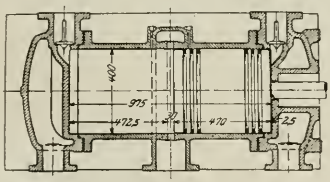


Fig. 1 Straight-Flow Steam Engine with the New Stumpf High-Lift Nozzle-Disk Valve

motion of the eccentric is transmitted to the disk valve by means of an intermediate lever and an angular lever located in the casing. The intermediate lever is made up in the form of an eccentric ring set on a rigid eccentric disk running at the same speed as the main engine shaft. The arrangement is such that when the main eccentric takes the position corresponding to the maximum valve lift

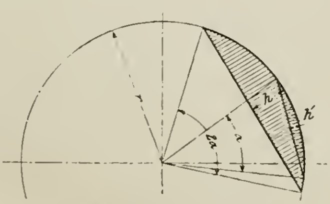


Fig. 2 Valve Diagrams

the auxiliary eccentric on the second lay shaft is in the opposite extreme position, thus producing an increased valve lift. When the main eccentric occupies the next similar position, the auxiliary eccentric reaches the opposite location so that the actions of the two eccentrics have to be subtracted from each other. The resultant valve motions are shown again in Fig. 4 by means of the Zeuner polar diagram, which emphasizes the extent of the valve opening resulting from the fact that the valve lay shaft runs at twice the speed of the main engine, and also shows the absence of all necessary motion of the valve in the opposite position. The linear lead remains the same. As a result of this arrangement it becomes possible to use small valves with a total clearance in the cylinder of between $^3/_4$ and 1 per cent and with an extremely small area of cylinder condensation surfaces. If it be assumed

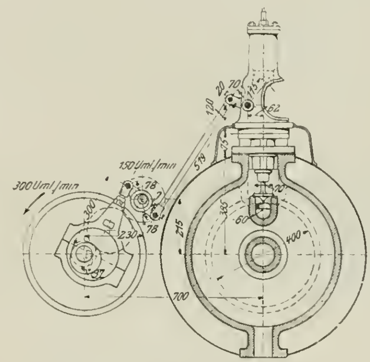


Fig. 3 Valve-Gear Drive

that these condensation surfaces are ideally small, that is, equal to twice the cross-section of the cylinder, it would appear that the additional cylinder condensation surface entailed by the use of the small high-lift nozzle-disk valve is only from 3 to 5 per cent thereof. It is claimed that this arrangement affects the reduction of cylinder condensation area in a most favorable manner, which

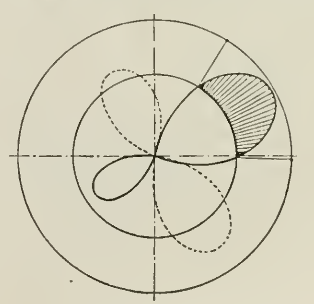


Fig. 4 Zeuner Polar Valve Diagram

is generally low in straight-flow steam engines. As regards this latter, reference is made to tests carried out on a straight-flow cylinder by Professor Nagel at the Dresden Polytechnic Institute. (The temperature diagram of these tests is reproduced in Fig. 5.) In that case only the cylinder head was provided with a jacket and the engine was operated with an extremely good vacuum. Notwithstanding this fact, during the exhaust stroke the temperature, as determined by a thermometer in the head, did not fall below 100 deg. cent. Because of the extensive temperature drop during the exhaust and because of the appearance of a very considerable percentage of moisture in the steam (as high as 20 per cent), the heat of the steam in the head was caused to flow with great energy into the rest of the steam still present in the cylinder. Of this heat practically none is lost in the exhaust. The piston

on its return stroke collects this overflow of heat by the compression of the remainder of steam to something like 2.5 to 3 atmos., corresponding to a clearance of about 3.3 per cent. The next compression occurs practically along the saturation adiabatic curve, which is joined at an angle by the superheat adiabatic curve and gives the startlingly high compression and temperature of 510 deg. cent. At the end of the admission the superheat expansion adiabatic curve joins on, and then abruptly the saturation adiabatic curve. This latter, in its last stages, is raised by the setting up of the flow of heat referred to above until the exhaust again causes temperature drop, which is, however, immediately opposed by the flow of heat from the cylinder-head steam.

However, when, by the use of the high-lift nozzle-disk valve

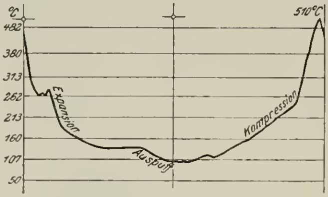


Fig. 5 Temperature Diagram
(*Auspuff* = exhaust)

the clearance is reduced from 3.3 per cent to something between $^3/_4$ and 1 per cent, the compression end pressure is raised correspondingly, resulting in a rise of compression and temperature of between 900 and 1000 deg. cent. In this connection Professor Nagel has established the surprising fact that in the same manner a final compression temperature with saturated steam is obtained

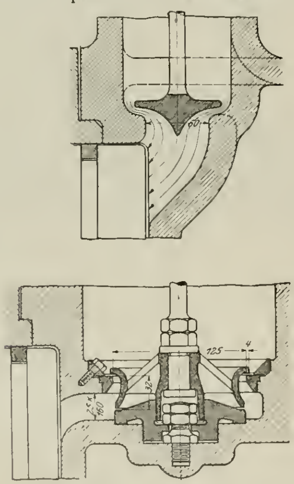


Fig. 6 Comparison of Two Kinds of Engine Valves with Same Area of Steam Passage: Above, High-Lift Nozzle-Disk Valve; Below, Double-Seated Valve

100 deg. cent. higher than with superheated steam, which is probably attributable to the higher heat conductivity of saturated steam.

If, however, these favorable heat conditions are combined with small cylinder condensation surfaces as becomes possible with the new high-lift nozzle-disk valve, it may be ultimately possible to do away with cylinder condensation entirely.

The upper part of Fig. 6 shows the new high-lift nozzle-disk valve operated by a lay shaft running at twice the speed of the main shaft, as compared with the double-seated valve of standard design below it, and also their relative dimensions. It is also claimed that the new valve is considerably simpler and cheaper both in manufacture and in installation. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 19, May 7, 1921, pp. 492–494, 7 figs., *d.*)

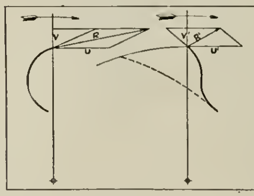
Short Abstracts of the Month

AIR MACHINERY

Centrifugal-Fan Design

Some Developments in Centrifugal-Fan Design, F. W. Bailey and A. A. Criqui. The authors claim that when multiblade forward-curved-blade fans supplanted the older type of straight radial-blade fans, two very good characteristics of the old blade fans were lost. One of these was the pressure curve which rose continuously with the decrease in capacity, and the other was the power curve which increased constantly with increasing capacity. In the forward-curved-blade fan the pressure curve drops or flattens with decreasing capacity within the working range of the fan, while the power curve has a more abrupt rise as the load increases, a combination which sometimes causes serious trouble in fan installations. The flat portion of the pressure curve makes the fan very sensitive to resistance variations, and if used at a capacity corresponding to this portion of the curve may make the fan run under or over the estimated capacity. This is particularly so if the friction of the system is slightly greater or less than was estimated or if an existing duct system is changed with the consequent change in resistance.

With a directly connected unit, when a fan which has an abruptly rising power curve runs above the estimated capacity, there is a decided danger of overloading the motor. With a motor-driven forward-curved-blade fan run at this critical point in its range, it is necessary to supply an excess of motor power with a probability of running the motor at reduced capacity and therefore reduced efficiency to guard against the possibility of the fan overloading. This represents a perpetual insurance payment when using a forward-curved-blade fan under these conditions. The flat or drooping portion of the pressure curve also causes trouble in double-width fans, or when two single fans blow into the same duct system, provided that the capacity comes within the range of this flat portion of the curve. If there is some difference in the resistance at the two inlets, which frequently happens, the capacity of one wheel will be reduced without any corresponding increase in pressure and this wheel then has no power within itself to regain the load, with the result that sometimes air will go in only one inlet of a double-width fan and the other wheel will merely churn the air in and out of its inlet.



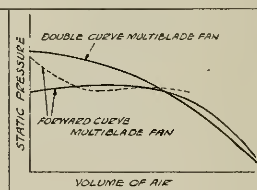


Fig. 1 Fig. 2

Fig. 1 Comparison of the Forward-Curved and the Backward-Curved Designs of Blades for Centrifugal Fans

Fig. 2 Comparison of Pressure Curves of the Forward and Double-Curved-Blade Types of Fans

A desirable combination of fan characteristics would be to retain the good features of the old radial-blade fan and at the same time have the high capacity range, insuring a small housing, together with the higher efficiency of the forward-curved-blade fan. During the past few years a new type of multi-blade fan has been developed which is said to combine these good features. This fan has blades which curve forward at the heel to meet the incoming air, but curve backward at the tip to discharge the air. Thus, while the blade of the forward-curved fan is a portion of the surface of one cylinder or one cone, the blade of the new backward-curved blade is formed from the surfaces of two cylinders or two cones, as shown in Fig. 1.

Fig. 2 shows the comparative pressure curves of a forward- and double-curved-blade fan. The latter has the continuous rising pressure curve, which, when capacity decreases, builds up a presssure to overcome the added resistance. In double-width fan, when one inlet is more restricted than the other, the tendency is for less air to flow through that inlet. In such a case the restricted wheel will build up a pressure to meet the added resistance and will thus retain its share of the load. As a result, a double-width fan of the double-curved-blade type will divide the load between the two wheels throughout the whole range of capacities and neither of the parts will simply churn the air as in the forward-curved-blade type.

The original article gives also curves showing the comparative static efficiencies of forward- and double-curved-blade fans and a comparison of their power curves.

The two types are not always competing. The forward-curved multi-blade fan is preferred where very high outlet velocity is required and noise is not objectionable. On the other hand, the double-curved multi-blade fan is essentially the medium-capacity fan and lends itself particularly to that class of ventilating work where very high outlet velocities are not needed or desirable; at the same time it is decidedly a higher-capacity fan than was the old radial-blade fan.

Double-curved multi-blade fans are inherently higher-speed fans than are those with forward-curved blades and this brings up the question of specifications. With the advent of the forward-curved-blade trouble was experienced from noisy fans, which was attributed to the higher speeds at which these fans ran. Engineers and architects therefore got the habit of writing into their specifications clauses which limited the speeds of multi-blade fans in order to insure large sizes or relatively slow-speed makes. As a matter of fact, the noise had very little to do with the speed of the fan. Double-curved-blade fans do not cause as much noise and at the same time must be run at high speeds. Therefore specifications which fix low speeds would practically prohibit the use of double-curved-blade fans. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 27, no. 4, May 1921, pp. 375–380, 7 figs., *pc*)

BUREAU OF STANDARDS (See Engineering Materials)

CORROSION (See Machine Parts)

ENGINEERING MATERIALS (See also Machine Parts)

Theory of Hardening of Metals

The Slip-Interference Theory of the Hardening of Metals, Zay Jeffries and R. S. Archer. The authors define hardness as resistance to permanent deformation. Metals owe their hardness and strength to the attractive forces between their atoms. Metals, however, are also crystalline and are built up of atoms arranged in definite and repeating patterns. The regularity of the atomic arrangements gives rise to certain planes of weakness or low resistance to shearing stress.

When an external load produces on such a plane a shearing stress which exceeds the resistance of the crystal to shear on that particular plane, fracture of the crystal takes place. Fragments formed may or may not adhere to each other. If they do not the failure of the crystal is complete and it is said to be brittle, the plane of weakness being then known as the "cleavage plane." In the useful metals, more generally, the crystal fragments adhere and merely glide or "slip" over each other. In such a case the planes of weakness are called "slip planes."

Anything that serves to hinder slip is a source of strength and hardness. The hardening and strength of metals may be considered as due principally to interference with slip.

The authors express the relation between grain size and strength for pure metals by stating that the most simple source of increased hardness is grain refinement, which introduces slip interference at the grain boundaries due to the different orientations of the adjacent grains and especially in fine-grained metals to the disorganized or amorphous metal between the grains.

This theory is applied to the aging of duralumin, with respect to which the authors arrive at the conclusion that there is a certain average size of particle which produces maximum hardness, any size either larger or smaller causing less hardness. This is opposed to the generally held idea that a given amount of substance added to a metal produces the greatest possible hardening effect when it is in solution, that is, when it is in the highest possible state of dispersion.

The paper is too extensive to permit of making a complete abstract, and the following is taken from the summary prepared by the authors themselves:

Cold-working introduces slip interference by the fragmentation of the grains and the production of amorphous metal.

The hardness and strength of amorphous metal itself are due to the absence of the planes of weakness characteristic of crystals.

Slip within grains is opposed by the presence of a strong constituent at the grain boundary, provided that if the strong constituent is brittle, its shape and size are not such as to lead to effective weakness due to eccentricity of loading.

Effective hardening is obtained by slip interference within the grains, due to the presence of hard constituents uniformly distributed in the form of very fine particles.

It is not necessary that the hard constituent possess great adhesion for the matrix.

The effect of a given amount of hard constituent increases with the fineness of subdivision, reaching a maximum at an average particle size denoted by the term "critical dispersion." The critical dispersion probably consists of the smallest particles having the characteristic properties of the crystalline substance.

The order of magnitude of the diameter of such particles is probably about 10^{-7} cm. A higher degree of dispersion, particularly the atomic dispersion of solid solutions, is less conducive to hardness.

Corresponding to the maximum hardness at critical dispersion, there is a minimum in ductility.

Increase in the amount of dispersed substance produces increased hardness, but the brittleness also increases, so that there is a limit to the useful hardness and strength that can be obtained.

The amount of hard dispersed substance which produces the greatest useful strength increases as the size of particle increases.

The actual amounts of hard dispersed substances which produce useful results are from about 2 to 15 per cent by volume.

The only manner in which the high degrees of dispersion desired are produced consists in the limited decomposition of solutions, and in particular of solid solutions.

Martensite consists of a solid solution of carbon in very fine-grained alpha iron. The hardness is due chiefly to the grain refinement of the ferrite, but partly to the carbon in solution.

The tempering of martensite involves two changes: ferrite grain growth and the precipitation and growth of cementite particles. Ferrite grain growth causes progressive softening. The precipitation of cementite causes hardening, but the growth of the particles above the critical size produces softening. (*Chemical and Metallurgical Engineering*, vol. 24, no. 24, June 15, 1921, pp. 1057–1067, 11 figs., *tA*)

Wood-Reinforced Concrete

Concrete Reinforced with Wood, M. Levatel. Shortage and at times complete lack of steel during the war has given an impetus toward the use of concrete and, concurrently, a method for reinforcing concrete with non-metallic materials. The Italian engineer, Mario Viscardini, in the early part of 1918 produced concrete beams reinforced with wooden lattice work. Tests on these beams have shown that in general they behave practically in the same manner as similar beams reinforced with steel, but, of course, the numerical values of elastic limit and total strength are different. If wood-reinforced beams are overloaded they begin to crack, the cracks being larger and more clearly defined than in the case of steel-reinforced beams, but like the latter they can be easily repaired provided the stress did not exceed the elastic limit.

The same results have been obtained in tests made by Von Emperger and an Austrian commission, who have carried out an extensive

series of tests on wood-reinforced concrete beams and have found that the ratio of coefficients of elasticity of concrete and wood may be practically taken as unity.

One of the difficulties with wood reinforcement lay in the fact that in the first place the reinforcing elements had to be straight, and in the second place the stirrups could not be counted on to increase the adhesion between the concrete and the reinforcing elements. Among other things, it was found that tarring the wood reinforcing elements reduced the adhesion, whereas a wash of lime or cement, and in particular magnesia cement, over the wood reinforcing elements apparently increased the adhesion. Fur her tests by the Austrian commission have also shown that the proportion of wood to the total section of the beam should

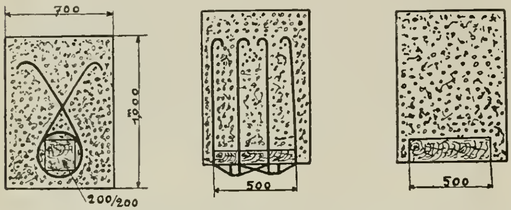


Fig. 3 Distribution of Wood Reinforcing Elements in Concrete Beams Recommended by an Austrian Commission

not exceed a certain percentage. In particular, beams of sections such as shown in Fig. 3 proved to be best.

In Germany a beam has been developed employing both steel and wood reinforcing elements (Fig. 4). In this the reinforcements which are in tension are of steel and those in compression are of wood, the latter being placed so that they form the top of the

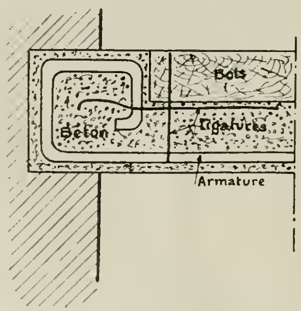


Fig. 4 German Steel-Wood Reinforced-Concrete Beam
(*Beton*, concrete; *Bois*, wood; *Armature*, steel reinforcement; *Ligatures*, tie pieces.)

beam and may be used for attaching boards, etc. Theoretically such a construction is complicated but it may have practical advantages.

One of the most interesting applications of wood-reinforced concrete has been made in the construction of the steamer *Linnea* in Sweden. This is a 700-ton vessel built essentially with the framework of an ordinary wooden ship and having concrete applied over it. The vessel has been in service on the Baltic and has apparently given satisfaction. (The original article describes an interesting method for launching it as concrete vessels cannot be conveniently launched with the usual gear.) (*L'Outillage*, vol. 198, no. 10, Mar. 10, 1921, pp. 283–284, 10 figs., *d*)

Tests of New Concrete Pressure Pipe. Description of tests recently carried out at Cleveland on a new type of reinforced-concrete pipe designed to withstand a pressure of 115 lb. per sq. in. (Failed at 255 lb. to the sq. in.) The chief feature of the design of the pipe is a longitudinally welded steel cylinder carrying a wire reinforcing mesh on the inside and outside, the whole being encased in concrete. The reinforcement is locked to the cylinder by strips of metal welded to its inside and outside faces. The ends of the steel cylinder are welded to sheet-metal hoops so formed as to take care of the expansion and contraction during the life of the pipe. The ends of the pipe are formed into the bell-and-spigot type, the sheet-metal hoops coming together in laying to form a lap joint on a bevel.

The pipe used in this test consisted of a steel cylinder 42 in. long, and 40 in. in diameter. Seven steel ribs $^5/_8$ in. by $^3/_{16}$ in. were equally spaced on the outside and inside of the cylinder and spot-welded to hold them upright. These ribs were punched with $^1/_2$-in. holes on $^3/_4$-in. centers to give a good bond with the concrete. They also acted as spacers for the reinforcing wire mesh.

The pipe was poured in steel forms from a rather wet mixture of Universal portland cement, roofing gravel with a density of 115 lb. per cu ft. and Pelee Island sand of a uniformity coefficient of 2.18 and an effective size of 0.22 mm. A mix of one part of cement, two parts of sand and four parts of gravel by volume was used.

In making the internal-hydraulic-pressure test, pressure was applied by means of a boiler test pump. At a pressure of 230 lb. per sq. in. horizontal cracks appeared in the two end sections. At 255 lb. per sq. in. a break occurred in one of the pipes. The rupture was directly caused by the failure of a large portion of the longitudinal lap weld which extended through the length of the main cylinder. In breaking, the concrete on both the inside and outside of the pipe was shattered.

An external pressure test was also applied in accordance with the method outlined by the American Society for Testing Materials.

From these tests it would appear that the wire-mesh reinforcing may be assigned a portion of the stress, perhaps the greater part of it, in which case it would seem advisable to increase the thickness of the concrete on the outside of the pipe and space the wire mesh at a somewhat greater distance from the steel cylinder. (*Concrete*, vol. 18, no. 5, May 1921, pp. 242–244, 4 figs., *de*)

Some Factors Affecting the Life of Machine-Gun Barrels, W. W. Sveshnikoff. The star-gage measurements made on six machine-gun barrels at various stages of firing indicate that when the life limit is reached, exhaustion is due to a combination of the abrasive action of the bullet and the abrasion by hot gases.

The author's experiments using the electric arc show that the rapid cooling (which is due to the large mass of cold metal near the highly heated inner surface of the steel) from temperatures near the melting point of the metal produces a martensitic layer. A similar layer is produced in firing a machine gun, indicating that the temperature conditions for development of martensite by the electric arc are similar to those in the gun under actual fire.

The selective hardening of the steel sets up surface strains, and the surface of the bore is readily cracked on account of the dimensional changes of the hardened brittle surface of the steel resulting from sudden changes in temperature between separate shots. The cracks originate at irregularities in the surface of the bore, attributable to the method of manufacture of the barrels. (*Abstract of Technologic Paper of the Bureau of Standards*, No. 191, *e*)

Comparative Tests of Steels at High Temperature, R. S. MacPherran. Data of tests made in the laboratory of the Allis-Chalmers Manufacturing Company to determine the comparative properties of various steels at high temperatures. The work was undertaken with the view to obtaining information as to the best material for use under operating conditions of 600 to 1000 deg. fahr.

Measurements were made with an electrically heated box in which the pyrometer head was practically in contact with the center of the test specimen. It was found that there is no one temperature at which all steels show a decided change in physical properties and that this point varies with the composition and treatment of the steel.

The maximum tensile strength for rolled carbon steel annealed,

and forged 3.25 per cent nickel steel annealed, occurs at about 600 and 650 deg. fahr.

The majority of the tensile-strength curves, especially those of heat-treated steels, drop sharply as the temperature exceeds 800 deg. fahr. The effect of nickel in small amounts is slight, but in large percentages it tends to lower the temperature at which tensile strength begins to decline. Nickel steel is the only steel examined where the ductility materially diminishes at the higher temperatures, monel metal bars, it is to be noted, however, behaving in the same manner.

Alloy steels containing chromium are less affected by rise in temperature than carbon steels, and it has been generally found that apparently the introduction of metals forming carbides tends to strengthen steels at high temperatures.

This, to a certain extent, bears out the results of tests on the comparative retention of physical properties in alloy steels at 1200 deg. fahr. or over by Leslie Aitchison, who finds the order of value to be tungsten, high-chromium and 3 per cent nickel. (Paper read at the meeting of the American Society for Testing Materials, June 24, 1921, abstracted through *Chemical and Metallurgical Engineering*, vol. 54, no. 26, June 29, 1921, pp. 1153–1155, 13 figs., *eA*)

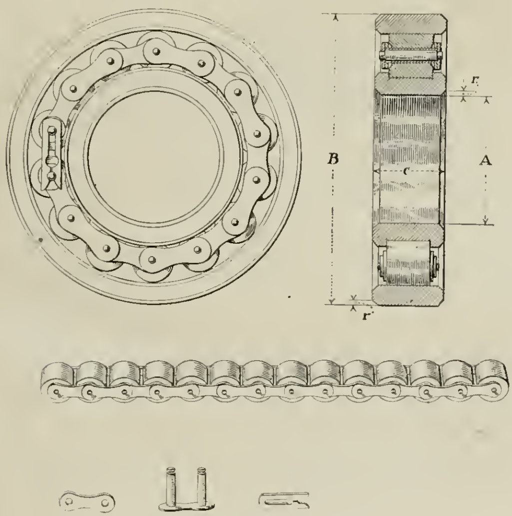


Fig. 5 Chain Roller Bearing

FUELS AND FIRING

A New Engine Fuel. At the meeting of the Society of German Chemists recently held at Stuttgart, Doctor Schrauth of the University of Berlin announced the development of a new fuel derived from naphthalene.

Naphthalene was used as a fuel even before the war, but the difficulty with it is that it is solid at ordinary temperatures and therefore requires preheating devices. It appears that now it has been converted into a liquid compound, tetrahydronaphthalene, having its boiling point at 205 deg. cent. (401 deg. fahr.) and a flash point of 78 deg. cent. (172.4 deg. fahr.) with the heating value of 11,600 calories per kilogram (20,880 B.t.u. per lb.), which makes it very desirable for high-compression engines of the aviation type. In ordinary automobile engines it can be used by mixing with materials boiling at lower temperatures such as gasoline—preferably in the proportion of one to one. Benzol may also be used instead of gasoline. It is stated that the new material, which, for the sake of brevity, is referred to as tetraline, has also a high dissolving power and can be used as a cleaning agent instead of gasoline. In this respect its low inflammability is of particular value. (*Aeronautics*, vol. 20, no. 398, June 2, p. 391, *g*)

INTERNAL - COMBUSTION ENGINEERING (See Fuels and Firing)

MACHINE ELEMENTS

Chain Roller Bearing. Description of a new bearing placed on the market about a year ago by a British company.

The principal feature of the bearing (Fig. 5) is the employment of an endless and detachable chain as a separating and guiding means for the rollers. This gives certain advantages. Thus, the maximum number of rollers of the largest possible diameter are employed in each bearing, because the chain cage allows the rollers the minimum margin of clearance between one another without permitting them to come in contact; this eliminates separating pieces between the rollers and thereby provides an increased load-carrying capacity.

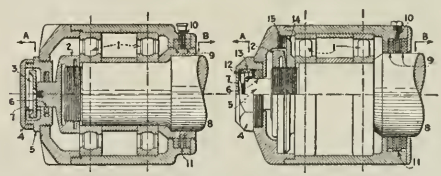
Each chain has a detachable link with spring-fastening clip which allows the chain to be unwrapped from the inner race for inspection, cleaning or replacement. This is an important feature with large drums where a standard pitch of chain cage of any length with any size of rollers can be simply wrapped around the drum without any special cage being required. (*The Practical Engineer*, vol. 63, no. 1788, June 2, 1921, pp. 347–348. 1 fig., *d*)

MACHINE PARTS

Ball Bearings on Electric Cars

Destructive Effect of Current on Ball Bearings of Electric Cars, Hilding Angstrom. Ball bearings on electric cars, in addition to great mechanical stresses, are also subjected to the destructive influences of current. The present paper (the author of which is connected with the Engineering Department of the Tramway System in Malmo, Sweden) is based on tests made by the General Electric Company and the Union Aktien-Gesellschaft, as well as on European practice.

From these tests it appears that a current as low as one ampere per square inch corrodes the housings and that a much smaller current is sufficient to damage the bearing metal. This is partly due to the fact that with ball bearings there is an almost metallic contact between the parts and no film of insulating oil intervenes.



Figs. 6 and 7 Journal Boxes Fitted with Auxiliary Contacts for Carrying Current

Fig. 6 At Left, Double Nut Arrangement

Fig. 7 At Right, Additional Pressure Provided by Spring

The flow of current from the trolley wheel downward is such that the various motor bearings and the gearing are in the path of the current with the ground. The action of the current is partly chemical but largely of the character of a weld, and it is chiefly the rupturing effect of the current that produces the welding action on the balls.

Figures in the original article show balls and bearings which have been thus destroyed. Of particular interest are dark stains on the balls which appear in the photographs. These were formerly considered as having been caused by acid in the lubricant or by shelling through fatigue.

Additional experiments have shown that the current distribution among the balls depends to a large extent on the load placed on them and that it is the rupturing effect and not the permanent current due to metallic contact that has the most damaging influence on their durability.

To prevent damage to the balls through the passage of electric

current some form of shunting device should be applied. The insulation of the outer ring of the ball bearing is possible but does not appear practical, as the repeated blows and shocks to which ball bearings are subjected would probably rupture or at least compress the insulating material and this would then produce additional stress in the ball bearings. A better way is to place a shunt or auxiliary contact arrangement outside of the ball- and roller-bearing casing. This shunt should have such a low resistance that it would practically exclude all transmission of current through the balls or the rollers.

A journal box fitted with N.K.A. disk bearings is shown in Fig. 7. This type of bearing has rollers which are self-centering, so that they tend to adjust their axis of rotation parallel to the axle of the wheel. The right-hand sides of the bearings shown in Figs. 6 and 7, which are marked *B*, show a current-transmission arrangement that can be applied to new bearing boxes. This arrangement consists of two brass rings which bear against the collar of the wheel axle. These brass rings also serve to support the felt rings 9, against which they are pressed by means of a spring. To provide a better contact and a path of less resistance for the current, the space between the brass rings is filled with graphite or mercury. The conducting power of graphite is about 10^{14} times as great as that of oil, and it is thus evident that the use of graphite facilitates the transmission of current to a high degree. This type of box provides a path of low resistance for the current and at the same time gives a very tight construction against the entrance of sand or dust from the outside. The left-hand ends of Figs. 6 and 7 marked *A* show a contact nut arrangement which can be applied to old ball- or roller-bearing boxes. In general this type of construction corresponds to that just described. In Fig. 6-*A* the current passes through the double nut at 4 and 5 to the graphite or mercury layer 7 and then to the contact disks 3, contact pin 2, and then to the axle of the wheel. In Fig. 7 *A* the nut arrangement is simplified somewhat and the tightening ring has been made more effective by the use of a spring bearing on a brass contact disk 7. The path of the current in this construction is through the contact nut 4, the contact spring 12 and the contact disk 7 to the contact pin 5 and then to the axle of the wheel. (*Electric Railway Journal*, vol. 57, no. 21, May 21, 1921, p. 941–944. 13 figs., *te*)

MACHINE SHOP

Cold Swaging

Cold Swaging. Swaging is used for work having a circular cross-sectional area and metal cannot be swaged by a swaging machine into any other sectional shape. Swaging is used mainly for producing small wire parts, sewing needles and instrument parts, and for tapering and reducing the diameter of tubing. [It may be added that swaging is also used in certain metallurgical processes as, for example, in the production of malleable tungsten wire by the Coolidge process—Editor.]

The article describes in particular the Dayton swaging machine which has a spindle speed of 300 r.p.m. and gives an average of 3600 quick short blows each minute.

Swaging increases the strength of materials, as has been shown by tests conducted in the physical laboratory of the Torrington Co. In six tests made there on cold-drawn steel wire ranging in diameter from 0.175 to 0.467 in. it was found that in all cases the tensile strength of the wire was increased by swaging and that the greatest gain in tensile strength occurred in the wire of the least strength before swaging. Furthermore, it does not appear that swaging affects unfavorably resilience or ductility of the material.

One of the most important applications of the swaging process is the reduction in diameter and tapering of tubes. Fire-hose nozzles and bicycle-frame parts in larger sizes and metal pencil shells and lightning-rod ends in smaller sizes are handled in this way. Swaging is also used in jewelry work and it is the only known process by which a gold-plated base-metal ingot may be reduced in diameter and still produce a plated article which will successfully withstand the acid test. It is stated that when a sample of wire of the sizes used in optical and jewelry trades is fractured and examined, the protective covering is so thin that there is no visible indication of an existing plate. On the other hand, case-hardened steel cannot be swaged as the hardened case fractures and crumbles.

Screw threads may be produced by swaging, the wire passing through the dies and the hollow spindle of the swaging machine to a reel at the rear. The threaded wire thus produced is not suitable for precision purposes but is extensively used for electrical and plumbers' supplies. Characteristic of the swaged thread is its accuracy in lead rather than in thread form. The form of swaged threads, however, is not excessively irregular.

The amount of reduction in diameter that can be successfully effected by the swaging process is largely an empirical matter. Small wire can be reduced the desired amount in one pass of the work through the dies, but on solid work which is large enough to withstand as great a reduction as $^1/_{16}$ in. a greater amount than this is not recommended in a single pass. This applies also to tubes if a mandrel is used, but tubing swaged without a mandrel will stand a greater reduction than this.

Some difficulty may be experienced in swaging tapered parts, particularly if the taper is abrupt, by the ends of the stock splitting, and there appears to be no remedy for this except to employ a preliminary lathe operation to break down the ends of the work. After this has been done, the ends may be successfully tapered and will not pipe or split. Where such abrupt tapers are produced, whether the stock is solid or tubular, some form of positive feeding device must be employed to overcome the axial thrust produced by the revolving dies. The Dayton swaging machine makes use of a rack-and-pinion feed for work of this type.

A high degree of accuracy can be obtained by the swaging process. In fact, swaging is extensively used for sizing wire, in which work a diameter can be readily and uniformly held to within limits of plus or minus 0.001 in., or even less for the smaller sizes. A corresponding degree of accuracy can be obtained when reducing the diameter by swaging, this accuracy increasing if anything, with the smaller diameters of work. One of the chief advantages claimed for the swaging process, as compared with machining, is the saving of stock effected. Besides saving stock and improving the physical qualities of the metal, many subsequent finishing operations, such as lapping and grinding, may be eliminated; also, the resilience of the metal is retained, as previously stated, even though it is increased in hardness and tensile strength.

The original article describes and illustrates various samples of swaged work. (*Machinery* (London), vol. 18, no. 453, June 2, 1921, pp. 257–261, 8 figs., *d*)

A New Sub-Press

Sub-Press for Blanking, Drawing and Punching, J. Blakey and J. Shankley. The sub-press shown in Fig. 8 is so designed that the plunger has not to be connected to the ram of the press and does not depend on the ram for its upward motion, because this is actuated by spring *O* under flange of extended buffer plug *K*. The base *C* can be fixed in any position on the press proper and over any existing clearance holes which can be utilized to get the punchings away, instead of having to force them back into the blanks. The cap *J* screwed on to body *G* for taking up the wear on the plunger babbitt bush *H* is made strong enough to withstand the pressure of the spring *O* when buffer *K* is forced down. The blanking and drawing die *D* has four punches *F* screwed into it. Die *D* is fastened to plunger *I* by four screws and two dowel pins as shown in sketch alongside. These punches *F* are a ground fit in stripper *E* (see sketch alongside), which in turn is spigoted into the bottom of piston *M*. It will be noted that punches *F* do not reach to the face of stripper *E*. As the plunger *I* descends along with plug *K* the stock is blanked by the outside diameter of *D* and inside of die *A*. Punches *F* do not come into operation until die *D* has commenced drawing and stripper *E*, piston *M* and spring *N* are depressed, thus preventing any distortion of the blank. Knockout *P* is a tee-sectioned ring and, as will be seen, is operated by four springs

equally spaced. The holes in die B for punches F are slightly tapered to the lower end for clearance after leaving a generous amount at the top parallel. A hole, shown dotted, is drilled in the center of piston rod M, which meets a small hole drilled to drill through its center to allow the air when piston is forced up to escape through the hole shown in plug L. The cup shown in section under plunger and in view in the upper left-hand corner was made from No. 17 gage sheet brass and was $2^1/_4$ in. in dia-

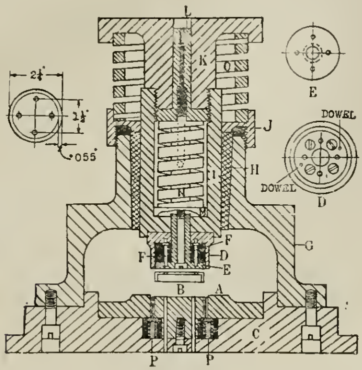


Fig. 8 Sub-Press for Blanking, Drawing and Punching

meter and $^7/_{16}$ in. deep, with four $^3/_{32}$-in. holes in the bottom. (*The Practical Engineer*, vol. 63, no. 1788, June 2, 1921, p. 349. 1 fig., *d*)

MILITARY ENGINEERING (See Engineering Materials)

POWER PLANTS

Boiler Corrosion

The Corrosion of Steam Boilers. As soon as steam turbines took their place as the standard type of prime mover for large powers, engineers hoped that the greater part of their boiler troubles would be over. The availability of the condensed steam, with its freedom from all scale-forming salts or traces of oil, for boiler-feeding purposes, opened up prospects of a new era in the boiler room. Experience, however, showed that a very soft feedwater involved troubles of its own, though just why soft feedwater attacks boilers is not quite certain. The opinion most commonly held is that with very soft water, corrosion is due to oxygen or carbon dioxide dissolved in the water. If this is so, it is desirable to avoid as much as possible the exposure of the condensate to the atmosphere and especially prevent all unnecessary agitation of the water in the presence of air. This led to the advocation of closed condensate systems. Another method consisted merely in bringing the feedwater into intimate contact with an extensive surface of unprotected iron, the idea being that the water should be allowed to satisfy its craving for iron by attacking metal specially provided for the purpose.

The engineer of a large London power station some time ago tried the experiment of filling his hot well with pieces of old boiler tubes. They were strongly attacked by the water, which was found to contain far less dissolved oxygen after passing over them than did the air-pump discharge. In the course of time, however, the action practically ceased on account of the protective coating of rust which was formed on the tubes. Mr. Kestner (paper before joint meeting of the Institution of Mechanical Engineers and Society of Chemical Industry, Mar. 4, 1921) secured continuous operation by reversing the direction of flow of feedwater. In another instance interesting results were secured by fitting some of the boilers with cast-iron economizers and the rest with steel ones. With the same feedwater, corrosion took place in the boilers with cast-iron economizers, but not in the others, the steel economizers themselves being attacked.

This would indicate that the corrosive capacity of feedwater is limited and may be eliminated by giving the water something to attack. In this connection it is stated that corrosion troubles were practically stopped in a certain steel economizer by filling it up with a mixture of lime and carbonate of soda, removing the safety valves and subjecting the mixture to a protracted boiling at atmospheric pressure.

The attacks are often of an erratic nature. Sometimes one boiler out of a group is attacked; at other times the main feed line along the boiler fronts is safe while considerable trouble is experienced with the smaller vertical connections of the boiler drums. These facts point to the probability that something in the composition of the steel may be a determining factor. Test by H. P. Gaze of the Central Electric Supply Co. would further indicate that ordinary commercial steel tubes supplied by the economizer makers suffer less from corrosion than charcoal-iron tubes, which would dispose of the contention that modern steel is a poorer metal in respect to corrosion than old-fashioned iron.

The author arrives at the conclusion, however, that there is more than a possibility that pitting is not entirely due to chemical causes but is rather of an electrolytic nature. A lack of perfect homogeneity in the steel would tend to cause electrical currents to circulate between different points, the currents passing through the body of the metal and returning through the water. Wherever such currents left the metal they would carry iron into solution and so eat away the surface. The suspension of a zinc plate in the boiler might not suppress these parasitic currents, as it could do nothing to alter the fact of a relative difference of potential between two points on the boiler shell.

The general conclusion arrived at is that until we can get metal which is chemically homogeneous or can devise some effective method of protecting the surface or possibly rendering it passive, corrosion can only be prevented by paying careful attention to the impurities in the feedwater. In modern plants these consist of little more than dissolved gases, which fortunately can be eliminated or neutralized without very great difficulty when once the danger of their presence is properly appreciated. (Editorial, *Engineering*, vol. 111, no. 2891, May 27, 1921, pp. 651–652, *tpA*)

Cross-Current Flow-Type Water-Cooling Tower. The water-cooling tower recently erected at the Government Electric Station at Dresden, Germany, is reported to be one of the largest in Europe. It has a capacity of 120 cu. m. (28,000 gal.) per min. A feature of this type of cooler is that the air and water do not flow on the counter-current principle, but the air enters the cooler horizontally while the water falls vertically. There is a central tower or "chimney," and the entire cooling system is external to the "chimney," surrounding it at the base. There are two important advantages. The interior of the tower (which is 120 ft. high) remains quite free from obstruction, and so a very free air draft is obtainable, with a constant velocity over the whole of the "chimney." The cooling plant consists of twelve independent compartments, any one of which may be isolated for cleaning and repairs. The water enters at a height of only 16 ft. above the foundations, thus requiring much less power for its elevation than with the high type of tower. The air current, entering the spray chambers horizontally, passes transversely through the falling water and exhausts into the central tower. Its passage is very much less impeded than if it had to force its way upward against a falling spray. Less substantial foundations are necessary and much less excavation. The floor space covered is, however, somewhat greater.

The whole of the cooling chambers are roofed by shallow distributing pans, which connect to the spraying devices below. These consist of short lengths of vertical piping, delivering on to spash plates rigidly connected to the latter. The splash laths are arranged below the plates, to cause the water to assume the form of films. This region of the cooling system is boarded in to prevent wind action blowing the water outside, and the formation of ice in the air entrances. Means are also provided for a measurement

of the water supply by troughs and weirs preceding the distributing system. (*Beama* [Journal devoted to the Interest of British Electrical and Allied Engineering], vol. 8, no. 5, May 1921, p. 418, *d*)

Spray Pond Formula. In connection with the formula for computing the temperature reduction which can be effected by a spray-nozzle installation, given in Mechanical Engineering, June 1921, p. 406, the following formula having the same purpose in view, is quoted from the latest catalog of the Cooling Tower Company (15 John Street, New York City):

$$T_1 = T - \frac{[0.5\,(T + 460) + 0.5(t_2 + 460)]^4 - (t_2 + 460)^4}{C \times 100{,}000{,}000}$$

Where t, t_1, T and T_1 are respectively the temperature of wet bulb or air, wet bulb, water before spraying, and water after spraying; $t_2 = (4t_1 + t)/5$ and $C = 5.1$ for average installations operating at $6^1/_2$ lb. pressure.

PUMPS

New Diagram for Determining Efficiency of Centrifugal Pumps

Determination of the Efficiency of Centrifugal Pumps, Allen F. Sherzer. The efficiency of a centrifugal pump is a function of the speed, head developed, and quantity discharged.

Since the efficiency of pumps cannot be reliably estimated solely on the basis of discharge, another method has been established in which the efficiency is made a function of the so-called constant of specific speed (N_s). This constant is supposed to include the effect of each of the variables.

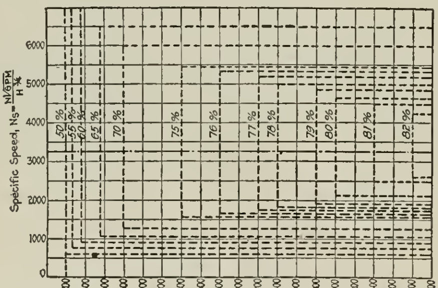


Fig. 9 Efficiency Contours for Centrifugal Pumps in Terms of Gal. per Min. and Specific Speed

The usual range of pumps have values of N_s from 500 up to about 5000, and the author shows by a curve that the efficiency increases quite rapidly with the specific speed until it reaches a maximum (N_s = about 3000), after which it falls off slowly. Moreover, he shows that the efficiency may be high over quite a range of specific speed and that, in general, there are two values of N_s corresponding to a given efficiency. Since neither capacity nor constant of specific speed alone give reliable indications as to efficiency, the author attempted to combine the two into a composite curve (Fig. 9), in which lines of equal efficiency are plotted on discharge in gallons per minute as abscissæ and values of N_s as ordinates. The lines of equal efficiency join to form a rectangle of equal efficiency. In other words, all points within the rectangle of equal efficiency are equal to or above the efficiency marked on the line enclosing them. By drawing a suitable number of these equal-efficiency lines intermediate values may be readily interpolated with sufficient accuracy.

The following instructions are given as to the use of this diagram: To make use of the diagram (Fig. 9), it is necessary to know the conditions of head, discharge, and speed under which the pump is to operate. Having these data, compute the value of N_s. Using this value of N_s as ordinate, and with the discharge as abscissæ, locate the point on the diagram in Fig. 9. In case this does not fall exactly on any of the lines shown, interpolate horizontally and vertically, which will give the probable efficiency with sufficient accuracy for all usual purposes.

An example may help to make this clear. Assume that a centrifugal pump is to be designed for a discharge of 600 gal. per min. against a total head of 120 ft. when operating at a constant speed of 1750 r.p.m., and that it is desired to estimate its probable maximum efficiency.

We first find that the value of $N_s = 1750\sqrt{(600)}/120^{3/4} = 1185$. Now turning to Fig. 9 and traveling up to the 600 G. P. M. line till we come to $N_s = 1185$, we find that the point lies at the lower left-hand corner of the 65 per cent rectangle and that its probable efficiency would be about 65 per cent or perhaps a little more. This value agrees quite satisfactorily with practical experience, but when used for power-estimating purposes it should be reduced a little for safety, as it frequently happens that the power required to drive the pump at its point of maximum efficiency is somewhat exceeded when discharging a greater quantity of water against a lower head, which may easily take place in any given installation. The accuracy of this method is necessarily limited by the accuracy of the data on which it is based, but as such were selected from various sources and include the results of tests on a great number of pumps, it is believed that it is at least representative of average practice. The method given in this paper may be readily applied to any type of pump and can be modified if necessary to accord with the experience of any who may care to make use of it. *Engineering News-Record*, vol. 86, no. 26, June 30, 1921, pp. 1114–1115, 3 figs., *epA*)

RAILROAD ENGINEERING

Double-Capacity Air Brakes on the Virginian Railway. The Virginian Railway, because of its predominant tonnage of bituminous coal which has to be hauled over comparatively steep grades, is especially interested in the question of the rapidity with which traffic of that character can be handled. In particular, on the section east of Princeton, long, heavy trains have to be handled down grades of 1.5 per cent, while near Elmore the trains have to be pushed up a 2.07 per cent grade.

This has materially affected the character of the rolling stock, with the result that today the Virginian Railway operates ten of the most powerful locomotives in the world and 1000 of the highest-capacity cars ever built, namely, 120-ton.

Incidentally these cars make the braking problem very serious, owing to the fact that their weight when empty is only one-quarter of the gross weight loaded, which is very desirable from an economical standpoint but makes difficult the handling of trains composed of such cars when loaded and going down grades and the return of long trains composed wholly of empty cars.

The problem of designing proper brakes in this case lay in the necessity to compensate for the great discrepancy in weight between empty and loaded trains. With single-capacity brakes the braking force developed is constant in magnitude but varying in its relation to the car weight. The usual practice has been to design the brake layout so as to provide the highest practicable percentage of braking forces on the empty car and then to accept whatever reduced braking ratio might be available for the loaded car. This was scarcely applicable to the conditions prevailing as stated above on the Virginian Railway, because it might not have provided a sufficiently safe control of the loaded trains on the down grades, or in long trains of empties might have resulted in severe shocks because of the high braking ratio of the empty train. In fact, the high-capacity cars on the Virginian Railway operated under so divergent conditions of loaded and empty trains that any attempt at a compromise between the two extremes would have resulted in unsatisfactory operation with either one or the other. The double-capacity brake equipment solved this problem, the layout being designed to provide for 40 per cent braking ratio (as against the usual 60 per cent) for an empty car, and also 40 per cent for the loaded car as against the usual average of 15 per cent. The additional force required to raise the braking ratios on loaded cars is obtained by the combination of an additional cylinder and increased leverage, a small load reservoir supplying the additional air.

When the equipment is set for empty-car operation the take-up

and empty cylinders, which are built into one structure with the small piston operating withinthe larger, operate as one 10-in. cylinder similar to the standard single-capacity brake. When the equipment is set for loaded-car operation the take-up cylinder piston first takes up the slack in the rigging and brings the shoes firmly against the wheels. Then the empty cylinder piston moves out a slight amount, its clutch gripping the notched push rod of the take-up cylinder piston, thus supplying additional force. Finally, as the brake-pipe reduction continues, the load cylinder piston moves out a slight amount, gripping its notched push rod and adding to the force already developed, through the connecting rods and levers. By this method of slack take-up and short travel of the larger pistons the volume of air required for a given application is reduced to a minimum.

The higher braking ratio necessary for the loaded car is obtained only when desired, and the equipment is manually changed for loaded car braking by the mechanism which shifts the change-over valve to its load position. Extensive tests have been made to demonstrate the efficiency and reliability of the new brake, one of the most spectacular of which was a test on a train consisting of 100 loaded 120-ton capacity cars, the brakes operating to the complete satisfaction of every one concerned.

Among those witnessing this test were four men who were present 35 years ago at the famous Burlington test of the Westinghouse air brake, which did much toward the universal acceptance of that type of brake on American railroads. (*Railway Review*, vol. 68, no. 24, June 11, 1921, pp. 885–894, illustrated, *d*)

SAFETY ENGINEERING

Influence of Mine Atmospheric Conditions on Fatigue. The effect of varying atmospheric conditions in mines may express itself in lowering the efficiency of the defensive mechanism of the human frame against disease. Such conditions may not be directly conducive to specific diseases, such as miners' tuberculosis, and yet may lead to a more feeble resistance against them. Such conditions are the creation of an undue amount of fatigue, the presence of minute quantities of irritant poisonous gases, such as carbon monoxide, nitrogen oxide, chlorine and cyanogen chlorite, a large deficiency of oxygen, or a large excess of carbon dioxide or nitrogen.

In this connection attention is called to the fact that in recent years there have been two remarkable changes in the opinion of competent authorities on the question of the relation of atmospheric conditions in mines to health. In the first place, contrary to what was formerly believed, the opinion came to prevail that much larger amounts than 0.20 per cent of carbon dioxide are tolerated by the human system. The author doubts, however, if this truly applies to cases where people have to breathe contaminated atmosphere for a very considerable length of time.

The other question on which medical opinion has lately undergone considerable change is the effect of high temperature and humidity on health. It was formerly held that while a wet-bulb temperature of 83 deg. fahr. might greatly diminish a laborer's output of work, it had no detrimental effect on his health. The experiments with air in motion, and, more recently, the introduction of the katathermometer, have shown, however, that conditions which induce undue fatigue when performing work must be detrimental to health. (Contribution by Sir Robt. Kotze to a paper by Dr. A. J. Ornstein and H. J. Ireland before the South African Institution of Engineers. *Journal of the South African Institution of Engineers*, vol. 19, no. 10, May 1921, pp. 202–204, *gp*)

SPECIAL MACHINERY

Aluminum Casting, John G. A. Rhodin. Discussion of dies, pressure casting and defects in aluminum castings.

As regards the design of dies, the author discusses dies constructed as individual units with all clamping arrangements, etc., made and adapted for the die, and dies made in sections to suit a universal holder, like the plates in a filtering press. In England the first method has been found to be best, as it gives the designer more freedom in selecting the position of the casting in the die, combining vertical and horizontal sections, etc.

Some information is given as to the design of such dies and it is stated that the principal thing is to start working out the die from the main section and find out the smallest number of others feasible. So far such dies have been used only for making pistons of various more or less complicated design. Fans, propellers, etc., have also been made in quantity, but they belong to the class of machine parts that work without accurate fitting. Resting parts of machinery of great variety have also been cast in built-up dies and their number was increasing rapidly when the industrial stagnation came.

One of the advantages of these self-contained dies is that they can be put bodily in a furnace for heating and taken out ready for immediate pouring. With regard to limits of dimensions the writer has seen castings with runs well over 2 ft. and weighing more than 25 lb. produced in dies of this type, such as gear cases and steering wheels for motor cars. On the whole, it is stated that die casting of aluminum by gravity feed was an almost unqualified success.

As regards the building up of a number of dies in the shape of plates capable of being handled in a screw press, the author is less optimistic. For very simple things the plan is satisfactory, but for complicated castings it is claimed to be hopeless. The plates were supposed to slide on bars, but the bars proved to be in the way of everything when the casting had to be removed. The dowel pins holding the outside plate of the die were found to have a tendency to stick on slight provocation, and, in general, while the whole thing worked occasionally, the universal application of the principle was abandoned.

The gravity method is not suitable for use on castings with very thin sections when high pressure must be used. Plunger pressure has proved successful with small castings of antimonial lead, but aluminum would spoil the fit of a plunger in no time. Because of this, the majority of pressure-casting machines are worked by compressed air.

The author tried a number of machines obtained from America in 1919 and says that with aluminum he had no luck. At the start really marvelous castings were produced, but in many cases the perfection was only apparent as they were full of gas bubbles under the skin.

His criticism of the design of these machines is that to begin with the permanent contact of the molten metal with iron is totally unnecessary and the same applies to the exposure of a large surface to the air. Furthermore, the gas in the castings is air which passes by hammer action through faulty design of the goose neck.

Generally, the author believes that the market for pressure die castings in England is confronted with serious difficulties not of a technical nature—purely the objection of the English public to articles produced from uniform patterns.

As regards defects in aluminum castings, blowholes are mentioned. They are apparently the result of an evolution of gas dissolved in the metal and are nearly always associated with overheating of the metal. Certain impurities like manganese, and to a lesser extent, iron, enhance the effect. (Aluminum and Its Alloys in Engineering, serial article, section 7, chapter 5; *The Engineer*, vol. 138, no. 3416, June 17, 1921, pp. 635–636, *p*)

SPECIAL PROCESSES

Development of the Bolt and Nut Industry, F. H. Chapin. The first machine-made bolt was produced in this country only 80 years ago, Micah Rugg, a country blacksmith in Connecticut, being the pioneer of the bolt industry in this country. Southington, Conn., can truly be said to have been the cradle of the bolt and nut industry in the United States.

The first heading machine was made by W. E. Ward about 1850 and used in making carriage bolts. In those days the $^5/_{16} \times 3$-in. carriage bolt sold for about \$33 per thousand and the bolt maker's wage was \$1 per day of 12 hours. Now, this same bolt is sold for about \$7.50 per thousand and the operators make from \$6 to \$8 per day for 10 hours' work.

It was only about the time of the Civil War that Wm. J. Clark of Milldale, Conn., brought out a method of forging carriage bolts from round iron. A little before that the manufacture of bolts by the cold forging process began.

The real development of the industry began with the advent of the method of making bolts from round iron.

As regards the industry as it is today, one of the most striking

features is the apparent total lack of standardization. Bolts and nuts are articles which function in such a simple manner that one would expect uniformity of types and sizes to come about practically automatically. As a matter of fact, the very opposite happens to be the case. The Upson Works of the Bourne-Fuller Co. alone have in their shops over 30,000 different dies for forging, trimming and threading, none of which are duplicates nor are considered entirely obsolete. (*The Iron Age*, vol. 107, no. 24, June 16, 1921, pp. 1609–1610, *g*)

British Seamless-Steel-Tube Manufacture

Seamless-Steel-Tube Manufacture. Review of the processes with especial reference to British practice, in particular such as employed by Accles & Pollock, Ltd., Oldbury, Birmingham, England.

Essentially the methods employed do not differ much from American methods. Great difficulty is said to be experienced in drawing tubes below $^7/_{16}$ in. diameter on a mandrel, and the usual practice adopted for finishing all sizes $^3/_8$ in. and under is by reducing the diameter only. (This process is called "sinking.") The tubes finished in this manner are not as consistent in quality as those finished on a mandrel and are not as strong.

Aircraft construction called for high-carbon and alloy-steel tubing, in particular chrome-nickel steel. At first trouble was experienced and mandrels and occasionally draw benches were broken through unsatisfactory annealing processes. These difficulties however, have been successfully overcome and chrome-nickel steel tubing is now being produced by the same plug-drawing process as used for mild steel, although the amount of reduction per draw is not nearly as great and care has to be exercised in annealing.

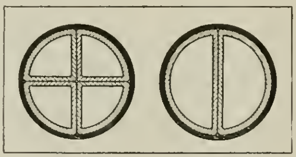


Fig. 10 Examples of Two Types of Reinforced Steel Tube

Reinforced tubes are also made. In the case of the flattened ends of struts on the rods it is quite common practice to insert a flat strip of steel, and rivet and solder it in position. This is not very satisfactory, however, as, unless some additional strengthening is provided, the tube is always weakened at the point where it changes its shape. A far more efficient method is that of inserting a tubular liner before flattening to extend some distance beyond the trapped portion. In Fig. 10 the tube to the left is formed by drawing a round tube over two D-sections. This particular combination was designed to withstand excessive vibration. The other combination is formed in the same manner but has four inner tubes. (*Engineering Production*, vol. 2, no. 35, June 2, 1921, pp. 675–679, 13 figs., *d*)

STANDARDIZATION (See Special Processes)

STREET RAILWAYS (See Machine Parts)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

N.M.T.A. AND INDUSTRIAL EDUCATION

(*Continued from page 522*)

3 Many of those who do attempt to train have nothing even approximating a definite schedule for this work, and have not definitely determined responsibility for instruction and training as part of the duties of some person or group
4 Very few foremen are able to give instructions to a learner in a proper manner
5 Conditions in the various plants determine the type of training necessary.

It is the belief of the Committee that in the majority of instances, shops with one hundred or more employees should consider seriously the establishing of a training department. In the smaller shops the quota could very properly be trained in connection with the tool room or some special department. Each plant should have some individual in charge of, and responsible for, training.

The individual members of the Committee naturally have some preference for certain methods of training within their own establishments, but the Committee as a whole has not reached the point where it recommends any one system of training as being applicable to all plants; and when consideration is given to the size of our membership, the great differentiation in products manufactured, the vast territory covered, and the changing conditions within industry, it is unlikely that it will ever do so.

It is the opinion of the Committee that each plant should be considered individually, having a careful regard for the character of the product manufactured, the varying degrees of skill and intelligence required, the number of workers employed, the type of plant organization, the labor turnover, the method of recruiting new workers, the method, if any, of training now in use, the wage scheme, the plant spirit, the local conditions, and many more points which have a direct bearing on the question of training and education for the individual plant.

Too much stress cannot be laid upon the fact that no real permanent benefit can be expected from mere training along the lines of manual dexterity alone, unless such training is supplemented by a common-sense education of the worker, either by the employer himself or through his authorized representatives who carry to the worker the real policy of the employer.

This brings up the question of leadership in industry. The Committee believes that the only true leadership of labor must be furnished by the employers themselves, because they are the only class who are in a position to understand in a practical way both sides of the so-called labor problem. The fact that the employers have not made much progress in assuming the duties of leadership would seem to indicate that many of them do not yet fully realize that this part of their business is as essential as the efficiency of the worker.

GENERAL EDUCATION AND THE ENGINEERING PROFESSION

(*Continued from page 520*)

determination of the best procedure. There should be, furthermore, a large committee of leading educators in association with this agency to secure the necessary coöperation of all departments of society and business.

A ways and means committee of men from such organizations as the American Bankers' Association, American Defense Society, National Industrial Conference Board, Chamber of Commerce of U. S., National Civic Federation, Associated Industries of Massachusetts and New York and like bodies has been appointed to effect the creation of the above agency. The A.S.M.E. will be represented in association with other national bodies of engineers through the Engineering Foundation by Mr. W. W. Nichols, Chairman of its Committee on Education and Training in the Industries. Working with this committee will be an Advisory Committee on Education, already formed. We may therefore confidently predict that for the first time in America there will soon be a source of information and suggestion representative of a cross-section of American society and associated with all state and local interests that desire its services. The effect upon the nation should soon be manifest in the higher development of the individual by his better understanding of the forces about him.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research in Detroit and Vicinity

THE Research Committee of the Detroit Section of The American Society of Mechanical Engineers, composed of J. E. Emswiler, Chairman, Charles S. Glenn, C. J. Hirshfeld, J. C. McCabe and F. W. Steere, Secretary, has recently made its report to the Research Committee of the Society on the Survey of Research among the Industries of this district. The Committee takes this opportunity to express its appreciation and thanks for the work done by the Sectional Committee in making this survey, which included correspondence with one thousand firms.

The report will be submitted to the Society for action, but it is advisable at this time to give the following conclusions made from the results of the survey:

1 Only 14. 3 per cent of the firms canvassed have any apparent interest in the subject of research.

2 Only 2.2 per cent of the firms canvassed are doing research work that they consider of general interest to the profession.

3 Of those firms doing research work of Class A, the kind of work that appears to be receiving most attention is along the line of improved methods of producing, heat-treating, and machining steel and alloys, a kind of work upon which seven firms reported.

The kind of work reported upon by the next largest number of firms, viz., 5, is that of automobiles and accessories.

4 As is to be expected, most of the general research work is reported by the larger organizations, which indicates a commendable attitude on the part of firms that are financially able to do it, and emphasizes the importance of all means that can be employed for pooling the research interests of engineering industries, such, for example, as the recently established Engineering Research Department of the University of Michigan, and the more general facilities of the A.S.M.E. for the free exchange of ideas.

5 There appears to be a considerable amount of material in this Section's jurisdiction available at once, and in the near future, for publication in the Society's Journal, MECHANICAL ENGINEERING.

Research Résumé of the Month

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches, which, in the opinion of the investigators do not warrant a paper.

Apparatus and Instruments A6-21. RULING SCALES BY LIGHT WAVES. See *Light A2-21.*

Cement and Other Building Materials A9-21. TESTS OF BUILDING PARTITIONS. Tests are being made on partitions made of brick and other building materials when exposed to high temperature for six hours. The test specimens are 11 ft. by 16 ft. in area and 8½ in. thick, supported by a heavy steel frame so that they can be swung into place and form the side of an oil-fired furnace. The temperature of this furnace is increased according to a predetermined program and the tests continued for six hours. Observations are made at various parts of the partition for temperatures and on the distortion caused by heating. The cold side of the panel is investigated for temperature to determine whether or not this is high enough to ignite inflammable material. Observations are also made to determine whether or not cracks develop. A number of tests are being made each month and engineers, architects or other interested parties are invited to visit the Bureau of Standards to witness these tests. Exact dates may be ascertained by correspondence. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuels, Gas, Tar and Coke A10-21. COKE BREEZE AND BITUMINOUS COAL AS FUEL. John Blizard and James Neil of the Bureau of Mines have made Report 2244 on the Value of Mixtures of Coke Breeze and Bituminous Coal as Fuel for a Hand-Fired Boiler. Tests were made at the request of the Chamber of Commerce of Pittsburgh, Pa., to determine the steam value of the mixtures and to determine whether or not mixtures would give off objectionable quantities of smoke. The tests were made on a No. 60 Smith boiler with grate bars containing air spaces ½ in. wide and occupying 52 per cent of the total grate area, and also with air spaces $^1/_4$ in. wide and occupying 31 per cent of the grate area. The Smith boiler contains a mixing chamber for the purpose of smoke prevention. The fuel consisted of coke breeze and Pittsburgh run of mine coal. The breeze was of two sizes, one passing through a $^3/_4$-in. to 1-in. screen and the other through a ½-in. screen. The coke breeze weighed 48 lb. per cu. ft. and gave heating values between 9500 and 10,000 B.t.u. per lb. The coal contained 10 per cent ash and 3 per cent moisture and had a heating value of about 13,000 B.t.u. per lb. With equal weights of coal and breeze the heating value of the mixture varied from 11,300 and 11,800 B.t.u. per lb. The tests showed that mixtures of coarser coke breeze with Pittsburgh coal gave less than one half the smoke given out by the Pittsburgh coal alone. It produced 20 per cent less steam and required a stronger draft. The finer coke breeze gave about the same amount but required a much stronger draft. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A11-21. COAL-DUST HAZARD. Coal-Dust Hazard in Industrial Plants is the title of report 2246 by L. D. Tracey to the Bureau of Mines. The report discusses the various causes of explosions and ignition and concludes with a number of observations to be used in designing apparatus for the use of pulverized coal. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Heat A10-21. PYROMETRY. Technologic Paper No. 170 on Pyrometric Practice from the Bureau of Standards is now available from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 60 cents a copy.

Light A2-21. RULING SCALES BY LIGHT WAVES. The Bureau of Standards has made for and delivered to the Brown and Sharpe Company a 6-in. scale, the rulings of which have been made by using the light waves from a tube containing neon (wave length = 5800 to 6600 A). No intermediary standard was used. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Lubricants A1-21. EFFECT OF PARAFFIN WAX UPON VISCOSITY. The Effect of Crystalline Paraffin Wax upon the Viscosity of Lubricating Oil is the subject of Report 2249 by E. W. Dean and L. E. Jackson to the Bureau of Mines. Tests were made on 5-gal. samples of Pennsylvania crude petroleum by distilling at various temperatures and determining the viscosities of various fractions which were subsequently subjected to treatment which removed successive percentages of paraffin wax by chilling and filtering. The conclusions are:

1 Changes of content of paraffin wax up to a maximum of approximately 9 per cent have been shown to cause negligible variation of viscosity of the fractions cut between 250 deg. cent. and 275 deg. cent. and 276 deg. cent. to 300 deg. cent. at 40 mm. reduced pressure.

2 The value of the Bureau of Mines method for determining viscosity of vacuum-distillation fractions is not affected apparently by the fact that paraffin wax is not separated from the products that are tested.

3 Variations of paraffin wax content have negligible effect on viscosity.

4 Present results are not sufficient to prove a general rule.

Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Properties of Engineering Materials A5-21. ALUMINUM SOLDERS. The Bureau of Standards has recently completed tests on aluminum solders and the results will be found in the revised edition of Circular 78 on Solders for Aluminum. No solder has been found which will stand the corrosion test, although fused zinc chloride solders will stand corrosion for the greatest length of time. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Transportion A1-21. FIBER BOXES. In the manufacture of fiber boxes made of laminated or corrugated paper board, silicate of soda has been used to form the adhesive substance employed. Silicate of soda may be so made that a small difference in concentration produces a large change in viscosity. Solutions may be prepared which change from a sirupy liquid to a solid by the loss of as little as 10 per cent of the moisture. This behavior is closely related to the ratio of alkali to silica in the silicate solutions. In practice silicates containing more than three molecules of SiO_2 to each molecule of Na_2O are used. The absorption of moisture from the solution by the paper board produces the setting. The bond strength exceeds 500 lb. per sq. in. The silicate of soda does not attract vermin, being a mineral product. Philadelphia Quartz Company, Philadelphia, Pa. Address James G. Vail, Chemical Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work, and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Fuel Utilization B2-21. Texas Lignite. An investigation on the method of handling Texas lignite under hand-fired boilers. University of Texas, Austin, Texas. Address Prof. Hal C. Weaver.

Heat B19-21. Heating and Ventilation. Prof. R. W. Noland is investigating the steam traps and vacuum valves used on radiators, utilizing new and original equipment for this purpose. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Heat B20-21. Heat Transfer. A determination of constants of heat transmission for new materials as well as the study of surface and humidity effects. Address Prof. A. J. Wood, Pennsylvania State College, State College, Pa.

Hydraulics B4-21. Hydraulic Jump Below Overflow Dams. A state of conditions determining the formation of the jump, its control and its utilization for useful purposes. Address Prof. S. M. Woodward, State University of Iowa, Iowa City, Ia.

Internal-Combustion Engines B6-21. Mixture Requirements. Prof. G. A. Young and C. S. Kegerreis have investigated the effect of speed on mixture requirements of an internal-combustion engine. Previous experiments showed that load has no effect on mixture ratio. The effect of speed is investigated in this research. Address Dean A. A. Potter, Purdue University, Lafayette, Ind.

Lubricants B4-21. Viscosity. Experimental Study of the Variation of Absolute Viscosity of Oils with Temperature is the subject of a thesis by A. R. Albouze. This will cover a large number of different oils with temperature variation from 60 to 320 deg. fahr. and incorporate all published data of other investigators. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, California.

Metallurgy and Metallography B9-21. Ingot Casting. A study of the difficulties in making ingots of nickel and monel metal which are similar to those encountered in making steel ingots. These difficulties are due to the peculiar relation between metals and their oxides. Address John F. Thompson, Manager, Technical Dept., International Nickel Company, 43 Exchange Place, New York.

Properties of Engineering Materials B2-21. Constantan. A study of the possibility of producing copper-nickel metal directly from the furnace, using different thermoelectric specifications to eliminate subsequent selection and testing of wire. Address John F. Thompson, Manager, Technical Dept., International Nickel Company, 43 Exchange Place, New York.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

State University of Iowa D1-21. The College of Applied Science of the State University of Iowa is just putting into use its recently completed Hydraulic Laboratory. This includes a concrete flume 130 ft. long and 10 ft. wide, so arranged that it can be supplied with water to a depth of 7 or 8 ft.; a small laboratory building in which hydraulic turbines up to 51 in. in diameter can be installed for testing and experimental purposes, under a head not exceeding 10 ft. A water supply is constantly available which is never less than 100 to 200 cu. ft. per sec. and during most of the year exceeds 1000 cu. ft. per sec. In conjunction with the laboratory a recording register is in use in the Iowa River and a cable gaging station across the river, which is about 300 ft. wide at this point. It is planned to have ultimately a full equipment available for studying the rating of current meters for all kinds of weir experiments and investigation of hydraulic apparatus and machinery. Address Prof. S. M. Woodward, State University of Iowa, Iowa City, Ia.

University of Pennsylvania D1-21. The Equipment of the Mechanical Engineering Laboratory of the University of Pennsylvania contains the following apparatus:

Boilers, Etc.

A 90-hp. B. & W. boiler for 200 lb. per sq. in. working pressure with Warren Webster open feedwater heater with Lea recorder and Wainwright closed feedwater heater. Foster independently fired superheater.

Steam Engines, Condensers, Etc.

- $10^1/_4$-in. by 24-in. Corliss with surface condenser
- 8-in. by 16-in. Porter-Allen with surface condenser
- 7-in. by 13-in. by 10-in. Reeves compound with surface condenser and air pump
- $6^1/_2$-in. by 10-in. Buckeye with surface condenser and air pump
- 6-in. by 6-in. Harrisburg with surface condenser
- 8-in. by 10-in. Kingsford vertical unaflow with condenser
- Two 8-in. by 10-in. Metropolitan
- 7-in. by 7-in. Fairbanks
- Extra 515 sq. ft. surface condenser for miscellaneous testing
- 8-in. by 10-in. Ames engine.

Turbines

- 15-hp. DeLaval single-stage turbine and reduction gear
- 25-kw. Kerr turbine direct-connected to d.c. generator with condenser and air pump
- 22-hp. Terry turbine direct-connected to 4-in. Worthington centrifugal pump.

Compressors

- 8-in. by 8-in. by $9^1/_4$-in. by $14^1/_4$-in. by 8-in. two-stage air, duplex simple steam-driven Ingersoll-Sergeant air compressor with air-measuring tanks and surface condenser
- 6-in. by 11-in. by 6-in. two-stage air compressor belt-driven by 10-hp. motor
- No. 4 Sturtevant air blower belt-driven by 5-hp. motor.

Pumps

- 8-in. by 12-in. by 7-in. by 12-in. Worthington duplex compound direct-acting pump
- $7^1/_2$-in. by $10^1/_4$-in. by 10-in. vertical duplex steam pump
- 5-in. centrifugal pump direct-driven by 20-hp. motor
- 4-in. American volute pump direct-driven by 20-hp. motor
- $1^1/_4$-in. Tacony three-stage centrifugal pump direct-driven by 2-hp. motor
- 4-in. by 4-in. Deming triplex pump direct-driven by 3-hp. motor.

Hydraulic Motors

- 12-in. Doble wheel
- 12-in. Pelton wheel.

Hydraulic Measuring Apparatus

- One V-notch weir
- Two 10-in., one 15-in. and one 18-in. contracted weirs
- Two 2-in. venturi meters with manometers
- Two 5-in. venturi meters with manometers
- Numerous hook gages, tanks, platform scales and manometer for measurement of discharge from orifices and nozzles.

Stationary Gas, Gasoline and Oil Engines

- $9^1/_8$-in. by $17^1/_2$-in. Otto with suction producer and scrubber
- 6-in. by 9-in. Warren single-cylinder horizontal
- $7^1/_2$-in. by 14-in. Springfield single-cylinder horizontal
- 8-in. by 10-in. Westinghouse two-cylinder vertical
- 10-in. by 16-in. Burger single-cylinder horizontal
- $7^5/_8$-in. by $10^7/_8$-in. Foos single-cylinder horizontal
- 6-in. by $6^1/_2$-in. Mietz single-cylinder horizontal
- 5-hp. Thermoil (semi-Diesel)
- 5-hp. New Way (air-cooled).

Automobile and Airplane Engines, Etc.

- 4-in. by 5-in. four-cylinder Teetor
- $3^1/_2$-in. by $5^1/_4$-in. six-cylinder Continental
- $3^1/_4$-in. by 5-in. eight-cylinder Peerless
- 80-hp. LaRhone airplane engine
- 150-hp. six-cylinder Hall-Scott airplane engine
- 8-cylinder Hispano-Suiza airplane engine
- 12-cylinder Liberty airplane engine
- 75-hp. Sprague electric dynamometer with test stand
- Fan dynamometer
- Detroit hydraulic dynamometer
- American balanced diaphragm high-speed indicator
- Midgely optical high-speed indicator
- Schultz manograph.

Fuel and Gas Testing

- Two analytical balances
- Complete apparatus for proximate coal analysis
- Emerson bomb calorimeter
- Parr bomb calorimeter
- Junker calorimeter for gas and liquid fuels
- Two Orsat flue-gas apparatus
- Two Franklin flue-gas apparatus
- Hempel gas-analysis apparatus
- Open-cup flash-point apparatus
- Closed-cup flash-point apparatus
- Saybolt viscosimeter
- Westfals balance
- Electric furnace.

Material Testing

- Two 30,000-lb. Riehlé tension and compression machines
- Two 30,000-lb. Olsen tension and compression machines
- One 50,000-lb. Olsen tension and compression machines
- One 60,000-lb. Riehle torsion machine
- One 6,000-lb. Thurston autographic torsion machine.

(Continued on page 557)

Conference on Present State of Knowledge of Properties of Steam

AT an informal conference held in Cambridge, Mass., on June 23, 1921, at the instance of Mr. Geo. A. Orrok,[1] fourteen gentlemen were present, including several representing important users of steam, several makers of steam tables, several experimental experts in the heat-measurement field, and the chairmen of the three A.S.M.E. committees most directly interested.

The following facts were presented as to the range and reliability of the experimental data on which the steam tables now in use are based:[2]

Vapor pressures are apparently satisfactorily known over the whole range up to the critical point, except for some slight uncertainty below 70 deg. fahr. This uncertainty might perhaps trouble designers of cooling towers or of air-conditioning apparatus. Otherwise it is unimportant. Incidental checks on the vapor-pressure curve are always desirable, but not at present greatly needed.

Our knowledge of the heat of the liquid is most unsatisfactory. Between 32 deg. fahr. and 212 deg. fahr. the great need is for a better determination of the mean heat unit now commonly used as the fundamental heat unit of our tables. Both the mechanical equivalent of the mean heat unit and its ratio to the heat units ordinarily employed in precision calorimetry are uncertain by at least two-tenths of one per cent. While this uncertainty seems small from an engineering point of view, it appears in so basic a place that it can hardly be ignored. The corresponding fundamental units of electrical engineering are experimentally reproducable to at least ten times this accuracy.

Above 212 deg. fahr. there are only two determinations of the variation of the specific heat of water with temperature, one of which is seventy-two years old and the other sixteen. Both are, for various reasons, unsatisfactory.

The density of water under the pressure of its saturated vapor is fairly well known up to 600 deg. fahr. It is not an important quantity in engineering computations. Further measurements might therefore be considered unnecessary, were it not for the fact that substantially equivalent work must apparently be done in any case in connection with the calibration of the apparatus for other highly important work.

Latent or total heats of saturated steam have been directly measured up to about 380 deg. fahr. (181 lb. gage saturation pressure) with probable errors, which, although small from the percentage point of view, are nevertheless large from the point of view, for example, of the turbine designer. This sort of measurement is very difficult to make with the desired accuracy, and total heats along the saturation line are best determined by other means.

In the superheated region three sorts of measurements can be made, namely, measurements of the specific volume, measurements of the specific heat at constant pressure, and measurements of the Joule-Thomson "cooling effect," each being determined as a function of pressure and temperature over any desired range of the variables. Theoretically, any one of these kinds of measurement, if made with sufficient accuracy, would suffice for the computation of a complete steam table (provided that various functions which appear as constants of integration were known, as is now largely if not wholly true). If, then, two of these quantities are measured, there is a check on the experimental work. If all three are measured, there is a triple check. Considering the difficulty of the precise experimentation in the whole field, such a multiple check is highly desirable.

On volumes, the Munich experiments are generally regarded as the best available. Their range is from atmospheric pressure up to about 150 lb. gage, and from saturation to a superheat that is sometimes as low as 20 deg. fahr. and is never as high as 100 deg. fahr. Their accuracy is good enough from the practical point of view, but neither accuracy nor range is sufficient for any check on rates of change of either specific heats or Joule-Thomson coefficients.

On specific heats, there is the large group of Munich experiments published in three instalments and from about half an atmosphere absolute (saturation temperature about 177 deg. fahr., to about 270 lb. gage (saturation tempe ature about 413 deg. fahr). As to temperature, these experiments cover, at all the above pressures, the range from saturation to about 725 deg. fahr., and up to about 100 lb. gage they run up to 1100 deg. fahr. This range covers admirably present commercial conditions, but should be supplemented at the high pressure end to provide for the pioneer development work now contemplated by many designers. Except near saturation, the accuracy of these experiments is probably good enough for our present needs, although there is still room for personal judgment in fitting smooth curves to the experimental points. There are also some experiments by Thomas. At least near saturation, they are seriously affected by priming. Callendar apparently believes that this can be corrected for, and much dependable information obtained from this work. The more generally held opinion seems to be that this work requires confirmation.

On the Joule-Thomson cooling effect, there are the classical papers of Grindley, of Griessmann, and of Peake that have been discussed by everybody for about fifteen years. These experiments do not show unmistakably even the sign of the pressure coefficient of the Joule-Thomson effect, to say nothing of the magnitude of this coefficient. And when plotted against temperature, the band of points that these experiments yield is from 15 to 40 per cent wide. There is also an isolated va'ue by Trueblood which is too lonesome to be important. And finally, in his recent book, Callendar casually introduces a dozen values, mostly at comparatively low pressures, "selected so as to cover the experimental range as evenly as possible," from a set of observations "most" of which "were taken between 150 deg. and 120 deg., and between 15 and 50 lb. pressure." The reliability of this work still rests solely on his previous reputation, since he has published no details.

The present experimental situation can, then, be summed up as follows: Vapor pressures and possibly liquid volumes are well enough known for the present; superheated specific heats are fairly well known except at pressures above 270 lb. gage; specific volumes are known directly only below 150 lb. gage and at low superheats; latent and total heats of the vapor are known directly but not entirely satisfactorily up to about 190 lb. gage; above that pressure they are not known directly at all; Joule-Thomson coefficients (from which total heats can best be determined) are scarcely known at all above 50 lb. gage; and finally, our knowledge of the heat of the liquid and of the fundamental heat unit on which the whole table is based is most unsatisfactory.

In the light of these facts, the conference agreed unanimously that the chief need at present is not so much for further discussion or study of the existing data, or even for an agreement among those interested in a "standard" table, as for more and better experimental work, especially at high pressures. They therefore outlined the appended experimental program which, in its present form, is in some ways a compromise between the best that could be wished for and what the apparatus and personnel in sight seem fitted to give. For example, the proposed work on the Joule-Thomson effect is limited to 600 lb. and 600 deg. fahr. because that is all that can be hoped for with the apparatus now available at Harvard without extensive changes and considerable delay. On the other hand, no limits are set to the range over which vapor and liquid volumes are desired, because the apparatus now available at the Massachusetts Institute of Technology is good up to the critical pressure, and at least up to the critical temperature. On the other hand, no limits are set to the range of the proposed experiments on liquid and vapor specific heats, because, although a considerable part of the development work on the necessary apparatus has already been done at the Bureau of Standards in connection with their ammonia work, the steam apparatus will have to be modified to cover any part whatever of the temperature range desired, and the efficient range of the new apparatus cannot be wholly foreseen until some work has been done on designing it. It was understood at the conference that the Bureau work could probably be pushed to 600 lb. and 600 deg. fahr., and perhaps even further in one or both directions.

(*Continued on page 557*)

[1] Consulting Engineer, N. Y. Edison Co.

[2] This discussion was prepared by Messrs. Harvey N. Davis, R. C. H. Heck, and E. Buckingham.—EDITOR

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

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C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

The Present State of Knowledge of the Properties of Steam

THE report of a conference which was held at Pierce Hall, Harvard University, in Cambridge, Mass., on June 23, for the consideration of the present state of knowledge of the properties of steam, is published on page 553 of this issue.

Geo. A. Orrok

During the last five years, while the divergences of the steam tables in this country have been small, we have been hearing of developments in England both in the superheated range and also with regard to supersaturation. Abstracts of a number of articles on the subject have appeared from time to time in Mechanical Engineering, including Martin's article on the new theory of turbine design (page 784, September 1918) which deals with supersaturation. Callendar's new steam tables which have been recently brought out differ widely from the more commonly used tables of Marks and Davis and of Goodenough, and these differences are of the order of one part in one hundred or larger. (A review of Callendar's book was published on page 259 of the April issue.) The minor differences between Marks and Davis and Goodenough have been covered in a paper by Professor Heck which was presented at the last Annual Meeting of the Society and was widely discussed.

It was brought out at the Cambridge conference that our heat unit is accurately known only to about one part in 300, while our electric units are known to at least one part in ten thousand. It appears that the range from 80 to 350 deg. fahr is fairly well covered. but our determinations are from fifteen to seventy-two years old and there are many minor differences. Pressures up to 160 lb. are fairly accurate, but our points in the superheated field are apparently doubted by more than one authority, the actual point and trend of the curves being problematical. Various explanations have been offered for these divergences, the latest theory being that supersaturation is responsible for most of the discrepancies.

Meanwhile, the march of progress is accelerating. Power plants using steam at 250 lb. pressure are common; 300 lb. is not unusual and at least one plant is operating at 400 lb. gage pressure. The use of even higher steam pressures is projected, and in the near future we may expect to see the use of 800 to 1000 lb. as common as is 250 lb. today. Steam temperatures are only limited by the nature of our materials of construction and 700 to 750 deg. fahr. are common, while superheater manufacturers are talking of 800 to 1000 deg. fahr. It is apparent that at the present time most of our data above 360 deg. are extrapolated and the location of the curves is a matter of personal opinion rather than of scientific fact.

The conference agreed that the only thing to do was to secure more data in the higher and lower ranges, carrying the work as far as possible but restricting it so that the results would be available in a reasonable time. From the nature of some of the apparatus available it is thought that the upper limits may be extended to 600 lb. and somewhere between 600 and 700 deg. fahr. The determination of the Joule-Thomson coefficient will determine the trend of the curves in the upper ranges, and the amount of extrapolation will be greatly reduced.

The conference expressed the belief that it will be possible to so conduct the various lines of experimentation that three independent checks on the pressure-temperature-volume relation will be obtained and many of the mooted questions which now appear in the discussion of this subject can be definitely settled for all time with an accuracy suitable to the purpose in view. The Council of The American Society of Mechanical Engineers has approved this program and the Research Committee of the Society will be charged with its administration. The results of the conference have attracted widespread interest among the manufacturers and users of steam apparatus. Geo. A. Orrok.[1]

Opportunity for Engineering Service

ABOUT February 20, 1921, New York experienced a heavy fall of snow. On Washington's Birthday, the 22nd, I was at home trying to take advantage of the holiday to catch up with my work. My attention, however, was continually distracted by the efforts at snow handling and removal going on outside. There seemed to be little planning behind the work, and much of the effort was misdirected and often harmful. Emergency work can never be highly efficient, and while this particular snowfall was handled better than had ever before been done in New York, it nevertheless left much to be desired.

Acting largely upon impulse, I sat down and dictated a letter to Mr. Calvin Rice suggesting that the Society take up the problem at a special meeting. In due time I received a reply from Mr. W. S. Finlay, Jr., saying that a meeting of the Metropolitan Section had previously been planned to be held in the fall for the consideration of the snow problem. This meeting has now been scheduled for September 23, and I have been asked to present the subject briefly in the columns of Mechanical Engineering to induce fellow-members to give it serious thought and demonstrate how much can be accomplished in solving our public problems by arousing widespread interest on the part of our Society members.

Few people realize what a vast weight and bulk is represented by a 12-inch snowfall. Possibly in New York this amounts to as much as 1,000,000 tons and more than 300,000,000 cubic feet. Calculations showing the quantity and weight will be both interesting and valuable.

The known cost of snow handling is very large,and the unknown cost due to lack of prompt removal and the impediment to traffic is perhaps much larger. Actual figures on the known cost and calculations on the unknown cost will be interesting and valuable. Listing all of the methods of handling or removing snow, and then giving comparative costs, will also be valuable.

For instance, snow can be scraped from narrow streets into nearby squares or parks. Much of it is now hauled away by trucks and wagons. It is so bulky that un'ess a special body is used a 10-ton truck with a body designed for construction material would probably be filled when it had a ton of snow on it. Query: How much weight can be loaded on a truck, and how shall we adapt the ordinary truck or wagon body to carry snow?

Special loading devices are being experimented with. Sug-

[1] Consulting Engineer, N. Y. Edison Co.

gested improvements will be in order for these devices, also for trucks with self-loading attachments.

Water is often used to flush the snow into the sewers. Except under special conditions this probably represents a very costly method of snow removal. Actual and calculated costs by this method will be valuable.

New York is using motor-driven scrapers. Suggested improvements of these machines will be valuable.

To create interest in the subject I gave to the newspapers a copy of my letter to Mr. Rice, and received a great many letters on the subject—some from engineers, but mostly from non-engineers. These letters showed how little the layman knows about the physical constants that underlie the problem—and I am sorry to say that some of the engineers showed little knowledge of the value of these physical constants and the quantities to be dealt with.

For instance, a general line of attack seems to be that of melting the snow to water and running it into the sewers. If New York has 1,000,000 tons of snow to deal with for every 12-inch snowfall, this would require greatly in excess of 10,000 tons of coal—and would still leave much labor expense to handle the snow, as it would be difficult to melt it in place.

I made a number of suggestions in my letter to Mr. Rice of methods of handling our snow, but as the space here available will not permit very extended treatment, I will have some of the correspondence printed and sent to the headquarters of the Society so that any one especially interested in the subject can send for copies.

I think the most promising suggestion I was able to make was to briquet the snow, thus compressing it to a much smaller volume and permitting it to be put in piles having vertical sides and thereby taking up very little of the width of the street. Several inventors have already gone to work to design automatic briquetting machines that will gather up the snow, briquet it and stack it. One engineer connected with a machinery-manufacturing concern of this character told me that he had worked out a preliminary design, and had made some preliminary figures on speed and cost, and that he was inclined to think that snow handling by briquetting and stacking would prove so efficient and economical that it would supersede all other methods and therefore would be applied universally.

The officers of the Metropolitan Section want to demonstrate that the big public problems can be best solved by the engineer, and to do this they must bring out at this meeting means for dealing with our snow problem vastly better than anything we now have. Will you help?

Henry L. Doherty.

A.A.A.S. Plans Engineering Activity

Mr. L. W. Wallace has recently accepted the appointment as secretary of the Engineering Section of The American Association for the Advancement of Science for the term ending with the Toronto Meeting of the Association in December.

The American Association for the Advancement of Science is organized in sixteen sections, such as mathematics, physics, medicine, astronomy, engineering, etc., each of which holds its own session at the annual meeting of the Association. The American Society of Mechanical Engineers, and the other leading national engineering bodies are affiliated with the Engineering Section and nominate annually two honorary councilors. Dr. Ira N. Hollis and Prof. Robert W. Angus are the nominees this year.

Mr. Wallace, Secretary of the American Engineering Council of The Federated American Engineering Societies, which organization embraces the whole profession, will bring to his new work a keen understanding of the needs of the engineering profession in developing contacts that will add to it dignity and usefulness. The activity of the Engineering Section of the American Association for the Advancement of Science leading up to the convention in Toronto next December should be productive of greater understanding, not only between the branches of pure and applied science but between the various branches of engineering represented in the Engineering Section. In other words, another link has been added to the chain of engineering and professional coöperation.

To achieve the true ideal of service the engineering professions should have many professional alliances. Although the engineer may occupy a strategic position of service to the public, he can accomplish little alone. The true ideal can be attained only by coöperation of the broadest nature.

Frederick F. Sharpless Elected New Secretary of the Mining Engineers

At a meeting of the Board of Directors held on June 24, Frederick Fraley Sharpless, mining engineer and metallurgist, educator and editor, was unanimously elected secretary of the American Institute of Mining and Metallurgical Engineers, to succeed Bradley Stoughton, whose resignation was noted in our July issue.

Frederick F. Sharpless

Mr. Sharpless is a native of Pennsylvania and a graduate of the University of Michigan, class of 1888. He was professor of metallurgy at the Michigan School of Mines for five years and American representative of the Consolidated Mines Selection Co., Ltd., London, for fourteen. He has traveled widely throughout the United States, as well as in Alaska, Canada, Mexico, Central and South America, Asia and Africa.

In addition to having been a member of the A.I.M.E. for thirty-two years, Mr. Sharpless holds membership in the Mining and Metallurgical Society of America and the Institution of Mining and Metallurgy of London. His varied experience and wide travels make him especially well fitted for the office.

War-Invention Disclosures

Since the armistice there has been a flood of information published as to war inventions made by the various military agencies of the United States, and this flood is still continuing.

In Great Britain a similar policy was followed at first, but as time goes on less and less information is being published, considerable secrecy being maintained in regard to really important things. Thus, for example, while a very large volume of data is available in print as to the production of military gases by the Chemical War Service of the United States Army, comparatively little is known as to what similar agencies have done in England.

Only driblets of information regarding the military secrets of the French Army have become available through French sources, and next to nothing has been made public by the Germans as to their technical achievements during the war.

A New Management Magazine

The first issue of management engineering, styled "The Journal of Production," appeared July 1. It is published by the Ronald Press Company, under the direction of Leon P. Alford, Vice-President A.S.M.E., a technical editor of experience who served in that capacity on the *American Machinist* for nine years and on *Industrial Management* for two years. Mr. Alford is assisted by E. W. Tree, formerly associate editor of Mechanical Engineering.

The July number contains articles on a number of the fundamentals of management engineering, such as, The Training of Foremen, Responsibilities of Management, Educational Courses in Management Engineering, Cost Accounting, and Storeskeeping. The leading article is a contribution from Edwin S. Carman, President A.S.M.E., entitled The Pioneer Spirit in Engineering.

Each of the articles is indexed according to the Brussels classification of the Dewey decimal system, and Harrison W. Craver, director of the Engineering Societies Library, presents a method

by which this system of classification may be utilized to advantage by the engineer in connection with his own library.

Dr. Philip B. Woodworth New President of Rose Polytechnic Institute

Rose Polytechnic Institute has selected as its president Dr. Philip B. Woodworth, to succeed Dr. C. L. Mees who resigned in 1919 upon the completion of twenty-seven years of service.

Dr. Woodworth was graduated from Michigan State Agricultural College in 1886 with the degree of B.S.; he received the degree of Master of Engineering in electrical engineering from Cornell University in 1890. The year of 1891–92 he spent as a student of engineering and science at the University of Berlin. In 1920 his alma mater conferred upon him the honorary degree of Doctor of Science. Dr. Woodworth began his teaching experience in the Michigan public schools before entering college; in 1892, when he returned from abroad, he became professor of physics and engineering in Michigan Agricultural College. Seven years later he became professor of engineering in Lewis Institute, Chicago, and later dean, which position he held until 1917 when he was called into Government service. There he was successively executive secretary of the National Council of Defense and regional director for the North Central States, in charge of vocational training work for enlisted men.

In addition to that gained through his teaching Dr. Woodworth has had wide experience in engineering. He served as designing and consulting engineer for the Piatt Power Co. in the construction of a dam at Lansing, Mich., and for three years as superintendent of operation. He was also managing superintendent of the Lansing Street Railway for two years. He has been retained in the capacity of expert consultant by the Chicago surface lines, the Peoples Gas, Light and Coke Co., the Chicago Elevated Railway, the Chicago Telephone Co., the Commonwealth Edison Co., the Western Electric Co., the Aeolian Co., New York, the Christensen Air Brake Co., Milwaukee, and numerous other smaller corporations. The greater part of the work was done under the firm name of Rummler, Rummler & Woodworth, attorneys and engineers.

Dr. Woodworth is the author of numerous technical and education papers and of a textbook on Engineering Principles. He is a member of the American Institute of Electrical Engineers, the Western Society of Engineers, the Society of Automotive Engineers, the Society of Industrial Engineers, the Engineers' Council (Masonic organization) and also of the Chicago Electric Club.

Francis Bacon Crocker Dies

Francis Bacon Crocker, eminent electrical engineer, died on July 9, 1921, at his home in New York City, at the age of sixty-one. Born in New York City, he was educated in the city schools and attended the School of Mines, Columbia University, from which he was graduated in 1882. Later he organized the school of electrical engineering at Columbia and served as its head for twenty years, when he retired because of ill health. His most important contribution to the electrical industry was the commercial motor, the first of which was put into use in 1886. This was produced in conjunction with Charles G. Curtis and Schuyler S. Wheeler as the C. & C. Co. and later the Crocker-Wheeler Co., of which he was a director at the time of his death.

Professor Crocker was one of the two American delegates to the International Electrotechnical Commission in London, and at its most important session was able to insure the standardization necessary to make worldwide electrical manufacturing successful. For this work Lord Kelvin described him as one of the world's two greatest electricians. During the war Professor Crocker acted as adviser to the Naval Consulting Board. With Peter Cooper Hewitt he developed the first successful helicopter in this country, which was taken over by the Government and put into manufacture shortly before the armistice came. He was also the author of a number of standard treatises on electric lighting and electrical machinery.

Samuel Storrow Webber

Samuel Storrow Webber, life member of The American Society of Mechanical Engineers since 1880 and manager from 1902 to 1905, died on April 27, 1921. Mr. Webber was born in Springfield, Mass., on March 31, 1854. When sixteen years of age he entered the drafting department of the Rogers Locomotive Works, Paterson, N. J. He was next associated with the Blood Manufacturing Works at Manchester, where he became acquainted with the practical side of the business. As mechanical engineer, Mr. Webber accompanied several expeditions for gold dredging in California and South America. He was connected with the Trenton, N. J., Iron Works for twenty-five years, retiring in 1914.

Samuel S. Webber

Mr. Webber became a member of the Society in 1880. He was a member of the Engineers' Club of New York.

James Prentice Sneddon

James Prentice Sneddon, general superintendent of The Babcock & Wilcox Co., Bayonne, N. J., died at the Johns Hopkins Hospital, Baltimore, on June 11, 1921. Mr. Sneddon was born on July 7, 1863, in Wishaw, Scotland. He came to this country at the age of thirteen and for three years attended the public schools of St. Louis, Mo. At the end of that time he entered the employ of the Carbondale Coal & Coke Co., Carterville, Ill. So successful was his work there that he was given charge of the construction of a forty-mile railroad for the company. Convinced that he possessed engineering ability, he returned to St. Louis to serve an apprenticeship as machinist with the Rankin-Fritsch Foundry & Machine Co.

Toward the end of his apprenticeship he was sent to Indian Territory as erecting engineer, and later to the Tennessee Brewery at Memphis to install power-plant and refrigerating equipment built by his company. When the plant was put in operation he was asked to assume charge and for the next four years held the position of plant engineer. In 1889 he became master mechanic for the Pittsburgh Plate Glass Co. at their works in Crystal City, Mo., with charge of installation of all equipment. Four years later the Rankin-Fritsch Foundry & Machine Co. tendered him the position of general manager with stock interest, which he accepted, assuming full responsibility for the design and building of their line of Corliss engines and other equipment for power plants.

In 1899 he became superintendent in charge of manufacturing of the Stirling Boiler Co., Barberton, Ohio. In 1906 the company had enlarged greatly and the boiler department of Aultman-Taylor Co. was absorbed, at which time Mr. Sneddon became general manager, in charge of all manufacturing, of the Stirling Consolidated Boiler Co. In 1907 a further consolidation was made with The Babcock & Wilcox Co., and Mr. Sneddon assumed the position of general superintendent with headquarters at Bayonne, N. J. Later his duties were broadened to include the vice-presidency of the Pittsburgh Seamless Tube Co., a subsidiary of The Babcock & Wilcox Co., with full charge of all manufacturing operations for these associated companies.

The war interrupted this service in 1915, at which time he was technical adviser to the British Mission in the U. S. During the following year he was a member of the staff of J. P. Morgan & Co., export department, when they were buying and furnishing supplies for the Allied Forces. When the United States entered the war he returned to his regular duties and continued his war activities in manufacturing shell forgings, boilers and tubes for the U. S. Navy Shipping Board and essential industries.

Mr. Sneddon was a member of the Engineers' Club of New York, the Machinery Club, and the Masonic Order. He became a member of the Society in 1891.

ENGINEERING RESEARCH

(*Continued from page 552*)

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

International Nickel Company E1-21. The Research Department of the International Nickel Company is located at the Orford Works at Bayonne, N. J. The department occupies over 5000 sq. ft. of floor space. It is under the direction of Dr. P. D. Merica. The work of the department is along a number of lines including the following:

The possible use of non-metallic compounds such as black nickel sulphide, black nickel hydrate and nickel chromate as paint or printing pigments. Compounds of nickel oxide with zinc oxide for body colors in ceramic ware and solid nickel compounds for fungacides. Many nickel compounds are not thoroughly known by chemists. Investigations are made of their properties for use in the arts.

The laboratory is also working on the properties of monel metal, constantan, soda glass with approximately 30 per cent of sodium oxide, and black glass for table tops. A study is also being made of the properties in production of ingots in casting. Address John F. Thompson, Manager, Technical Department, International Nickel Company, 43 Exchange Place, New York.

Massachusetts Institute of Technology E1-21. The various laboratory facilities at the new plant of the M.I.T. have been increased materially since the original installation. The Road Materials Testing Laboratory has been increased and the laboratory dealing with heat treatment has been doubled in size, while the Metallographic Laboratory under the immediate charge of Dr. Fay has been made much larger. Prof. Cowdray has been specializing in the cellular structure of wood and has found that there is a great demand for information regarding this matter. Address Prof. Edward F. Miller, Massachusetts Institute of Technology, Cambridge, Mass.

Ohio State University E1-21. The Engineering Experiment Station is about to issue a bulletin on the Economy in Liquid Fuel Utilization by Professor Norman. Professor Judd is continuing his work on pulsating flow in pipes. Theses regarding the strength of fillets, friction in bearings and on the strength and elasticity of indicator cords have been completed, although they are not ready for publication. Address Prof. W. T. Magruder, Ohio State University, Columbus, Ohio.

Pennsylvania State College E2-21. The Experiment Station of the Pennsylvania State College will be engaged during the summer on investigations of heat transfer, using a new hot plate for determining constants of new materials and studying surface and humidity effects. Dr. P. Nicholls of the Franklin Manufacturing Company will work in the laboratory during the summer. The laboratory will also investigate oxy-acetylene welding and will make a preliminary study of fuels for house-heating boilers. Address Prof. A. J. Wood, Pennsylvania State College, State College, Pa.

State University of Iowa E1-21. During the next twelve months Prof. Floyd A. Nagler and two research assistants, appointed and paid by the University, will devote half of their time to the conduct of original research in the recently completed hydraulic laboratory belonging to the University. It is expected that this research will deal largely with fundamental principles regarding the flow of water over weirs. These studies will take such special direction as may seem of most immediate practical use to the engineering profession. The laboratory will welcome suggestions from engineers as to immediate needs in this direction. Address Prof. Floyd A. Nagler, State University of Iowa, Iowa City, Ia.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Petroleum, Asphalt and Wood Products F2-21. Recent Articles on Petroleum and Allied Subjects. The Bureau of Mines issued each month a bibliography on Recent Articles on Petroleum and Allied Subjects prepared by E. H. Burroughs. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

University of Pennsylvania E1-21. Among the investigations made at the University of Pennsylvania during the past year have been those relating to the efficiency of operation and mechanical construction of hoisting apparatus and the efficiency and conductivity of pipe. Address Prof. R. H. Fernald, University of Pennsylvania, Philadelphia, Pa.

CONFERENCE OF PRESENT STATE OF KNOWLEDGE OF STEAM PROPERTIES

(*Continued from page 553*)

The conference also discussed at some length the question of supersaturation, and its bearing both on turbine design and on the form of future steam tables. Some gentlemen felt strongly that an experimental study of this question should be added to the proposed program. All agreed that this would be highly desirable if practicable. No such action was finally agreed upon, however, partly because a definite suggestion worthy of unanimous approval as to just what ought to be attempted in a laboratory or experimental plant failed to materialize, and partly because the personnel question seemed difficult. The whole matter was therefore reluctantly laid aside for the present. It deserves thoughtful consideration by all who may by any chance be able to contribute to the desired solution.

REPORT OF THE CONFERENCE

We the undersigned, having met in informal conference in Cambridge Massachusetts, on June 23, 1921, have discussed at some length the present situation with respect to steam tables in the United States.

We feel strongly that it is of great importance to all users of steam in the United States that the properties of steam should be known with reasonable accuracy at pressures considerably higher than those at which any reliable experimental data are at present available.

After canvassing the situation we believe the following experimental program should be undertaken:

1 The specific heat of water should be determined with the greatest possible accuracy up to the boiling point of water at atmospheric pressure for the more accurate determination of the mechanical equivalent of the mean heat unit. The specific heat of water should also be determined at higher temperatures for the better determination of the heat of the liquid.

We believe that this work can best be done at the United States Bureau of Standards.

2 The pressure-temperature-volume relation of superheated steam should be determined experimentally at high pressures and over as wide a range of superheats as possible.

We believe that this work can best be done at the Massachusetts Institute of Technology under direction of Prof. Frederick G. Keyes.

3 The density of liquid water should be redetermined accurately over a wide temperature range above that at which satisfactory data are now available.

We believe that this work can best be done at the Massachusetts Institute of Technology under the direction of Prof. Frederick G. Keyes. We understand that in this connection Professor Keyes will be able to check the vapor-pressure curve of Holborn and Baumann.

4 The Joule-Thomson cooling effect in superheated steam should be determined at pressures up to 600 lb. and at temperatures up to 600 deg. fahr.

We believe that this work can best be done at the Harvard Engineering School under the direction of Prof. Harvey N. Davis.

5 Independent measurements of the specific heat at constant pressure of superheated steam should be made at higher pressures than those covered by the Munich experiments as a check on the volume and Joule-Thomson measurements. This work should be undertaken at the earliest possible moment. At present no one seems willing to undertake this work.

We believe that it could best be done at the United States Bureau of Standards, and that they should be requested to undertake it as soon as other conflicting work can be finished.

We estimate that this program could be undertaken at a cost of about $35,000 a year, and we hope that it could be completed in about three years.

We earnestly recommend that The American Society of Mechanical Engineers undertake the furtherance of this research program through its Research Committee, and that the Society undertake to receive and administer the necessary funds. We wish to recommend this program to the favorable consideration of the various interests concerned with the use of steam and to request their financial coöperation in making its realization possible.

Geo. A. Orrok	Harvey N. Davis
F. R. Low	Edwin H. Brown
Arthur M. Greene, Jr.	Robert C. Allen
Robert C. H. Heck	Ernest L. Robinson
Lionel S. Marks	H. C. Dickinson
Frederick G. Keyes	Edgar Buckingham
G. A. Goodenough	E. F. Mueller
per R. C. H. Heck	C. E. Davies.

Not present but concurring in the recommendations:

D. S. Jacobus	C. F. Hirschfeld	Francis Blossom
C. A. Adams	John E. Bell	W. F. M. Goss
C. H. Smoot	John H. Lawrence	O. P. Hood
O. Junggren	John Hunter	E. N. Trump
A. C. Flory	Percy H. Thomas	Owsley Brown
J. E. Moultrop	H. A. Lardner	C. C. Thomas
W. S. Munroe	George I. Rhodes	Peter Junkersfeld
C. E. Fisher	W. S. Finlay, Jr.	W. C. L. Eglin
W L Abbott	C. A. W. Brandt	W. B. Gregory.

John Fritz Medals Presented at International Gatherings

Representatives of Four National Engineering Societies Visit England and France—Sir Robert Hadfield and Eugene Schneider Recipients of John Fritz Medals—Engineering Institutions of England Confer Honorary Memberships on Visiting American Engineers

AMERICAN engineers have felt a great admiration and gratitude for the work performed by the engineers of England and France during the war and their activities in reconstruction since. The desire to convey these sentiments in a personal manner to those of the profession allied with them in the war, together with the inability of Sir Robert Hadfield, the recipient of the 1921 John Fritz Medal, to come to this country to receive the medal in person, led to the development of a plan to send a delegation of representative American engineers to England. The anticipation of the 1922 award to Eugene Schneider by the John Fritz Medal Board of Award broadened the plan so that similar ceremonies were carried out in France.

Organizers of the expedition, feeling that the scientific and technical coöperation built up during the war was a very solid foundation on which to build wider sympathies and better understandings between these three countries, therefore included the presentation of the John Fritz Medals for 1921 and 1922 as a feature of international ceremonies of marked importance in the beginning of an era of closer association of the ideals and activities of the engineers of the United States, Great Britain, and France.

Robert A Cummings Charles T. Main Jesse Merrick Smith F B Jewett William Kelly
Ira N Hollis Arthur S Dwight Ambrose Swasey Charles F Rand John R Freeman

The deputation consisted of twelve distinguished engineers representing the four national engineering societies of America. Their names and the societies they represented are as follows:

John Fritz Medal Board of Award:
AMBROSE SWASEY, *Chairman*

American Society of Civil Engineers:
CHARLES T. MAIN
ROBERT A. CUMMINGS
JOHN R. FREEMAN.

American Institute of Mining and Metallurgical Engineers:
COL. ARTHUR S. DWIGHT
CHARLES F. RAND, Secretary John Fritz Medal Board of Award
WILLIAM KELLY.

The American Society of Mechanical Engineers:
DR. IRA N. HOLLIS
JESSE M. SMITH.

American Institute of Electrical Engineers:
DR. F. B. JEWETT
DR. A. E. KENNELLY
MAJOR-GENERAL G. O. SQUIER.

The John Fritz Medal Fund was established in 1902 by friends and associates of John Fritz as a means of perpetuating the memory of his achievements in industrial progress, and the medal itself is one of the highest honors conferred by American engineers. It is awarded annually for scientific and industrial achievement in any field of pure or applied science, the first award being made in 1902 to John Fritz, and the second in 1905 to Lord Kelvin. Others among those who have since received the medal are George Westinghouse, Dr. Alexander Graham Bell, Thomas A. Edison, Sir William H. White, Robert W. Hunt, Elihu Thomson, Dr. James Douglas, Prof. H. M. Howe, Gen. Geo. W. Goethals, and Orville Wright. The Board of Award is made up of representatives of the four national engineering societies, one member of each society being elected annually to serve for a period of four years. The present board consists of the following men:

A.S.C.E.	Geo. H. Pegram F. S. Curtis Arthur N. Talbot Arthur P. Davis	A.I.M.E.	Herbert Hoover C. R. Corning Charles F. Rand Benj. B. Thayer
A.S.M.E.	Ambrose Swasey Henry B. Sargent F. J. Miller W. M. McFarland	A.I.E.E.	E. Wilbur Rice Calvert Townley Comfort A. Adams A. W. Berresford

Sir Robert Hadfield, the recipient of the 1921 medal, has taken a prominent part in the development of the steel industry. In addition to the invention of manganese steel, for participation in which he was awarded the medal, he has invented a magnetic steel of high permeability and other valuable steel alloys. During the war he was one of the largest producers of munitions for the British Navy. As a member of various scientific societies of Great Britain he has contributed largely to their growth; he is also an honorary member of the American Institute of Mining and Metallurgical Engineers. He is a pioneer in advocating in Great Britain the getting together of the engineering societies of the kingdom just as they have done in the United States, with common headquarters, a joint library, etc.

Eugene Schneider was awarded the 1922 medal for "achievement in metallurgy of iron and steel; for development of ordnance, especially the 75-mm. gun, and for notable patriotic contribution to the winning of the war." He has been head of the Creusot engineering and steel works of France since the death in 1898 of his father, who in his lifetime was an Hon. Mem. Am.Soc.M.E., and has given a great deal of attention to the well-being of his employees, as well as leading in the development of the steel and engineering industries of France. He is a member of various French clubs and societies and has been the recipient of many honors at home and abroad. M. Schneider is the first engineer outside the English-speaking world to receive the medal.

The presentation of the medal to Sir Robert took place at the opening conference of the British Institution of Civil Engineers in London on June 29. The meeting was attended by many eminent British engineers and scientists and also by the American ambassador and Viscount Bryce, representing Mr. Lloyd George. The president, Mr. J. A. Brodie, welcomed the deputation to the institution and to the country. Dr. Ira N. Hollis, representing the four American national engineering societies, delivered an address in which he conveyed the best wishes of the engineers of the

United States to those of Great Britain and expressed the hope that eventually engineers not only in the United States but in Canada, Great Britain and South Africa—all speakers of the same language—would be banded together for the welfare of the world. He spoke at some length on the admiration of engineers of this country for the achievements of British engineers during the war and the advantages to be gained by close coöperation between engineers of the two nations. He outlined the problems of the day in which engineers should take a leading part and closed by presenting an engrossed message to the engineers of Great Britain from the members of the four American national engineering societies in which these sentiments of admiration and good will were set forth.

Following the address by Dr. Hollis, Col. Arthur S. Dwight, representing the American Engineering Council of The Federated American Engineering Societies, as well as the American Institute of Mining and Metallurgical Engineers, presented the greetings of American engineers in the form of a resolution adopted by the Council expressing appreciation of the achievements of British engineers during the war and sympathy for the sacrifices involved, and a desire for close coöperation and mutual interest among the members of the engineering profession in England and the United States in the problems of reconstruction.

Dr. W. C. Unwin, who was asked to reply on behalf of the British engineers, spoke in appreciation of the assistance rendered by the United States in the war and of the engineering work in which engineers of the two countries are working together. He felt that the attendance of the delegation to the Conference was an indication of the better human relations spreading through the United States and Britain.

Lord Bryce, on behalf of those present who were not engineers, welcomed the delegation and shared the sentiments expressed by Dr. Hollis. He emphasized the international character of the engineering profession and congratulated members of the profession on their opportunities.

Ambrose Swasey, as chairman of the John Fritz Medal Board of Award, then presented the medal for 1921 to Sir Robert Hadfield, sketching briefly the history of the medal and the attainments of Sir Robert for which it was presented to him.

Sir Robert, in accepting the award, said that he regarded it not only as an honor conveyed upon him but as an expression to the British nation, on the part of the engineers of the United States, of their high regard and appreciation of the work of the British engineer in the war.

In connection with the award made to him Sir Robert submitted an address covering the history of the John Fritz Medal, the work of the United Engineering Societies in the United States, references to manganese steel and its applications, a general statement concerning his own research work, with a final section dealing with the history and work of the Royal Society. He has also presented a set of engineering papers and presidential and other addresses to the Engineering Societies Library, New York, to be permanently available for inspection and reference.

Other events participated in by the American delegation during its visit in England include a dinner party on the evening of June 27 given by Mr. Swasey, also one on June 28, at which the president and council of the British Institution of Civil Engineers were hosts; and an inspection of the National Physical Laboratory on June 28. On June 30 the deputation attended general meetings in the auditorium of the Institution of Mechanical Engineers, and in the evening were dinner guests of the president and council of the Institution of Electrical Engineers.

On July 8 the deputation went to Paris to present the 1922 medal to M. Schneider. The ceremonies followed the general plan of those in England. Greetings were extended to the engineers of France through La Société des Ingénieurs Civils de France in a resolution of the American Engineering Council similar to that presented to the British engineers.

The party was conducted through the Eiffel Tower by its builder, Alexandre Gustav Eiffel, who was afterward host at a luncheon which was served on the uppermost platform of the tower structure.

It is to be hoped in connection with these events bringing together engineers of Great Britain and the United States that a movement may be developed to bring into still closer coöperation the engineering societies of the British Empire according to the general plan of the American engineering societies.

During the visit of the American engineers to England and France leading engineering institutions of England conferred honorary membership upon four of the group and at a special session of the French Society of Civil Engineers, Ambrose Swasey was made an officer of the Legion of Honor and an honorary member of the Société. He also became an honorary member of the British Institution of Mechanical Engineers, the British Institution of Mining Engineers, the British Institution of Mining and Metallurgy and the Athenæum Club. The two mining institutions, the Athenæum Club, and the Iron and Steel Institute of Great Britain, conferred honorary membership upon Charles F. Rand, and the Institution of Mining Engineers honored Col. Arthur S. Dwight and William Kelly in a similar manner.

Ambrose Swasey is well known in the mechanical world and scientific circles on both sides of the Atlantic. His first inventions were the epicycloidal milling machine and a new process for generating and cutting spur gears. The Warner and Swasey Company, formed in 1880 for the manufacture of machine tools, was soon engaged also in the design and manufacture of astronomical instruments, and has been largely responsible for the development of the world's largest telescopes from the time of the 36-in. Lick refractor constructed in 1886 to the 72-in. reflecting telescope completed in 1916 for the Dominion Astronomical Observatory at Victoria, Canada.

Dr. Swasey has taken a large part in the design of these telescopes and of many other astronomical instruments, including an extremely accurate dividing engine for graduating astronomical circles. He has also developed instruments for seacoast defense and the Swasey range finder.

Dr. Swasey's efforts have ever been toward the advancement of the engineering profession and education in general, and among his many gifts for this purpose are the observatory at Denison University; the science building at the University of Nanking, China; the Y. M. C. A. building at Nanking; and $500,000 for the establishment of the Engineering Foundation.

The honorary degree of doctor of engineering was conferred upon him in 1905 by the Case School of Applied Science, and that of Sc.D. by Denison University five years later. He became a chevalier in the Legion of Honor in 1900.

Dr. Swasey has been a member of the A.S.M.E. since its organization in 1880 and was its president in 1904. He was made an honorary member in 1916. He is a member and past-president of the Cleveland Engineering Society, a member of the Institution of Mechanical Engineers of Great Britain and the British Astronomical Association, and a fellow of the Royal Astronomical Society. He was recently made an honorary member of the American Society of Civil Engineers.

Charles F. Rand, a leading figure in industrial research and a prominent mining engineer of New York City, is director and a past-president of the American Institute of Mining and Metallurgical Engineers and secretary of the John Fritz Medal Board of Award. Mr. Rand is also a member of the American Iron and Steel Institute, the National Research Council, and the American Society for Testing Materials. He is a past-president of the United Engineering Societies and chairman of the Executive Board of Engineering Foundation.

Mr. Rand is identified with the construction of railways and the opening and operation of iron mines in Cuba, and with the iron ore mining industry in the Lake Superior District, besides being largely interested in mines of manganese and copper ores.

In 1913 Mr. Rand was decorated by King Alfonso of Spain with the Grand Cross of Knight Commander (Comendador con Placa) of the Order of Isabella Catolica, for distinguished services to Spain and to mining. He now becomes one of five honorary members of the Iron and Steel Institute, the others being the Prince of Wales, King Albert of Belgium, and Dr. Richard Akerman and Baron Gustaf Tamm of Stockholm.

Col. Arthur S. Dwight, consulting mining and metallurgical engineer of New York, is vice-president of the American Institute of Mining and Metallurgical Engineers and a member of the American Electrochemical Society and the Institution of Mining and

Metallurgy (London). He is a former trustee of Columbia University and one of its leading alumni; he is actively interested in the development of the university's engineering school.

Colonel Dwight has engaged in mining and smelting in the United States and Mexico and is a patentee of the Dwight and Lloyd system of blast roasting of fine ores. He served continuously in France throughout the war, receiving the D.S.O. and other recognition for service.

William Kelly is a member and former director of the American Institute of Mining and Metallurgical Engineers. He is also a member of the Mining and Metallurgical Society of America, the Lake Superior Mining Institute (of which he was president in 1899), and the Institution of Mining and Metallurgy (London), and a fellow of the American Association for the Advancement of Science.

Mr. Kelly has had wide experience as chemist, manager and superintendent in various mining undertakings in Pennsylvania, Ohio and Michigan. He was president of the Board of Examining Engineers for Bituminous Mines Inspectors for Pennsylvania from 1885 to 1889. He has also acted as a member and as chairman both of the Public Domains Commission of Michigan and of the Board of Michigan College of Mines.

NEWS OF OTHER SOCIETIES

American Institute of Electrical Engineers

Annual convention at Salt Lake City, Utah, on June 21 to 24. Water power and long-distance transmission of electric power were the subjects of the principal papers. John L. Harper and J. A. Johnson of the Niagara Falls Power Co. surveyed the progress in the development of water power at Niagara Falls. A continuous flow of 200,000 cu. ft. per sec. passes through the Niagara River. Of the total fall of 336 ft. between Lakes Erie and Ontario, there is a head of 314 ft. that may be developed within about five miles. By an international treaty entered into in 1906 between the governments of the United States and Canada it has been agreed not to divert for power purposes more than 20,000 cu. ft. per sec. on the American side and 36,000 cu. ft. per sec. on the Canadian side. The entire amount of 20,000 cu. ft. per sec., which is available in the United States under the existing treaty, has been utilized, but with varying efficiency. One of the early plants obtains 12.1 hp. per cu. ft. per sec., while in Station No. 3 Extension, completed in 1920, 21 hp. per cu. ft. per sec. is developed. The total power generated in the five plants on the American side is 385,000 hp. If the five plants would operate at the efficiency of Station No. 3 Extension their combined power would be 420,000 hp. Thus, a loss of 34,500 hp. is traceable to inefficient utilization.

W. M. White, of the Allis-Chalmers Co., spoke on Advances in the Art of Water-Wheel Designs and Settings. The present tendency in hydroelectric practice, he said, is to develop each power site completely and to use larger units that will permit the maximum utilization of water power available. The working speed of units is increasing steadily. The best material for runners, according to Mr. White, is bronze without any zinc.

Long-Distance Transmission of Electric Energy was discussed by L. E. Imlay of the Superpower Survey, New York, N. Y. This paper was based on studies made in connection with the development of a superpower system for the industrial district along the Atlantic seaboard. In Voltage Regulation and Insulation for Large Power, Long-Distance Transmission Systems, Frank G. Baum, consulting engineer, San Francisco, Cal., proposed 220,000 volts as standard for national transmission systems. Two other papers on long-distance transmission of power were presented: Some Transmission Line Tests, by W. W. Lewis; and Notes on the Operation of Large Interconnected Systems, by L. L. Elden.

Numerous committee reports were submitted. The committee on the iron and steel industry reported progress in the simplification of control equipment for reversing-mill and finishing-mill drives. The committee on power stations pointed out developments in the design of large power stations such as the Colfax Power Station in Pittsburgh, the Hell Gate Station in New York City, the Delaware Station in Philadelphia and the Calumet Station in Chicago. Increased activities in research work in the colleges were reported by the committee on technical education.

American Society for Testing Materials

Annual meeting at Asbury Park, N. J., on June 20–24. More than 150 specifications were discussed. Of these, 71 were presented for the first time, 63 were revised, and others finally adopted as standard. Steel standards were changed to permit acceptance of steel made by duplex or more complicated processes. The provision adopted as a war emergency permitting the increase by one per cent of the sulphur and phosphorus limits on a considerable number of steel standards was removed from ten of the fourteen specifications on which it still remained. The society, however, is conducting in coöperation with other technical organizations numerous experiments to determine the effect of residual sulphur and phosphorus in otherwise normal open-hearth rolled steel products. The results thus far obtained led to the decision that it would involve no danger to extend permanently the sulphur limits from 0.05 to 0.06 per cent on structural steel for locomotives, cars and ships, owing to the heavy tonnages involved and to the continued difficulty in obtaining low-sulphur fuels and melting stock.

The phosphorus and sulphur limits were both extended 0.01 per cent for steel castings for the same reason. The sulphur limit is thus now reduced on all materials that are to be worked hot and increased on structural materials that are to be fabricated cold.

The committee on corrosion of iron and steel reported that the results of exposing uncoated sheets to atmospheric action indicated that copper-bearing metal is markedly superior in rust-resisting properties to non-copper-bearing metal of the same composition.

A preliminary specification for concrete was submitted by a joint committee composed of 25 members, five each from the American Society of Civil Engineers, the American Railway Engineering Association, the American Concrete Institute, the Portland Cement Association and the American Society for Testing Materials. The specification takes up the subject under the headings: materials, proportioning and mixing concrete, depositing concrete, forms, details of construction, waterproofing and protective treatment, surface finish, and design.

Facts regarding the testing and proportioning of concrete brought out through numerous tests conducted in various laboratories were presented by the committee on concrete and concrete aggregates. The cylindrical shape has been found to be the best for concrete specimens. A specimen having a height twice the diameter is recommended. Specimens of concrete stored in dry air from the time of mixing were found to gain but slightly in strength from 28 days up to a period of several months or even years.

R. S. MacPherran recorded tests made in the laboratory of the Allis-Chalmers Manufacturing Co. to determine the comparative properties of various alloy steels at high temperatures. The work was undertaken with a view to obtaining information as to the best material for use under operating conditions of 600 to 1000 deg. fahr. No temperature was found at which all steels showed a decided change in physical properties. The maximum tensile strength for rolled carbon steel, annealed, and forged 3.25 per cent nickel steel, annealed, occurred at between 600 and 650 deg. fahr. The maximum tensile strength usually occurred at a higher temperature than the minimum ductility. Other technical papers were: Impact Tests on Cast Steel, by F. C. Langenberg; Magnetic Spring Testing, by T. Spooner and I. F. Kinnard; A Test for Shock Strength of Hardened Steel, by C. E. Margerum; Improvements in Apparatus for Testing Petroleum Products, by T. G. Delbridge; and Some Mechanical Properties of Hot-Rolled Monel Metal, by P. D. Merica.

American Society of Heating and Ventilating Engineers

Semi-annual meeting in Cleveland on June 14 to 17. An experimental study on the resistance of materials to the flow of air was presented by A. E. Stacey, Jr. The following conclusions were formulated: (1) That the resistance of air filters varies directly with the velocity of the air through the material; (2) that the resistance is not affected by variations in relative humidity; (3) that the resistance of cotton felt is approximately 100 per cent greater than wool felt of the same weight.

A paper on By-Product Coke Ovens and Their Relation to Our Fuel Supply was read by E. B. Elliott. After reviewing the decreasing reserves of coal, petroleum, natural gas and wood and the

possibilities of conserving these fuels, Mr. Elliott pointed out the unlimited capabilities of the coking process in by-product recovery. He detailed the construction and operation of coke ovens, coke preparation and yields from a ton of coal, and studied the utilization of coke as domestic fuel. The society went on record as favoring a greater production of coke and its increasing use for domestic purposes.

Information on the application of gas to heating residences and commercial buildings was given by Thomson King. A survey of developments in the design of centrifugal fans, together with a description of a new type of multi-blade fan with double-curved blades, was presented by F. W. Bailey and A. A. Criqui (see p. 542 ante).

American Boiler Manufacturers' Association

Annual convention at Bedford Springs, Pa., on June 20 to 22. Progress was reported on the work being undertaken jointly by the Association and the Uniform Boiler Law Society in preserving unity among the states that have already adopted boiler legislation and in urging others to do so.

E. R. Fish reported as the representative of the association on the Boiler Code Committee of The American Society of Mechanical Engineers. A subcommittee was appointed by the Boiler Code Committee to consider the question of Rules for Inspection. Differences of opinion arose particularly in regard to the tolerances that an inspector may make in enforcing the Code. The apprehensions of boiler manufacturers were aroused in consequence of a questionnaire sent out to them soliciting their views. In order to assure the Association that nothing was to be done without their knowledge and coöperation, the Boiler Code Committee asked the Association to suggest some of its members to be added to the Sub-committee, and Starr H. Barnum, R. G. Cox, and Lawrence Connelly were named for that purpose. The report of the subcommittee will have to be discussed at a public hearing before it can be made a part of the Code.

F. R. Low, editor of *Power*, spoke on the Duties and Possibilities of a National Board of Boiler Inspectors. H. L. Parks, of Arthur G. McKee & Co., Cleveland, read a paper on the Proper Method of Filing and Numbering Drawings.

LIMITATIONS OF STOKERS USING MID-WEST COALS

(Continued from page 537)

high capacity. This is on account of the necessity, even with the so-called clinker grinder, of getting the clinker loosened up and into the ashpit by the use of bars in the side doors of the furnace. The ironwork at the rear of the stoker, under conditions just mentioned, comes in for very severe service, and the repairs thereto are likely to be excessive.

Some types of overfeed stokers have been used with good success in this section; and where only a limited capacity is required and suitable coal is available, results that will compare favorably with those from other stokers can be obtained.

The necessity of securing improved refractories, as well as improving the furnace design, is emphasized by the difficulties encountered with the brickwork when high boiler capacities are obtained. While this condition is probably in no way peculiar to stokers using coal from this section, it is possible that it may prove to be one of the factors governing the capacity which will be obtained in future installations.

One condition of primary importance to the stoker manufacturer has come about in the past few years, and that is that the class of help in the boiler room has improved to such an extent that a piece of equipment is not barred from consideration on the ground that it requires intelligence to operate it.

Engineering and Industrial Standardization

Elevator Standardization

The Plan and Scope Committee of the Sectional Committee on the Standardization of Elevators has completed its work and submitted its report to the Sectional Committee. The following are a few extracts from the report which it is believed will be of general interest.

The value of standardization as applied to elevators has been unanimously attested to by the representatives of all the organizations from which the members of the Sectional Committee have been selected. (See March 1921 issue of Mechanical Engineering, p. 218.) In fact, there has been a natural process of standardization as to type throughout the evolution of the modern elevator.

While it is generally recognized that the elevator has been perhaps the most important factor in the development of high buildings, very few appreciate the fact that in large centers of population in this country more passengers are carried by vertical means of transportation than by horizontal means. To give an idea of the extent of elevator traffic, it may be stated that in the Borough of Manhattan there are approximately 23,000 elevators, of which about 12,000 are passenger elevators. From data collected it has been calculated that the latter carry over 12,000,000 persons per day, which is approximately twice the number of passengers carried by the railroads and other horizontal transit facilities of Manhattan Island.

Considering the importance of vertical transportation, it is manifestly well worth while to make an earnest effort to improve the instrumentality for such service—the modern elevator. Some of the specific benefits of this standardization are as follows:

a It will give increased safety and better service to elevator users, the passengers

b It will make it possible for the owner to select an installation suitable for his purpose

c It will reduce first cost, as well as the time required to complete the elevator installation

d It will reduce the cost of maintenance and facilitate securing spare parts.

These values cannot be realized, however, unless the standards are accepted and intelligently used by producers and consumers. Hence it seems advisable that means should be provided immediately for informing both producers and consumers concerning the work which is being done, and ultimately as to the use of the proposed standards. Full publicity following careful standardization will not only tend to bring the manufacturer to a realization of the faults or incompleteness of his apparatus, but it will educate the consumer so that there will be less insistence than at present on the installation of inefficient or inadequate apparatus. To accomplish this end it is proposed to give the subject publicity in the technical press and in the publications of the organizations represented in the Sectional Committee.

The work of the Committee comprises the setting up of standards for both passenger and freight services, and their application not only to the elevator mechanism but also to the hoistway structure as an integral part of the means for vertical transportation. The result of the work should be the following:

Standards. The presentation in suitable form of—

- *a* Fundamental principles governing elevator service
- *b* Technical information sufficient for at least a general determination of elevator plants
- *c* Technical information sufficient for the formulation of specifications covering elevator plants.

Standardization of Design. The presentation in suitable form of—

- *a* Description in general of the design of the several types of hoistway structure and elevator mechanism conforming to the standards promulgated
- *b* Description in detail of the design of such parts of hoistway structure and elevator mechanism as are necessary to make them "fit" together
- *c* Description in detail of the design of such parts of both the hoistway structure and the elevator mechanism as

it may be practicable to standardize dimensionally.

In setting up the standards and in the standardization of design all of the following elements should be considered in the sequence of importance as given: (1) Safety; (2) Maintenance of Operation; (3) Quality of Service; (4) Quantity of Service; (5) Cost of Maintenance; (6) Initial Cost of Elevator Installation; (7) Depreciation and Amortization.

The Report proposes the organization of the following sub-committees to carry on this work:

1 A committee on engineering standards for passenger traffic
2 A committee on engineering standards for freight traffic
3 A committee whose problem will be the standardization of hoistway construction
4 A committee whose problem will be the standardization of elevator construction
5 A consulting committee to pass on the work of the other committees.

Copies of the complete Report may be obtained on application to the A.S.M.E. Standards Department.

A.I.E.E. Standards Submitted for Approval

The American Institute of Electrical Engineers has submitted its Standards (1921 edition) to the American Engineering Standards Committee for approval as an American Standard. This is done in accordance with the special provision in the procedure of the Committee under which important standards adopted or in process prior to 1920 may be approved without passing through the regular procedure. The standards submitted represent the latest revision of the A.I.E.E. standardization rules, revised during 1919 and 1920. These rules were first issued in 1899, so that they may be considered in truth a standard which has by actual practice proved its right to become an American Standard.

The American Engineering Standards Committee would be very glad to learn from those interested of the extent to which they make use of these specifications and to receive any other information regarding the manner in which the specifications are meeting the needs of the industry.

Standards Recently Approved by the A.E.S.C.

Standards recently approved by the American Engineering Standards Committee include four copper specifications submitted by the American Society for Testing Materials as Tentative American Standards, as follows:

Soft or Annealed Copper Wire
Lake Copper Wire, Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars
Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars
Battery Assay of Copper.

Sectional Committees Recently Designated by the A.E.S.C.

In compliance with the request of the American Institute of Electrical Engineers, the American Engineering Standards Committee has designated the A.I.E.E. sponsor for the formation of a sectional committee on Standard of Aluminum for Conducting Purposes.

In conformity with the request of a conference of interested national organizations, the American Engineering Standards Committee has designated the American Institute of Architects, the American Institute of Electrical Engineers, and the National Association of Electrical Contractors and Dealers joint sponsors for a sectional committee on Symbols for Electrical Equipment of Buildings and Ships.

Upon recommendation of its General Correlating Committee for Mining Standardization, the American Engineering Standards Committee has authorized the organization of sectional committees on Safety Rules for Installing and Using Electric Equipment in Bituminous Coal Mines· Portable Electric Mine Lamps; and Storage-Battery Locomotives for Use in Gaseous Mines. The U. S. Bureau of Mines has been designated as sponsor for each of these sectional committees.

Boiler Code Committee Meets in Rochester

The June meeting of the Boiler Code Committee of the A.S.M.E. was held in Rochester, N. Y., where the Committee members were the guests of S. W. Miller, member of the Sub-Committee on Welding, F. A. Collins, Jr., Secretary of the Rochester Local Section of the Society, Roger DeWolf of the Rochester Railway Light Company, A. I. Jones and W. B. Miller of the Pfaudler Company. Through the courtesy of the Pfaudler Company, the library of their office in the Cutler Building was utilized for the Committee meetings which were held in two sessions, June 23 and 24, and the hotel headquarters of the meeting was at the Hotel Seneca.

The purpose of the meeting was to consider a report of the Sub-Committee on Miniature Boilers and a number of communications which were acted upon as formal interpretations. This report however, was tentative and the Sub-Committee received instructions from the Committee for the continuation of its work. In addition to the above proceedings, on June 23 hearings were granted to inquirers who came personally before the Boiler Code Committee.

The second day of the meeting, June 24, was devoted to revision work and excursions to a number of mechanical plants in Rochester.

TECHNICAL PROBLEMS IN AERONAUTICS

(Continued from page 528)

Captain Stevens also explained the need for oblique and vertical pictures which, viewed through the proper apparatus, cause the ground detail to stand out in relief. The two aerial photographs shown on page 528 illustrate oblique views at different heights.

Machine-Gun Synchronizers

In his remarks on machine-gun synchronizers H. O. Russell emphasized the need of a synchronizing gear to control machine-gun fire to prevent bullets from striking the propeller blades, especially with the high-powered engines of today where one shot through the propeller may splinter it sufficiently to unbalance the engine, thus causing it to tear itself loose from the bed.

The synchronizing gear is essentially a mechanism connecting the engine and the trigger of the machine gun. The machine-gun fire is interrupted when the blade of the propeller is opposite the bore of the gun. The original patent taken out by the Germans in 1913 consisted of a tappet rod operating from a cam on the engine and extending to the rifle trigger. The French overcame the difficulties of wear, whip and chatter of this mechanism by utilizing an oscillating rod. The English developed the C. C. Hydraulic Gear which maintained communication between the engine and trigger by means of compressional waves in oil. Leaks and air pockets affect the proper functioning of this gear.

In the Nelson gun control the impulse from the engine is transmitted to the machine gun by a pull on a wire. This scheme has operated satisfactorily, but the wire cable must be led from the engine to the machine gun in a straight path, which limits the variety of installations possible.

Three systems have been designed and have been tested out to eliminate the defects of the Nelson gun control. One utilizes a flexible brass tube carrying the impulse cable from the engine to the machine-gun trigger through a flexible shaft. This requires a large shaft so that it will come up to speed within one-half revolution and stop within one-half revolution. Considerable work has been done upon electrical mechanisms, and although a satisfactory one has been developed, it is quite heavy and complicated. Some further advances are contemplated on the electric gear.

A Correction

In the discussion on the paper by W. M. White on the Hydraucone Regainer published in the July issue of Mechanical Engineering, the remarks made by M. Spillman, chief engineer of the Worthington Pump and Machinery Corporation, Harrison, N. J., were in error, credited to C. B. Spellman of Philadelphia, Pa.

THE ENGINEERING INDEX

(Registered U. S. Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Steel Erection. Instructions to Foreman for Prevention of Accidents in Steel Erection. Eng. & Contracting, vol. 55, no. 21, May 25, 1921, pp. 518–521. Prepared by erection department of McClintic-Marsball Co., Pittsburgh, Pa.

AERODYNAMICS

Motion in a Resisting Medium. Motion of the Center of Gravity of a Symmetrical Solid with Relation to a Vertical Plane Moving in a Resisting Medium (Mouvement du centre de gravité d'un solid symétrique par sapport à un plan vertical se déplaçant dans un milieu résistant), M. Alayrac. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 18, May 2, 1921, pp. 1089–1092, 1 fig. Study of mechanical problem involved and its application to aeroplane in flight.

AERONAUTICAL INSTRUMENTS

Anschutz Horizon. German Gyro Gauges, Alfred Gradenwitz. Aeronautics, vol. 20, no. 398, June 2, 1921, pp. 390–391, 5 figs. Anschutz gyrocompass for determining angle of inclination of aeroplane in regard to horizon.

Speed Indicators. The Altitude Effect on Air Speed Indicators, Mayo D. Hersey, Franklin L. Hunt and Herbert N. Eaton. Nat. Advisory Committee for Aeronautics, report no. 110, 1921, 27 pp., 8 figs. Theoretical study of experiments with venturi tubes.

AEROPLANE ENGINES

Fuels. Fuels Used in Aeroplane Engines (L'essence et les combustible employés en aviation), M. P. Dumanois. Aérophile, vol. 29, nos. 7–8, April 1–15, 1921, pp. 110–114. Utilization of other fuels than gasoline in aeroplane engines. Tests conducted by French Aeronautical Technical Service.

Liberty. Induction System Pressures in Liberty Twelve and 300 H.P. Hispano-Suiza Aeronautical Engines, U. S. War Dept., Air Service Information Circular, vol. 3, no. 223, May 1, 1921, 12 pp., 7 figs. Determination of manifold, carburetor choke and float chamber depressions in standard Liberty twelve and 300-hp. Hispano-Suiza engines.

Performance Test of G.A.X. with Two 400 H.P. Liberty "12" Engines. U. S. War Dept., Air Service Information Circular, vol. 2, no. 193, Mar. 25, 1921, 8 pp., 5 figs. Endurance, full throttle at 10,000 ft. including climb was 1 hr. 48 min.; minimum speed at sea level, lowest throttle, 63.6 m.p.h.

Packard. The Packard "Altitude" Aero Engine, J. G. Vincent. Flight, vol. 13, no. 22, June 2, 1921, pp. 371–373, 7 figs. Engine designed for use at high altitudes. Standard compression ratio is 6½ to 1, but pistons giving 5½ to 1 ratio can be fitted for low-altitude work.

Performance. Experimental Study of Performance of Aeroplane Engines in Rarified Atmosphere (Étude expérimentale du fonctionnement des moteurs en atmosphère raréfiée), Mortinot-Lagarde. Aéronautique, no. 23, April 1921, pp. 175–177, 1 fig. Experiments with Lorraine-Dietrich engine.

Radiators. Turbulence in the Air Tubes of Radiators for Aircraft Engines, S. R. Parons. Nat. Advisory Committee for Aeronautics, report no. 106, 1921, 13 pp., 12 figs. Investigation of characteristics of flow in air passages of aircraft radiators.

Superchargers. Aeroplane Superchargers, W. G. Noack. Aerial Age, vol. 13, nos. 12, 13 and 15, May 30, and June 13 and 20, 1921, pp. 272–275, 5 figs.; 322–325, 23 figs. and 347–349, 18 figs. Technical study. Design of superchargers and effect of supercharging aeroplane engines. Swiss and German types. Translated from Zeitschrift des Vereines deutscher Ingenieure.

AEROPLANE PROPELLERS

Super-Speed. Super-Speed Propellers. Sci. Am., vol. 124, no. 22, May 28, 1921, p. 430, 3 figs. Air propellers with blade-tip velocity above that of sound.

AEROPLANES

Aerofoils. Report of Wind-Tunnel Test of U.S.A. 27 A, B, and C Airfoils. U. S. War Dept., Air Service Information Circular, vol. 3, no. 224, May 10, 1921, 12 pp., 10 figs. Tables giving lift, drag, lift-drag ratio and other characteristics of various types of aerofoils.

Wings. Ground-Plane Influence on Aeroplane Wings, A. F. Zahm and R. M. Bear. Aerial Age, vol. 13, no. 13, June 6, 1921, pp. 299–301, 5 figs. Technical study discloses material ground-plane influence at small incidence and ground gap. Life is augmented drag diminished; lift-drag may be increased 30 to 40 per cent.

PW-1. U.S.A. 27 Wings. U. S. War Dept., Air Service Information Circular, vol. 3, no. 225, May 5, 1921, 4 pp. Necessary changes to make in strut locations and sizes of members when span is reduced.

AIR COMPRESSORS

Piston. The Air Losses in Piston Compressors (Die Luftverluste bei Kolbenverdichtern), Arthur Balog. Fördertechnik u. Frachtverkehr, vol. 14, no. 9, Apr. 29, 1921, pp. 99–100, 2 figs. Equations for approximate determination of losses.

[See also ELECTRIC DRIVE, Air Compresso rs.]

AIR FILTERS

Resistance. Resistance of Several Materials to the Flow of Air, A. E. Stacey, Jr. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 4, May 1921, pp. 355–364, 4 figs. Investigation showed that resistance of air filters varies directly with velocity of air through material. Resistance is not affected by variations in relative humidity.

AIRCRAFT

Design. Practical Points in the Structural Design of Aircraft, A. P. Thurston. Aeronautics, vol. 20, no. 396, May 19, 1921, pp. 355–358. Paper read before Instn. Aeronautical Engrs.

Research. The Influence of Scientific Research on Aircraft Construction (Der Einfluss der wissenschaftlichen Forschung auf die Konstruktion der Flugzeuge), K. G. Gaule. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, nos. 4, 5, 6, 7 and 9, Feb. 28, Mar. 15, 31, Apr. 15 and May 17, 1921, pp. 53–58, 73–74, 88–90, 102–106 and 133–137, 4 figs. Notes on development of relation of theory to practice. Part I deals with the development of calculating methods and constructive guide lines. Part II with development of constructive expedients.

AIRSHIPS

R.36. Britain's First Passenger Airship. Flight, vol. 13, no. 20, May 19, 1921, pp. 339–342, 7 figs R.36. Characteristics: Overall length, 672 ft. 2 in.; diameter, 78 ft. 9 in.; height from bumping bags under cars to top of bull, 91 ft. 7 in.; cubic capacity, 2,200,000 cu. ft.

ALCOHOL

Equilibrium Curves. Recovery of Volatile Solvents by the Bregeat Process, M. Roulleux and Robert G. Dort, Chem. & Metallurgical Eng., vol. 24, no. 21, May 25, 1921, pp. 916–921, 8 figs. Equilibrium curves at 20 deg. cent. between cresol and ether, ethyl alcohol, methyl alcohol, acetone and benzene. Influence of water dilution of absorbent. Operation data.

[See also AUTOMOBILE FUELS, Alcohol.]

ALLOY STEELS

Properties. Alloy-Steel—Its Rise and Secrets, A. E. White. Trans. Am. Soc. for Steel Treating, vol. 1, no. 9, June 1921, pp. 480–499, 25 figs. Composition diagrams of commercial alloy steels.

ALLOYS

Electric Resistance. On the Determination of Electric Resistance of Alloys Lead-Tin and Lead-Zinc at High Temperatures, Seibei Konno. Tohoku Imperial University, Science Reports, vol. 10, no. 1, Mar. 1921, pp. 57–74, 7 figs. From resistance-temperature curves experimentally obtained equilibrium diagrams of alloys were determined. Curves coincide almost exactly with those obtained by thermal analysis.

Equilibrium Diagrams. Theory of Metallic Alloys and Its Principal Industrial Consequences (La théorie des alliages métalliques et ses principales conséquences industrielles), M. Léon Guillet. Chimie & Industrie, vol. 5, no. 4, April 1921, pp. 371–383, 31 figs. Study of equilibrium diagrams of binary alloys.

Heat Treatment. The Extension of Heat Treatment Processes to Non-Ferrous Alloys, F. C. Thompson. Metal Industry (Lond.), vol. 18, no. 21, May 27, 1921, pp. 404–407. Note on thermal-equilibrium diagrams.

Separation of Components. New German Metallurgic Processes. U. S. Dept. of Commerce, Commerce Reports, no. 128, June 3, 1921, pp. 1282–1283. Method of separating alloys into their metal components and extracting metals from mineral ores. According to process metals treated with catalytic agent go into solution in short time, treatment of large blocks of metal being effected in less than 30 min.

Testing. The Use of the Shearing Test for Determination of the Mechanical Properties of Alloys (Die Verwendung des Scherversuches zur Beurteilung der mechanischen Eigenschaften von Legierungen), Rudolf Krulla. Zeit. für Metallkunde, vol. 13, no. 6, Mar. 15, 1921, pp. 137–139, 6 figs. Account of shearing-test method and apparatus.

Zinc-Aluminum-Copper. The Utilisation of Zinc Aluminium-Copper Alloys, Pendleton Powell. Metal Industry (Lond.), vol. 18, no. 22, June 3, 1921, pp. 422–423. Methods suggested by experts to German government for disposing of large quantities of alloy left in its possession at termination of war.

[See also ALUMINUM ALLOYS; BEARING METALS; BRASS; GUN METAL.]

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Macby.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

ALUMINUM

Furnaces. Gases in Aluminum Furnaces and Their Analysis, Robert J. Anderson and J. H. Capps. Chem. & Metallurgical Eng., vol. 24, no. 23, June 8, 1921, pp. 1019–1021. Portable device for sampling furnace atmospheres.

World Production. Distribution Production and Commerce of Minerals of Metals Other than Iron and Manganese (La répartition, la production et le commerce des minerals et métaux a l'exception de ce qui concerne le fer et le manganèse), Eugene Prost. Revue universelle des Mines, vol. 9, no. 2, April 15, 1921, pp. 108–131. World statistics for aluminum and mercury.

ALUMINUM ALLOYS

Uses. Aluminium and Its Alloys in Engineering, John G. A. Rhodin. Engr., vol. 131, nos. 3410–3413, May 6, 13, 20 and 27, 1921, pp. 488–489, 501, 559, and 531–532. Electrothermic production of aluminum bronze; properties and uses; uses of aluminum in brass; wiredrawing of aluminum alloys.

AMMONIA COMPRESSORS

Performance. Compressor Performance, John E. Starr. Ice & Refrigeration, vol. 60, no. 6, June 1921, pp. 427–430. Records of performance of compressors in reliquefying ammonia. Comparative test of York and De La Vergne compressors.

APPRENTICES, TRAINING OF

Methods. Training Machine Shop Workers, George A. Seyler. Iron Trade Rev., vol. 68, no. 20, May 19, 1921, pp. 1391–1392. Operation of training department in plant of Lunkenheimer Co., Cincinnati.

Research. Research on Education of Workmen (Essai d'éducation ouvrière), M. A. Bostsarron. Revue de Métallurgie, vol. 18, no. 3, Mar. 1921, pp. 163–179, 5 figs. Experimental studies conducted by French Forge Co. in training of apprentices from ages of 12 to 18 yr.

AUTOMOBILE ENGINES

Cooling System. A New Method of Cooling Automotive Engines, P. M. Heldt. Automotive Industries, vol. 44, no. 21, May 26, 1921, pp. 1103–1105, 3 figs. System intermediary between air cooling and ordinary water cooling systems. Water is used as cooling medium but jacket outlet temperature is constantly maintained above boiling point of water. Radiator core is filled with steam to certain height depending upon relation between heat absorption in cylinder jackets and heat dispersal per unit of core surface.

Flywheels. Machining Nash Flywheels, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 954–959, 3 figs. Use of vertical automatic lathes for finishing all surfaces at two settings of work

Manifolds. Disc Grinding Manifolds for Automobile Engines, J. H. Moore. Can. Machy., vol. 25, no. 22, June 2, 1921, pp. 25–28, 7 figs. Notes on grinding gear covers, manifolds, cast-iron pipe flanges, drop-forged parts, cast-iron tanks and car brasses.

Steam. The Stanley Steam Car Power Plant, Fred H. Colvin. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 955–958, 9 figs. Boiler is of fire-tube type having drawn shell. Steam pressure of from 575 to 600 lb. per sq. in. is normally carried.

Testing. Routine Factory Tests and Final Inspection of Packard Engines, J. Edward Schipper. Automotive Industries, vol. 44, no. 22, June 2, 1921, pp. 1162–1163, 2 figs. Operations include five-hour running-in during which engine is driven by electric motor and two hour dynamometer test in silent room, where measurements of power developed, compression pressure of each cylinder, fuel consumption, etc. are made, and noises are located.

AUTOMOBILE FUELS

Alcohol. Power Alcohol: Its Position and Prospects, T. Baker. Sci. & Industry, vol. 2, no. 2, Feb. 1920, pp. 95–100. Report of Power Alcohol Committee appointed by Australian Advisory Council of Science & Industry.

Power Alcohol Developments. Autocar, vol. 46, no. 1336, May 28, 1921, pp. 977–978. Natalite, an alcohol-ether mixture originated in Natal, So. Africa, is to be produced in England for automotive vehicle service.

Economical Use. Elements of Automobile Fuel Economy, W. S. James. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 543–562, 21 figs. Analytical study of factors affecting amount of power supplied car as fuel to produce at road power required for transportation. Graphs are given which show relations between characteristics of engine and power developed, also between fuel consumption and power developed under various conditions.

Naphthalene. A New Engine Fuel. H. Schrauth. Aeronautics, vol. 20, no. 398, June 2, 1921, p. 391. Conversion of naphthalene into tetra-hydro-naphthalene by chemical process.

Storage and Handling. A New Arrangement for the Storage and Handling of Inflammable Liquids (Ein neues Lager- und Förderverfahren für feuergefährliche Flussigeiten). Oel- u. Gasmaschine, vol. 18, no. 4, Apr. 1921, pp. 54–56, 2 figs. Method and arrangement employed by the Berger Works, Ltd., Berlin, according to which the liquid remains constantly under protection of a non-inflammable gas which, however, is not used to force liquid out of tank, this being effected by a hand or mechanically operated pump.

See also AEROPLANE ENGINES, Fuels; GASOLINE.

AUTOMOBILES

Headlights. Devices for Controlling Headlight Glare. Automotive Industries, vol. 44, no. 23, June 9, 1921, pp. 1199–1200, 2 figs. Crockett reflector designed to permit control of beam of light.

AVIATION

Aerial Transportation. Aerial Transportation of the Immediate Future, Ralph H. Upson. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 593–597, 3 figs. Capacity and cost curves of commercial airships based on average air speed of 70 m.p.h. Comparative cost of freight transportation by steamship, railroad, motor truck, airship and aeroplane.

Air Ports. The New Air Port of Rotterdam. Flight, vol. 13, no. 20, May 19, 1921, pp. 344, 3 figs. Besides offices and residential quarters air port will include storeroom for aeroplane parts, and two hangars, one 72 ft. by 125 ft. and the other 79 ft. by 165 ft.

Commercial. Air Transportation and the Business Man, V. E. Clark. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 563–569. Suggested business uses of aircraft.

An Air Time Table. Aeronautics, vol. 20, no. 396, May 19, 1921, p. 363. List of air fares, freight rates and time table of European airways.

Ground Engineering. Ground Engineering, H. W. S. Outram. Aeronautical Jl., vol. 25, no. 125, May 1921, pp. 237–245 and (discussion) pp. 245–250. British Government air-navigation regulations and directions issued on April 30, 1919. Examination, supervision and duties of a ground engineer.

Lighthouses. Aerial Lighthouses (Le balisage lumineux), Edmond Marcotte. Aerophile, vol. 29, nos. 7–8, April 1–15, 1921, pp. 99–107, 6 figs. Notes on design of aerial lighthouses.

Soaring Flight. Experimental Studies of Soaring Flight (Études expérimentales sur le vol à voile), M. Idrac. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 19, May 9, 1921, pp. 1161–1164, 1 fig. Graphical record of vertical components of forces acting on flying kite.

Soaring—A New Theory of Flight. (Der Segelflug, eine neue Flugtheorie), Gustav Lilienthal. Annalen für Gewerbe u. Bauwesen, vol. 88, no. 8, Apr. 15, 1921, pp. 67–71, 10 figs. Investigation of the soaring flight of birds with regard to its application to aeroplanes; possibility of eventual flight without engine.

Speed of Flight. Obtaining Very High Speeds in Aviation by Using Constant Power Engines (Les très grandes vitesses en aviation par les moteurs à puissance constante), Auguste Forissier. Génie Civil, vol. 78, no. 15, April 9, 1921, pp. 138. Reference is made to note presented by M. Rateau before Academy of Sciences on June 23, 1919 where he discussed the maximum obtainable speed under present conditions. Present writer computes that it is now possible to fly with speed of 500 km. per hr.

Weather Reports. Daily Weather Report for Aviators by Radio. Aerial Age, vol. 13, no. 13, June 6, 1921, pp. 298–299. Explanation of bulletin issued by U. S. Weather Bur. in coöperation with Office of Communications of Navy Dept. Bulletin, which is intended for benefit of marine and aviation interest, began June 1, 1921.

B

BEAMS

Concrete. Design of Simple Reinforced Concrete Structural Members—II, Harold W. Barker. Concrete, vol. 18, no. 6, June 1921, pp. 285–287, 3 figs. Formulas for computing shear and bond stresses in beams.

BEARING METALS

Genelite. Self-Lubricating Bearings. Sci. Am., vol. 124, no. 24, June 11, 1921, p. 467, 3 figs. Bearing material, termed genelite, developed by Gen. Elec. Research Laboratory. Material is mixture of graphite and high-grade synthetic bronze.

BEARINGS

Anti-Friction. A New Patent Anti-Friction Bearing. Practical Engr., vol. 63, no. 1788, June 2, 1921, pp. 347–348, 5 figs. Roller bearing manufactured by Chain Roller Bearing Co., Stockport, England. Feature is employment of endless and detachable chain as separating and guiding means for rollers.

BEARINGS, BALL

Electric Cars. Destructive Effect of Current on Ball Bearings of Electric Cars, Hilding Angstrom. Elec. Ry. Jl., vol. 57, no. 21, May 21, 1921, pp. 941–944, 13 figs. Tests made under various conditions show that very rapid destruction of ball bearings results from electric current which flows through them. Types of construction are suggested for overcoming trouble and testing apparatus is described for reproducing conditions as they occur in service.

Railway Cars. Ball and Roller Bearings and their Use in Railroad Operation (Wälzlager und ihre Verwendung im Eisenbahnbetrieb), H. Heberling. Fördertechnik u. Frachtverkehr, vol. 14, no. 5, Mar. 4, 1921, pp. 58–60, 5 figs. Longitudinal and transverse bearings; advantages of ball and roller bearings over sliding bearings; their introduction into railroad practice; Swedish tests.

Standardization. International Ball Bearing Standardization, R. S. Burnett. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 577–578. Proposed international standardization.

BENZENE

Still. A New Type of Benzene Still in European Operation, A. Thau. Chem. & Metallurgical Eng., vol. 24, no. 23, June 8, 1921, pp. 1013–1017, 11 figs. Tubular type Bamag benzene still. Still consists of number of horizontally arranged cylinder sections joined by flanged branches.

BENZOL

Recovery. A Benzol Factory of New Design at the Coking Plant of the Oxelösund Iron Works (Die Benzolfabrik neuer Bauart auf der Kokerei des Oxelösunder Eisenwerkes), A. Thau. Glückauf, vol. 57, nos. 1 and 2, Jan. 1 and 8, 1921, pp. 4–11 and 25–31, 13 figs. Factory constructed by the Berlin-Anhalt Machine-Construction Corp. (BAMAG in Sweden, in operation since beginning of 1920 including description of apparatus with which a continuous separation of the raw products in two fractions is effected. Table showing distillation of the raw products, etc., determined during period of measurements.

Recovery of Benzol from Gas (La récupération du benzol). Génie Civil, vol. 78, no. 20, May 14, 1921, pp. 409–414, 5 figs. Scheme for recovering benzol from city gas. Paper read before Société d'Encouragement pour l'Industrie nationale.

BLAST-FURNACE GAS

Cleaning. Notes on the Cleaning of Blast-Furnace Gas, S. H. Fowles. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 4, 21 pp. 7 figs. Calculations involved in design of Halberg-Beth dry-gas-cleaning plant. Comparison of Halberg-Beth plant with other plants.

BLAST FURNACES

Auxiliary Equipment. Machinery for Pig-Iron Beds at Blast Furnaces, F. W. Broy. Iron & Coal Trades Rev., vol. 102, no. 2777, May 20, 1921, pp. 689–690, 7 figs. Deals with pig breakers, crane for carrying breaking hammer and delivery magnets, and utilization of crane equipment. Translated from Zeit. des Vereines deutscher Ingenieure.

Cowper Stoves. Regulation of Pressure in Cowper Apparatus (Du regime des pressions dans les appareils Cowper), M. J. Seigle. Revue de Métallurgie, vol. 18, no. 3, Mar. 1921, pp. 140–146, 11 figs. Graphs for determining air pressure at various points of apparatus.

Hot-Blast Stoves. Design and Proportions of Hot Blast Stoves, W. E. Groume-Grjimailo. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1527–1530, 15 figs. Consideration of laws governing circulation of gases while heating and cooling. Historical designs reviewed.

Heat Distribution in Hot Blast Stoves, W. E. Groume-Grjimailo. Iron Age, vol. 107, no. 24, June 16, 1921, pp. 1613–1616, 3 figs. Hot-blast temperature equalizers. Analysis of performance results. Calculations of convection velocities.

Slags. Blast-Furnace and Cupola Slags, J. E. Fletcher. Iron & Steel Inst., annual meeting, May 5–6, 1921 advance paper no. 3, 20 pp., 12 figs. Their composition and graphic methods for determining their constitution.

BOILER FEEDWATER

Treatment. New Boiler Feed Water System. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 392–394, 2 figs. We-Fu-Go system, which consists of two reaction-settling tanks holding 80,000 gal. each, equipped with mechanically operated stirring devices, driven by individual motors.

BOILER FURNACES

Improvements. Improvements in Furnace Installations for Solid Fuels (Neuerungen an Feuerungsanlagen für feste Brennstoffe), H. Pradel. Feuerungstechnik, vol. 9, no. 15, May 1, 1921, pp. 133–137, 10 figs. Details of recent German patents.

Phillips-Badenhausen-Stephens. Vertical Process of Combustion. Power, vol. 53, no. 22, May 31, 1921, pp. 875–876, 2 figs. Fuel is introduced at front of chamber, mixed with air and cast downward building up and thereafter maintaining incoherent, incandescent bed of fuel particles on furnace bottom. In downward movement dust and fine particles are burned before reaching bed.

BOILER OPERATION

Boiler Capacity. Burning More Coal to Increase Boiler Capacity, Thomas Wilson. Power, vol. 53, no. 23, June 7, 1921, pp. 924–927, 2 figs. Increasing boiler capacity by enlarging grate area, by adding to length or width of stoker, or by using forced-draft stokers. Practice of Commonwealth Edison Co.

Feeding. Boiler Feeding by Gravitation. Engr., vol. 131, no. 3410, May 6, 1921, pp. 491–492, 4 figs. Auto-thermal feeding system.

Stoker Firing. Changing a Hand-Fired to a Stoker-Fired Plant, Charles T. Main. Power, vol. 53, no. 24, June 14, 1921, pp. 954–957, 4 figs. Installation of twelve 3500-sq. ft. water tube boilers.

BOILER PLANTS

Oil-Burning. Automatic Oil-Burning Plant at Sugar Refinery, Claude C. Brown. Power Plant Eng., vol. 25, no. 12, June 15, 1921, pp. 599–602, 2 figs. Boiler plant consists of ten 600-hp. horizontal water-tube boilers.

Steel Mills. Cambria Steel Company New Boiler Plant, E. W. Trexler. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 389–392, 4 figs. Plant consists of six 655-hp. water-tube boilers equipped with underfeed stokers, superheaters, soot blowers, automatic feed-water regulators, fuel economizers, draft regulators, forced-draft and induced-draft fans.

BOILERS

Bettington. Pulverized Fuel Boiler. Eng. Rev.,

vol. 34, no. 11, May 1921, pp. 288–289, 2 figs. Bettington boiler designed to burn pulverized coal.

Efficiency. Arrangements for Improvement of the Efficiency of Steam-Heating Boilers (Einrichtungen zur Verbesserung des Wirkungsgrades von Zentralheizungskesseln), Jos. Fichtl. Gesundheits-Ingenieur, vol. 44, no. 18, Apr. 30, 1921, pp. 201–208, 9 figs. Details of various German coke-saving devices, including firebrick furnace linings, bridge walls and other devices.

Electrically Operated. Electrically Heated Steam Boilers, Eric A. Lof. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 515–518, 3 figs. Comparison of relative heating values of fuel and electric heat. Installation of electrically operated boilers in Sweden.

Marine. See MARINE BOILERS.

BOILERS, WATER TUBE

Yarrow. The Water Drums of Yarrow Boilers. Engr., vol. 131, no. 3413, May 27, 1921, pp. 566–567, 6 figs. Types recently developed.

BOLTS

Industry. Development of the Bolt and Nut Industry. F. H. Chapin. Iron Age, vol. 107, no. 24, June 16, 1921, pp. 1609–1610. First machine-fabricated product made in this country only 80 yrs. ago.

BONUS SYSTEMS

Railway Work. Piece-Work, Bonus Systems and Higher Efficiency, C. C. Cook. Ry. Age, vol. 70, no. 22, June 3, 1921, pp. 1263–1264. Experience of Baltimore & Ohio Railroad.

BRAKES

Cranes, Tests. Testing Equipment for Pneumatic Motors, J. V. Hunter. Am. Mach., vol. 54, no. 21, May 26, 1921, pp. 894–896, 4 figs. Importance of performance records for portable air motors. Examples of testing equipment in several railroad shops.

Double-Capacity. Virginian Demonstration of Double-Capacity Brake. Ry. Age, vol. 70, no. 24, June 17, 1921, pp. 1407–1410, 8 figs. Brakes for 120-ton cars. Characteristic is that equipment provides for same percentage of braking force (ratio of total shoes pressure to car weight) on loaded car as on empty car.

Stresses. Piston Travel and Shoe Clearance, H. M. P. Murphy. Elec. Ry. Jl., vol. 57, no. 25, June 18, 1921, pp. 1119–1122, 10 figs. Study of forces developed in brake riggings. Determination of relation between piston travel and shoe travel.

BRASS

Cracks. Annular Cracks, R. R. Clarke. Metal Industry (N. Y.), vol. 19, no. 6, June 1921, pp. 243–244, 2 figs. Discussion of various theories accounting for their formation. (Concluded.)

Nickel. Brasses Containing Nickel, L. Guillet. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1380. Mechanical tests and microscopic examination of copper-nickel-zinc alloys. Translated from Revue de Métallurgie.

Scrap. The Use of Scrap of New Material in Rolled Brass Foundry Work, L. Kroll. Metal Industry (Lond.), vol. 18, no. 19, May 13, 1921, pp. 364–365. Laboratory experiments. Translated from Giesserei Zeitung.

Season Cracking. Season-Cracking of Brass, H. Moore, S. Beckinsale and Clarice E. Mallinson. Chem. & Metallurgical Engr., vol. 24, no. 22, June 1, 1921, pp. 976–980, 7 figs. Investigation at Woolwich Arsenal, England, on action of corrosive agents on stressed brasses and determination of minimum loads required to produce corrosion cracks. Chemical action was found to be necessary for season cracking. (Abstract.) Paper read before Inst. of Metals.

BUILDING CONSTRUCTION

Labor Hours. Labor Hours Per Output Unit in Building Construction, Frank E. Barnes. Eng. News-Rec., vol. 86, no. 21, May 26, 1921, pp. 888–891. Tables showing time required to accomplish unit of carpenter work, masonry, excavation, painting, plastering and sheet metal work.

BUILDING MATERIALS

Research. The Utility of Research on Building Materials, Alan E. Munby. Jl. Royal Inst. British Architects, vol. 28, no. 13, May 7, 1921, pp. 373–382, and (discussion) pp. 383–390, 13 figs. Progress achieved by Science Standing Committee of Royal British Architects.

BUILDINGS

Concrete, Surface Treatment. Treatment of Exterior Surfaces of Industrial Buildings. Concrete vol. 18, no. 6, June 1921, pp. 263–265. Classification of surface treatments and suggestions in regard to method to follow in a given case. Committee Report of Am. Concrete Inst.

C

CARBURETORS

Heavy-Fuel. The Carburation Phenomena of Heavy Fuels (Zur Kritik der Vergasungsvorgänge schwerer Brennstoffe), Carl Wirsum. Motorwagen, vol. 24, no. 13, May 10, 1921, pp. 257–259. Results of experiments.

CAR DUMPERS

Gravity. Rotary Car Dump that Operates Solely by Gravity. Coal Age, vol. 19, no. 24, June 16, 1921, pp. 1074–1076, 4 figs. Gravity, springs and flywheels discharge cars by revolving them through approximately 135 deg. Cars can be dumped in full trips, hence swivel couplings are not needed.

CAR WHEELS

Cast-Iron. Proposed Tentative Specifications for Cast-Iron Car Wheels. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 4 pp.

CARS

Repair Shops. C. I. & L. Builds Modern Car Repair Shop. Ry. Age, vol. 70, no. 23, June 10, 1921, pp. 1325–1327, 4 figs. Steel-frame structure of longitudinal type 440 ft. long, 85 ft. wide and 40 ft. high.

Repairs. Scheduling Car Repairs Increases Shop Output, E. T. Spidy. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 349–352, 2 figs. Outline of schedule applicable to passenger or freight car repair work in large or small shops.

CARS, COAL

Hopper. A 70-Ton Hopper Car that can be Repaired in any Shop, H. Idoine. Ry. Rev., vol. 68, no. 24, June 11, 1921, pp. 894–899, 14 figs. Steel hopper car of 70-tons capacity built with interchangeable sheets and stakes.

100-Ton. Development of Coal Cars on the Norfolk & Western. Ry. & Locomotive Eng., vol. 34, no. 6, June 1921, pp. 160–163, 7 figs. Details of construction of 100-ton coal car.

New Norfolk & Western 100-Ton Coal Cars, John A. Pilcher. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 367–370, 10 figs. Tests to determine load on springs due to irregular track and clearance for curves.

Six-Wheel Trucks. New Designs of Buckeye Six-Wheel Trucks. Ry. Age, vol. 70, no. 22, June 3, 1921, pp. 1269–1270, 3 figs. Equalization of load is accomplished by use of equalizer casting which engages center journal.

CARS, PASSENGER

Design. On the Question of Passenger Carriages (Subject VII for discussion at the Ninth Congress of the International Railway Association), F. de Vargas. Bul. Int. Ry. Assn., vol. 3, no. 5, May 1921, pp. 461–506, 18 figs. Trend of developments in design of passenger cars by European and American railways since 1914.

Steel. The Steel Passenger Cars of the Prussian-Hessian State Railways—II, (Die eisernen Personenwagen der preussisch-hessischen Staatsbahnen), H. Speer. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 20 and 21, May 14 and 21, 1921, pp. 511–516 and 549–552, 42 figs. Present practice in construction of steel passenger cars; basic principles underlying design; construction of express-train, mail and baggage cars, and slow-train cars; recommendations for new construction of latter; repair of steel passenger cars.

CENTRAL STATIONS

Developments. Central Stations Lead in Showing Spirit of Progress, Samuel Insull. Elec. Rev. (Chicago), vol. 78, no. 23, June 4, 1921, pp. 887–890, 1 fig. Developments and possibilities of interconnected power plants and superpower zones in U. S. Paper read before Nat. Elec. Light Assn.

Electric-Furnace Load. The Electric Melting Furnace as a Central Station Load, H. A. Winne. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 510–514, 6 figs. It is estimated from past growth in installation of electric steel furnaces that in 1925 power consumption by them will total 500,000,000 kw-hr.

France. Project for the Distribution of Electrical Energy in France by Means of High-Tension Electric Networks (Projet de répartition de l'énergie électrique en France au moyee des réseaux électriquee à haute tension), Ch. Lavanchy. Revue générale de l'Electricité, vol. 9, no. 21, May 21, 1921, pp. 727–733, 1 fig. Scheme for interconnection of hydroelectric and steam power plants. Energy to be transmitted at 150,000 volts.

Industrial Heating. Industrial Heating and the Central Station, E. H. Horstkotte. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 579–582, 8 figs. Survey of progress in utilization of electric heating in industry.

Load Equalization. Load Equalization, F. L. Stone and T. W. Kennedy. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 501–504, 6 figs. Study based on typical cases, notably power house supplying five mines.

Operation. Three Years Operation at Windsor, E. H. McFarland. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 572–578, 8 figs. Central station operated jointly by American Gas & Elec. Co. and West Penn Power Co.

Steel Mills. Steel Mill Power-Factor and the Central Station, A. K. Bushmand and A. L. Lemon. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 483–486, 5 figs. Relation between full-load power factor on number of poles of induction motor.

The Use of Central Station Power in Mines and Steel Plants, K. A. Pauly. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 479–483. Notes on choice of frequency.

Superpower. Clydes Mill Station of the Clyde Valley Power Co. Elecn., vol. 86, no. 2246, June 3, 1921, pp. 686–689, 5 figs. Interconnection of steam-electric plants in and around Glasgow, Scotland.

The Superpower System—Its Scope and Relation to the United States Government, S. W. Murray. Nat. Elec. Light Assn. Bul., vol. 8, no. 6, June 1921, pp. 335–341, 1 fig. Legal, financial and economical considerations.

CHUCKS

Magnetic. Magnetic Chucks—VIII, Ellsworth Sheldon. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 945–948, 9 figs. Description of Persons-Arter chuck.

COAL

Carbonization. The Assay of Coal for Carbonization Purposes: A New Laboratory Method, Thomas Gray and James G. King. Dept. Sci. & Indus. Research (Fuel Research Board) technical paper no. 1, 1921, 12 pp., 3 figs. 1 on supp. plate. Includes table giving results of duplicate distillations of ten samples of coal, illustrating difference between yields of various products from different classes of coal.

Low-Grade. Australia's Brown-Coal Power Scheme. U. S. Dept. of Commerce, Commerce Reports, no. 117, May 20, 1921, pp. 1029–1031. Steaming value of brown coal is estimated at 50 per cent of that of black coal. Investigation of briquetting processes.

COAL BREAKERS

6000-Ton. Woodward Breaker Sizes and Prepares Six Thousand Tons of Anthracite Per Day, Dever C. Ashmead. Coal Age, vol. 19, no. 19, May 12, 1921, pp. 851–856, 10 figs. Types for sprinkling shakers and guarding shafts. Steel frame and glass walls. Chestnut washed in two sizes.

COAL CLEANING

Dry Process. Dry Cleaning of Coal by Means of Tables, Edward O'Toole. Am. Iron & Steel Inst., advance paper, May 27, 1921, 28 pp., 23 figs. Results of table tests of Indiana and Illinois coals.

[See also COAL WASHING.]

COAL STORAGE

Railways. Railways Lack Policy Toward Coal Storage Development. Ry. Rev., vol. 68, no. 22, May 28, 1921, pp. 810–819, 4 figs. Report of committee on coal storage submitted at Thirteenth Annual Convention of Int. Ry. Fuel Assn.

COAL TIPPLES

Steel. Hillsboro Wood Tipple Replaced by Steel While Shaft is Hoisting Coal, John A. Garcia. Coal Age, vol. 19, no. 19, May 12, 1921, pp. 857–860, 6 figs. Steel structure equipped with pendulum-hung three-track shaker screen, weigh pan, picking table, loading boom and like equipment.

COAL WASHING

Froth Flotation. Froth Flotation as Applied to the Washing of Industrial Coal, Ernest Bury, Walter Broadbridge and Alfred Hutchinson. Can. Min. Jl., vol. 42, no. 20, May 20, 1921, pp. 405–410, 4 figs. Also in Iron & Steel of Canada, vol. 4, no. 4, May 1921, pp. 112–119, 4 figs. Results of tests. Economic aspect of process. Paper read before Instn. Min. Engrs.

In Flotation Process Fine Coal Attaches Itself to Oil and Bubbles, Thus Floating Away with Froth, E. G. Hill. Coal Age, vol. 19, no. 22, June 2, 1921, pp. 993–995, 3 figs. Cleaning of coal by froth flotation.

COKE

Briquets. Tests with Substitute Fuels. (Versuche mit Ersatzbrennstoffen), W. Grunow. Gesundheits-Ingenieur, vol. 44, no. 18, Apr. 30, 1921, pp. 208–212, 1 fig. Results of heating tests carried out with coke briquets made from cinder and admixture of tar showed them to be poorly adapted to house-heating boilers but well adapted to Dutch-tile stoves.

Metallurgical. Study of the Efficient Use of Metallurgical Cokes (Contribution a l'étude de la valeur des cokes métallurgiques), G. Deadrière. Revue universelle des Mines, vol. 9, no. 2, April 15, 1921, pp. 93–107. Writer terms "use value" of a fuel the price which must be paid for fuel when it is substituted by another fuel, in order to effect with the former the same industrial operation that is performed with latter. Formula for use values of metallurgical cokes is developed.

COKE BREEZE

Utilization. Value of Mixtures of—Coke Breeze and Bituminous Coal as Fuel for a Hand-Fired Boiler, John Blizard and James Neil. U. S. Dept. of Interior, Reports of Investigations, Bur. of Mines, serial no. 2244, May 1921, 27 pp., 3 figs. Tests carried out at request of Chamber of Commerce of Pittsburgh in order to determine steaming value of coke breeze as fuel when mixed with Pittsburgh coal and fired by hand, and to see whether mixture when burnt would give off an objectionable quantity of smoke.

COKE OVENS

By-Product. By-Product Coke Ovens and Their Relation to our Fuel Supply, E. B. Elliott. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 381–400, 6 figs. Relative efficiencies in furnaces of coke and coal.

By-Products of Coal Distillation. Process of Extraction and Installations of Marine and d'Homécourt, Forging and Steel Manufacturing Co. at Boucau Works, France (Les produits de distillation de la houille. Procédés d'extraction et installations de la Cie des Forges et Aciéries de la Marine et d'Homécourt aux usines du Boucau (Basses-Pyrénés), A. Grebel. Génie Civil, vol. 78, no. 22, May 28, 1921, pp. 449–454, 15 figs. partly on supp. plate. Benzol recovery and tar distillation.

The Piron By-Product Coke Ovens. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1531–1533, 3 figs. Italian vertical downward combustion type. Installation at plant of Woodward Iron Co., Woodward, Ala.

COKE PLANTS

By-Products of. Developments in the Recovery and Treatment of By-Products from Carbonization of Coal (L'évolution dans la récupération et le traitement des sous-produits de la carbonisation de la houille), Ch. Berthelot. Chimie & Industrie, vol. 5, nos. 4 and 5, April and May 1921, pp. 384–397, 23 figs., and 508–517, 12 figs. Study of recent developments and possibilities in increasing recovery of ammonia sulphate and benzol. Methods for recovery and treatment of benzol.

COMBUSTION

Control. Exhibition of Apparatus for Controlling Combustion (Compte rendu de l'exposition d'appareils servant au controle de la chauffe), Pierre Appell. Chaleur et Industrie, vol. 2, no. 4, April 1921, pp. 177–183, 10 figs. Classification and description of principal types. Exposition was organized under auspices of Société des Ingenieurs civils de France and Société d'Encouragement pour l'Industrie nationale. (To be continued.)

Measuring Combustion (La comburimétrie industrielle), M. Andre Grebel. Chaleur et Industrie, vol. 2, no. 4, April 1921, pp. 191–195, 2 figs. Description of Grebel-Velter comburimeter. (To be continued.)

The Scientific Control of Combustion, H. T. Ringrose. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 8, 9 pp., 5 figs. Use of recording apparatus for controlling combustion.

Draft Influence. Draft and CO_2 Influence on Evaporation, James T. Beard, Jr. Power, vol. 53, no. 20, May 17, 1921, pp. 775–777, 3 figs. Graphs showing relation between combustion rate and draft for various fuels.

COMPRESSED AIR

Measurement. Measuring Compressed Air Consumption in Pneumatic Tools, M. Piette. Colliery Guardian, vol. 121, no. 3149, May 6, 1921, p. 1315, 3 figs. Apparatus consisting of a venturi tube 1 in. in diameter and provided with constriction. For measuring compression of air differential gage is mounted on venturi tube.

Metering. The Metering of Compressed Air, John L. Hodgson. Mech. World, vol. 69, no. 1794, May 20, 1921, pp. 387–388, 10 figs. Installation in gold mines at Witwatersrand, So. Africa. Paper read before Midland Inst. Min., Civil & Mech. Engrs.

CONCRETE

Alkali Action. Progress in Investigation of Alkali Action on Concrete, E. C. Bebb. Eng. World, vol. 18, no. 6, June 1921, pp. 391–393. Investigations of advisory committee appointed by Bur. of Standards Reclamation Service, Drainage Investigations Office of Dept. of Agriculture and Portland Cement Assn.

Consistency. A Comparison of the Results of the Slump Test and the Flow Table in the Measurement of the Consistency of Concrete, W. L. Schwalbe. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 6 pp., 4 figs. It is concluded that relative consistencies are more truly indicated by flow table for greater range of consistencies than by slump test.

Crusher Screenings. Effect of Crusher Screenings in Concrete. Can. Engr., vol. 40, no. 21, May 26, 1921, pp. 500–502, 1 fig. Tests carried out by Milton Hersey Co., Montreal, for Crushed Stone Corporation Dundas, Ont. Increase in strength of concrete through use of up to 20 per cent of crusher screenings is reported.

Mixer. Pneumatic Concrete Mixer for Jap Tunnel. Public Works, vol. 50, no. 22, May 28, 1921, pp. 452–454, 1 fig. Special compressed-air machine designed for lining Imperial Japanese Government Railways tunnel.

Porete. Porete—A New Kind of Concrete, E. Walter. Concrete Products, vol. 20, no. 5, May 1921, pp. 19–21, 5 figs. Building product developed by Porete Mfg. Co. which is much lighter in weight than ordinary concrete, weighing from 50 to 55 lb. per cu. ft.

Proportioning Aggregates. A Proposed Method of Estimating the Density and Strength of Concrete and of Proportioning the Materials by the Experimental and Analytical Consideration of the Voids in Mortar and Concrete, Arthur N. Talbot. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 29 pp., 9 figs. Characteristic mortar curves giving relation between mortar voids and ratio of fine aggregate to cement, both for basic water content and for water contents in excess of this. Analytical relations developed from characteristic curves for determining proportions of cement, fine aggregate and coarse aggregate for concrete of required density and strength.

Sea-Water Action. Effect of Sea Water on Concrete Structures. Cement & Eng. News., vol. 33, no. 5, May 1921, pp. 29–30, 1 fig. Experience with piers at Annapolis Royal, Nova Scotia.

Specifications. German Specifications for Concrete (Die Gütevorschriften für Beton), B. Löser. Bauingenieur, vol. 2, no. 9, May 15, 1921, pp. 229–233, 5 figs. From results of investigations writer concludes that officially prescribed testing method for soft and liquid concrete is unsuitable and leads to false conclusions.

Strength. Effects of Organic Impurities on Concrete. Public Works, vol. 50, no. 21, May 21, 1921, pp. 425–426. Investigations at Lewis Inst., Chicago. Minute quantities of tannic acid reduce strength one half. Surface loam always reduces strength. From proceedings Am. Soc. for Testing Matls.

Testing. Report of Committee C-9 on Concrete and Concrete Aggregates. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 19 pp. Proposed tentative methods for making compression tests of cement concrete, test for organic impurities in sands, test for sieve analysis of aggregates, and for securing specimens of hardened concrete from structure; also proposed tentative specifications for concrete aggregates.

Tests. Influence of the Grain Composition of the Aggregates of Gravel-Concrete Mixtures on Compressive Strength and Elasticity (Der Einfluss der Kornzusammensetzung der Zuschlagstoffe von Kiesbeton-Mischungen auf die Druckfestigkeit und -Elastizität), Josef Kortlang. Bauingenieur, vol. 2, no. 9, May 15, 1921, pp. 239–243, 5 figs. Results of experiments show that compressive strength is dependent upon water cement and cement ratios and the total surface of aggregates per unit.

Water Content. Mathematical Determinations of Water Content of Mortars and Concrete, According to the New Theories on Their composition and on the Rôle Played by Their Various Elements (Le dosage mathématique, en eau, des mortiers et bétons, d'après les nouvelles théories sur leur composition et sur le rôle de leurs divers éléments), J. Boudet. Vie technique & industrielle, vol. 2, no. 19, April 1921, pp. 39–45, 4 figs. Graphs.

CONCRETE CONSTRUCTION

Developments. New Methods Relating to Concrete Construction. Concrete & Constructional Eng., vol. 16, no. 5, May 1921, pp. 311–317, 15 figs. Inventions relating to construction of walls, wall ties, slabs, etc.

Technology. Some Problems in Concrete Construction, W. K. Hatt. Mun. & County Eng., vol. 60, no. 5, May 1921, pp. 182–187. Review of principles developed from results of various investigators.

CONCRETE, REINFORCED

Wood Reinforcement. Wood Reinforcements of Cement (Le béton armé de bois), M. Levatel. Outillage, vol. 5, no. 10, Mar. 10, 1921, pp. 283–284, 10 figs. Experiments show that wood reinforcements are effective, wood being preserved perfectly for indefinite time.

CONDENSERS, STEAM

Water Films. The Water Film on Evaporating and Condensing Tubes, P. H. Parr. Engr., vol. 131, no. 3413, May 27, 1921, pp. 559–561. Internal resistance of water film.

CONDUITS

Steam Pipe. Steam Conduit for Toronto's New Union Station. Contract Rec., vol. 35, no. 22, June 1, 1921, pp. 551–552, 4 figs. Two pipe lines in concrete tunnel convey steam from power house, several blocks distant. Provision for removal of seepage.

CONNECTING RODS

Machining Operations. Machining Connecting Rods. Eng. Production, vol. 2, no. 35, June 2, 1921, pp. 681–683, 6 figs. Jigs and tools for accurate production.

Rolls-Royce. The Rolls-Royce Connecting Rods, Ferd H. Colvin. Am. Mach., vol. 54, no. 24, June 16, 1921, pp. 1041–1043, 7 figs. Machining methods.

COOLING TOWERS

New Type. A New Type of Water Cooling Tower. Beama, vol. 8, no. 5, May 1921, p. 418. Tower recently erected at government electric station in Dresden, Germany. Air and water do not flow on counter-current principle, but air enters cooler horizontally while water falls vertically.

COPPER

Thermal Expansion. Thermal Expansion of Copper and Some of Its Important Industrial Alloys, Peter Hidnert. U. S. Dept. of Commerce, Scientific Papers of Bur. of Standards, no. 410, Mar. 21, 1921, pp. 91–159, 43 figs. Data on thermal expansion of 128 samples of copper and its important industrial alloys of various compositions, heat treatments, mechanical treatments, etc. Samples were examined from room temperature to about 300 deg. cent.

CORES

Core Oils. Tests Show the Quality of Core Oils, R. F. Harrington. Foundry, vol. 49, no. 11, June 1, 1921, pp. 447–448, 3 figs. Tests used by manufacturers of core oil to determine character of various ingredients are described. Effect of core oil varied by use of dry or wet sand.

CORROSION

Iron in Concrete. The Corrosion of Iron and Steel with Special Reference to Reinforced Concrete, J. Newton Friend. Concrete Inst. Trans., vol. 9, Apr. 1921, pp. 1–15 and (discussion) pp. D15–D20, 3 figs. It is shown that preservation of iron in concrete may be effected in one or more of three ways, namely by complete exclusion of air, of water, and by rendering concrete sufficiently alkaline to place it within the protective area. Suggestions are offered.

CRANES

Locomotive. Electrically Driven Locomotive-Lifting Crane (Elektrisch betriebene Lokomotivhebekrane), Ernst Schwarz. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 22, May 28, 1921, pp. 574–576, 4 figs. Crane of Hungarian Car & Machine Factory in Györ and AEG Union Electrical Co., Vienna, consisting of two coupled traveling cranes, each having two hoist trolleys. Details of mechanical and electrical equipment; control; original form of connection plug.

CUTTING TOOLS

Design. Metal Cutting Tools—X and XI, A. L. DeLeeuw. Am. Mach., vol. 54, nos. 21 and 23, May 26 and June 9, 1921, pp. 897–902, 13 figs., and 985–990, 13 figs. May 26. Notes on design of milling cutters, gear cutters, duplex cutters and various types of hobs. June 9: Cutter sharpening; characteristics of cup and disk wheels; importance of correct angles; cutter grinders; hob grinding.

Working Pressures. Origin and Calculation of Working Pressure with Single-Cutter Tools Based on Results of Recent Experiments (Entstehung und Berechnung der Zerspannungswiderstände bei einschneidigen Werkzeugen auf Grund der Ergebnisse neuerer Versuchsreihen), Ernst J. Wild. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 467–472, 5 figs. Critical investigation of results of experiments carried out in recent years on the behavior of single-cutter tools in turning and planing. Based on conclusions reached, new formulas are derived for the exact precalculation of the cutting forces, taking into consideration the shape of tool.

D

DIESEL ENGINES

Compression. The Compression Line in Diesel-Engine Cards (Ueber den Verlauf der Kompressionslinie bei Dieselmotoren), Arthur Balogh. Wirtschaftsmotor, no. 3, Mar. 1921, pp. 19–20, 8 figs. Results of experimental tests carried out on a single-cylinder Diesel engine to determine course of compression line of indicator cards.

Oil-Fuel Injection. Injection and Combustion of Fuel-Oil, C. J. Hawkes. Motorship, vol. 6, no. 6, June 1921, p. 483, 3 figs. Experiments with solid injection and air-blast in marine Diesel engines. (Continuation of serial.)

Standardization. Standardized Diesel Engines—IV, H. R. Setz. Mar. Eng., vol. 26, no. 6, June 1921, pp. 471–476, 11 figs. Description of engine with automatic valve-port scavenging arrangement.

Tar Oil as Fuel. The Use of Tar Oil in Diesel Engines (Die Verarbeitung von Teeröl im Dieselmotor), W. Riehm. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 20, May 14, 1921, pp. 522–526, 18 figs. Means whereby safe starting up of cold engine, reliable ignition and complete combustion under all load conditions can be obtained.

DRAWINGS

Filing. Indexing and Filing Industrial Drawings, L. H. Park. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1447–1449, 1 fig. Systems used by prominent engineers and manufacturers.

DREDGING

Tests. Tests of Dredge Pump Operation for Hydraulic Fill, Ivan E. Houk. Eng. News-Rec., vol. 86, no. 24, June 16, 1921, pp. 1034–1037, 3 figs. Velocities and power consumption decreased as friction head and solids increased.

DRILLING MACHINES

Radial. Carlton Heavy-Duty Ball Bearing Radial Drill Machine, J. V. Hunter. Am. Mach., vol. 54, no. 21, May 26, 1921, pp. 908–911, 6 figs. Heavy-duty, geared radial drilling machine made by Carlton Machine Tool Co., Cincinnati.

Tests. Investigations on Drilling Machines (Untersuchungen an Bohrmaschinen), S. ter Ohanessian. Werkstattstechnik, vol. 15, no. 9, May 1, 1921, pp. 241–244, 12 figs. Tests carried out at laboratory of Technical Academy of Charlottenburg with two motor-driven bench, two hand and one upright drilling machines, for determination of efficiency, etc.

DRILLS

Twisted vs. Twist. The Strength of Twisted Drills. Machy. (Lond.), vol. 18, no. 452, May 26, 1921, pp. 244–247, 15 figs. Data, comprising a series of micro-etchings and test results, obtained by J. Beardshaw & Sons, Ltd., Baltic Steel Works, Sheffield and representing outcome of extensive investigation to ascertain strength of twisted drills as compared with ordinary twist drills.

DROP FORGING

Plants. Fuel Economy of a Drop Forge Plant, N. A. Craigue and C. H. L. Thompson. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1521–1525, 6 figs. Tests on steam consumption of drop-forging hammers.

DUST

Cloud-Condensation Apparatus. The Shimizu-Wilson Cloud Condensation Apparatus. Engineering, vol. 111, no. 2892, June 3, 1921, p. 692, 2 figs. Apparatus for measuring dustiness of air.

E

EDUCATION, ENGINEERING

Industrial Training. Requirements of the Engineering Industries and the Education of Engineers, Magnus W. Alexander. Mech. Eng., vol. 43, no. 6, June 1921, pp. 391–395 and 397. Developments in organization of coöperative engineering courses in connection with manufacturing plants. Plan organized at Mass. Inst. of Technology and Lynn Works of Gen. Elec. Co. During their assignments at works, students are subject to usual rules and regulations applying to employees of Gen. Elec. Co.

EDUCATION, INDUSTRIAL

Steel Industry. Educational Work in the Wire Industry, Charles R. Sturdevant. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1460–1462. Courses

on salesmanship, Americanization and for foremen, being given by Am. Steel & Wire Co., Cleveland. Paper read before Am. Iron & Steel Inst.

ELECTRIC DRIVE

Air Compressors. Electrically Driven Centrifugal Compressors, R. S. Sage. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 559–553, 6 figs. Suitability of this load for central stations.

Motor Drives for Air Compressors, Gordon Fox. Power, vol. 53, no. 20, May 17, 1921, pp. 778–779, 3 figs. Types of air compressor, their limitations. power requirements and operating characteristics. Motors to use for different applications.

Slow Speed Motors and Their Application to Reciprocating Air Compressors, R. O. Joslyn. Armour Engr., vol. 12, no. 4, May 1921, pp. 226–239, 6 figs. Operation characteristics of typical installation.

Flour Mills. Electric Drive for Flour and Grist Mills, W. T. Edgell, Jr. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 542–546, 3 figs. Operating data obtained in existing installations.

Machine Shops. Electric Drive for Machine Shops, B. S. Pero. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 528–529, 2 figs. Types of motors used.

Machine Tools. Installation of Motor Drives on Old Tools, J. H. Vincent. Am. Mach., vol. 54, no. 23, June 9, 1921, pp. 100–1001, 3 figs. Expedients resorted to in railroad shop to provide individual motor drive for old planer and boring mill.

Oil Fields. Extension of Electric Power Service Into the Oil Fields, W. G. Taylor. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 535–538, 5 figs. Survey of developments.

Refrigerating Plants. Refrigeration Load. A. R. Stevenson, Jr. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 569–571, 2 figs. Typical load curves of ice plants.

Rolling Mills. Sheet Rolling Mills at Baltimore. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1535–1538, 7 figs. Top rolls of roughing mills driven by independent motor.

Skip Hoists. Electric Drive for Small Automatic Self-Dumping Skip Hoists, R. H. McLain and C. B. Connely. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 530–535, 13 figs. Notes on design of installations.

Steel Mills. Blooming Mill Motor Drive, B. M. Jones. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1386–1387, 2 figs. Replacing steam by electric drive on large reversing blooming mill at plant of Bethlehem Steel Co.

Load Conditions in Steel Mills, J. D. Wright and L. C. Moseley. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 487–490, 8 figs. Typical load curves.

Woodworking Industry. Motor Drive in the Woodworking Industry, F. H. Penney and E. L. Bamforth. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 554–557, 5 figs. Types of electrically driven machines used in wood-working industry.

ELECTRIC FURNACES

Crucible vs. Electric vs. Crucible Furnaces, H. W. Gillet and T. H. A. Eastick. Metal Industry (N. Y.), vol. 19, no. 6, June 1921, pp. 240–242. Opinions of Bur. of Mines experts on opposite sides of question.

ELECTRIC PLANTS

Interconnection. Interconnection Problems and Economies, E. P. Peck and Harry J. Burton. Elec. World, vol. 77, no. 22, May 28, 1921, pp. 1238–1240. Symposium. Titles of papers are: Charts for Quick Solution of Line-Drop Problems; Conditions that Must Be Watched When Inter-connecting Small Plants; and Economic Benefits Derived from Energy Interchange.

Protective Equipment. Protection of Power-Station Equipment, Edgar P. Slack. Power, vol. 53, no. 23, June 7, 1921, pp. 920–923, 3 figs. National Electrical Code as applied to power-station equipment.

ELECTRIC WELDING

Cast Steel. Repairing a Gold Dredge Bull Gear, C. M. Romanowitz. Eng. & Min. Jl., vol. 111, no. 25, June 18, 1921, pp. 1030–1031, 3 figs. Repairing cast-steel gear of about 14 ft. 2 in. in diameter and 15-in. face.

ELECTRIC WELDING, ARC

Automatic. Automatic Arc Welding, H. L. Unland. Gen. Elec. Rev., vol. 24, no. 6, June 1921, pp. 583–586, 5 figs. Apparatus developed for automatic welding by electric arc.

Kjellberg Process. Electric Arc Welding (La soudure électrique à l'arc), M. Lebrun. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 201–212, 11 figs. Tests of Kjellberg process at Naval College of Greenwich by Anglo-Swedish Elec. Welding Co. Kjellberg process consists in stabilizing direction of arc by surrounding electrode with non-conducting slightly fusible material. Arc is thus prevented from flickering.

ELECTRIC WELDING, RESISTANCE

Modern Machines. Recent Progress in the Construction of Electric Welding Machines (Neuere Fortschritte im Bau elektrischer Schweissmaschinen), Albert Neuburger. Werkstattstechnik, vol. 15, no. 9, May 1, 1921, pp. 250–255, 8 figs. Details of various improved types of machines for spot, butt and seam welding.

Tests. Resistance Electric Welding (La soudure électrique par résistance), J. Paturel. Vie technique & industrielle, vol. 2, nos. 19 and 20, April and May 1921, pp. 24–26, 5 figs., and 137–139, 11 figs. Tests on aluminum and steel articles.

ENAMELS

Copper. Some Data on the Composition of Arsenic Enamels for Copper, B. T. Sweely. Jl. Am. Ceramic Soc., vol. 4, no. 5, May 1921, pp. 350–356. Methods of application by wet slushing.

EVAPORATORS

Regenerative Compressor. G-R Regenerative Compressor. Power, vol. 53, no. 20, May 17, 1921, p. 777, 1 fig. Apparatus designed for installation on Reilly evaporators. Compressor is essentially jet flow compressor that entrains and compresses by means of live steam part of vapor produced by evaporator, and this entrained vapor is in turn led to evaporator coils together with boiler steam.

F

FABRICS

A.S.T.M. Committee Report. Report of Committee D-13 on Textile Materials. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 8 pp. Proposed tentative definitions of terms relating to mechanical fabric and proposed tentative specifications for imperfections and tolerances for square-woven tire builder fabric.

FACTORIES

Building Construction. Can I Put Up That Building More Cheaply? J. Morrow Oxley. Contract Rec., vol. 35, no. 9, Mar. 2, 1921, pp. 218–222, 8 figs. Cost analysis of structural design of standard factory type.

FACTORY MANAGEMENT.

See INDUSTRIAL MANAGEMENT.

FANS, CENTRIFUGAL

Design. Some Developments in Centrifugal Fan Design, F. W. Bailey and A. A. Criqui. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 4, May 1921, pp. 375–380, 7 figs. Comparison of static efficiencies of forward and double-curved-blade types of fans.

FATIGUE

Industrial. Fatigue and Efficiency in Iron and Steel Works—VII, H. M. Vernon and E. A. Rusher. Eng. & Indus. Management, vol. 5, no. 18, May 5, 1921, pp. 519–522. Health of steel workers. Abstract from Report No. 5 of British Indus. Fatigue Research Board.

Fatigue in the Boot and Shoe Industry, J. Loveday and S. H. Munro. Eng. & Indus. Management, vol. 5, no. 19, May 12, 1921, pp. 541–543, 10 figs. Records given in report to British Indus. Fatigue Research Board.

FIREBRICK

Spalling. Report of Committee C-8 on Refractories. Am. Soc. for Testing Matls., paper of annual meeting. June 21–24, 1921, 4 pp. Proposed tentative method of test for resistance of fireclay brick to spalling action.

FLAX

Scutching Machine. Flax Scutching Machine. Engineering, vol. 111, no. 2890, May 20, 1921, pp. 614–616, 7 figs. Combined flax-breaking and scutching machine invented by M. Swynghedauw of Motteville, France.

FLOW OF OIL

Pipes. The Flow of Petroleum Oils Through Pipes, W. A. Thomas. Oil News, vol. 9, no. 10, May 20, 1921, pp. 33–34. Tables of coefficients in formulas.

FLUE-GAS ANALYSIS

Excess-Air Determination. Determination of Excess Air from Flue Gas Analysis, R. Brown. Combustion, vol. 4, no. 6, June 1921, pp. 24–25, 2 figs. Chart and derivation of formula used in making it.

FORGE PLANTS

Erie. War Plant of Erie Forge & Steel Co., Sidney G. Koon. Iron Age, vol. 107, no. 24, June 16, 1921, pp. 1595–1603, 12 figs. Plant developed and built by U. S. Navy Dept. under emergency legislation of Oct. 1917.

FOUNDRIES

Layout. Completes Revision of Foundry, George H. Manlove. Foundry, vol. 49, no. 11, June 1, 1921, pp. 426–429, 8 figs. Layout of Chicago Steel Foundry Co. providing for straight-line traveling of products.

Power Plants. Power for the Toledo Machine and Tool Co. Power Plant Eng., vol. 25, no. 12, June 15, 1921, pp. 595–599, 8 figs. Plant furnishes power, light and heat necessary for operation of large foundry.

FUELS

Garbage. The Economic Utilization of House Garbage as Fuel (Die Vorbedingungen für die wirtschaftliche Verwertung des Hausmülls als Brennstoff), Jakob Bodler. Zeit. des Bayerischen Revisions Vereins, vol. 25, nos. 7 and 8, Apr. 15 and 30, 1921, pp. 49–52 and 57–62, 5 figs. Suggestions for preliminary treatment of garbage with view to obtaining a good combustion.

FURNACES

Flame Propagation. Examination of Theory of Flame Furnaces Based on Laws of Hydraulics (Essai d'une théorie des fours a flammes basée sur les lois de l'hydraulique), W. E. Groume-Grjimailo. Revue universelle des Mines, vol. 9, no. 2, April 15, 1921, pp. 132–144 15 figs. Fundamental idea is that circulation of flames in furnace is identical with movement of light liquid in heavy liquid.

G

GAGES

Screw. The Manufacture of Hardened Screw Gauges. Eng. Production, vol. 2, no. 34, May 26, 1921, pp. 644–645, 3 figs. Machines and processes employed.

GAS ENGINES

Measurement of Gas and Air. Measurement of the Suction Gas and Air Volumes in Gas Engines (Messung der von Gasmaschinen angesaugten Gas- und Luftmengen), K. Schreber. Oel- u. Gasmaschine, vol. 18, no. 5, May 1921, pp. 72–73. Results of investigation show that, with use of certain precautionary measures, it is possible with aid of a nozzle to carry out measurements for determining economy of gas engines.

GASOLINE

Cracking Processes. Manufacture of Motor Spirit by "Cracking" Processes. Chem. Age (Lond.), vol. 4, no. 101, May 21, 1921, pp. 578–580. Manufacture of gasoline by pyrolitic decomposition of higher boiling hydrocarbons.

Specifications. Report on Low Test Gasoline Specifications. U. S. War Dept., Air Service Information Circular, vol. 2, no. 165, May 1, 1921, 4 pp.

GEARS

Blank Manufacture. An Improved Method of Making Steel Gear and Wheel Blanks, George Atwell Richardson. Am. Mach., vol. 54, no. 23, June 9, 1921, pp. 981–984, 13 figs. Manufacture of high-grade steel gear blanks in hydraulic ram for production work.

Design. Odontograph for Layout of 20-Degree Gear Teeth, J. L. Williamson. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 929, 1 fig. Table giving calculated valuation of constant.

Involute. Slip of Involute Gear Teeth. A. B. Cox. Am. Mach., vol. 54, nos. 21 and 22, May 26 and June 2, 1921, pp. 913–917, 4 figs., and 951–955, 9 figs. Gear efficiency increased and wear decreased by using large numbers of teeth. Shorter addendum reduced slip. Friction losses increase with increases in angle of obliquity. Graphs. Diagrams for internal-gear formulas. (To be continued.)

The Evolution of the Involute Gear Tooth—V, A. Fisher. Machy. (Lond.), vol. 18, no. 453, June 2, 1921, pp. 273–276, 8 figs. Study of contact conditions.

Laminated. The Manufacture of Laminated Gears. Eng. Production, vol. 2, no. 34, May 26, 1921, pp. 653–655, 7 figs. Practice at works of Laminated Gears, Ltd., Sheffield, England.

Machining Operations. Machining a Large Gear Blank on the Automatic, J. H. Moore. Can. Machy., vol. 25, no. 21, May 26, 1921, pp. 71–74, 12 figs. Attachments used. Tool layouts for gear blanks, hubs and spark-plug shells.

Spiral. Chart for Selecting Spiral Gears. Machy. (Lond.), vol. 18, no. 449, May 5, 1921, pp. 141–143, 1 fig. Chart prepared from standard formulas.

GRINDING MACHINES

Cylinder. Cylinder Grinding Machine. Engineering, vol. 111, no. 2892, June 3, 1921, pp. 676–678, 20 figs. Machines manufactured by Heald Machine Co., Worcester, Mass.

GUN METAL

Properties. Reviews Properties of Gunmetal, Joseph Horton. Foundry, vol. 49, no. 11, June 1, 1921, pp. 436–439. Compositions and physical properties called for in different specifications are compared and views of number of investigators on effects of various metals and heat treatments are cited.

GUNS

Radially Expanded. Elastic Strength of Radially Expanded Guns, W. H. P. Blandy. U. S. Naval Inst. Proc., vol. 47, no. 220, June 1921, pp. 883–908, 14 figs. Process of gun construction by radial expansion was described in U. S. Naval Inst. Proc. for Dec. 1920. In present article elastic strength of radially expanded gun is computed analytically and compared with similarly computed strengths of other guns.

H

HANGARS

Reinforced-Concrete. Reinforced Concrete Hangars. Concrete Constructional Eng., vol. 16, no. 5, May 1921, pp. 318–320, 4 figs. Hangar recently built at Lucon Vendée, France. Design consists of arch 176 ft. high internally, 186 ft. externally, 362 ft. wide and 733 ft. long. Translated from Génie Civil.

HEAT TRANSMISSION

Research. Apparatus for Testing Insulating Materials, F. B. Rowley. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 469–474, 8 figs. Adaptations of hot-box methods of testing heat transmission.

Heat Transmission Investigations, A. J. Wood and E. F. Grundhofer. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 453–462, 1 fig. Results of study and experimentation on heat transmission through corkboard and air spaces. Work undertaken at Engineering Experiment Station, Pennsylvania State College.

HEATING, ELECTRIC

Factories. Air Heating by Electricity in Swiss Fac-

tory (Réchauffeur d'air électrique, à accumulation). Génie Civil, vol. 78, no. 18, April 30, 1921, pp. 376–377, 2 figs. Heater has capacity of 3300 kw.

HEATING, GAS

Coal versus. The Application of Gas to Space Heating, Thomson King. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 421–434, 10 figs. Comparative costs of heating by gas and by coal.

HEATING, HOT-WATER

Piping. Circulation Problems in Hot-Water Heating, A. W. Luck. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 409–416, 7 figs. Typical piping methods.

HEATING, STEAM

Gravity Systems. Fractional Distribution in Two Pipe Gravity Steam-Heating Systems, Alphonse A. Adler and James A. Donnelly. Jl. Am. Soc. Heat & Vent. Engrs., vol. 26, no. 4, May 1921, pp. 437–452, 4 figs. Typical devices for gravity return.

HOISTING ENGINES

Mine. A Large American Mine Winding Engine. Engr., vol. 131, no. 3412, May 20, 1921, pp. 540–542 and 544, 7 figs. Four-cylinder cross-compound condensing machine with drum 30 ft. diameter for raising 10-ton loads with rope speed of 3200 ft. per min. from depths of 6600 ft. to 8600 ft.

HOUSES

Stucco. Back-Plastered Stucco House Construction Concrete, vol. 18, no. 6, June 1921, pp. 274–278, 12 figs. Recommendations prepared by Committee of Am. Concrete Inst.

HOUSES, CONCRETE

Economic Construction. "Double C" Elements for Economic Construction of Buildings (Agglomérés en éléments dits "double C" pour la construction economique des bâtiments). Génie Civil, vol. 78, no. 18, April 30, 1921, p. 379, 3 figs. Concrete slabs with projecting members. In erecting wall projecting members are placed end to end and fastened together by suitable reinforcing bar.

England. The Development of Concrete for Housing in England. Concrete, vol. 18, no. 6, June 1921, pp. 279–281, 6 figs. Systems of constructing cavity walls. From Concrete & Constructional Eng.

Unit Dwellings. The One-Piece House, Harry A. Mount. Sci. Am., vol. 124, no. 22, May 28, 1921, pp. 424–425, 4 figs. Simon Lake's scheme for producing ready-to-live-in concrete unit dwellings and transporting them to site.

HOUSING

Industrial. The Present Housing Crisis and Suggested Way Out, John Ihlder. Jl. Engrs. Club of Phila., vol. 38, no. 197, May 1921, pp. 210–205. Government house building in England adopted as necessary for future. Political and economic aspect of housing shortage in U. S.

Mines. Rosita, Mexico, a Carefully Planned City; Pleasing, Comfortable and Hygienic—I, Hjalmar E. Skougor. Coal Age, vol. 19, nos. 22 and 23, June 2 and 9, 1921, pp. 983–987, 8 figs., and 1037–1040, 9 figs. Village for employees at coal mines and by-product plant of Am. Smelting & Refining Co. Each family to have lot 50 ft. square and share in a large community farm.

HYDRAULIC TURBINES

Design. A New Type of Water Turbine. Engr., vol. 131, no. 3411, May 13, 1921, pp. 518–519, 6 figs. Suggests use of continuously curved inner and outer surfaces of revolution for turbine water passages, thus avoiding all sudden changes of curvature.

Calculation of the Moment of Inertia of the Flywheel of a Hydraulic Turbine (Calcul du moment d'inertie a donner aux volants des turbines hydrauliques), P. Cayère. Houille Blanche, vol. 20, no. 51–52, Mar.-April 1921, pp. 57–63, 10 figs. Formulas and graphs.

Governors. Improvements in Hydraulic Turbines, H. Donath. (Neuerungen an Wasserturbinen), Elektrotechnischer Anzeiger, vol. 38, nos. 69–70, 71 and 72, May 4, 5 and 7, 1921, pp. 439–442, 447–448 and 453–455, 17 figs. Details of regulating devices.

Regulation. Regulation of Hydraulic Turbines (Les turbines hydrauliques et leur régulation). Revue genérale de l'Électricité, vol. 9, no. 18, April 30, 1921, pp. 616–623, 7 figs. Survey of developments. (Abstract.) Paper read before Société des Ingénieurs civils de France.

HYDROELECTRIC PLANTS

Canada. Hydroelectric Plant at Weedon, P. Q., for City of Sherbrooke. Elec. News, vol. 30, no. 10, May 15, 1921, pp. 30–31, 3 figs. Plant will develop 4000 hp. and deliver energy at 50,000 volts along transmission line 28 mi. long.

Design. Hydro-Electric Practice—Features of Design, C. Voetsch. Power, vol. 53, no. 21, May 24, 1921, pp. 818–823, 12 figs. Overall efficiency of hydroelectric power system. Effects of main unit sizes upon station efficiency. Importance of specific speed in turbine design. Curves given for checking turbine design or laying out preliminary designs.

Efficiency. How to Increase the Efficiency of Existing Water-Power Plants, Charles M. Allen. Jl. Worcester Polytechnic Inst., vol 24, no. 3, April 1921, pp. 192–200, 1 fig. Graph showing best speed for maximum horsepower at any gate for heads from 25 ft. to 33 ft.

Hydraucone Regainer. The Hydraucone Regainer, Its Development and Applications in Hydroelectric Plants, W. M. White. Mech. Eng., vol. 43, no. 6, June 1921, pp. 375–380 and 419, 17 figs. Device for recovering energy discharged from runner for useful effect on water wheel within limited space available in power-house foundations. Method consists in causing stream flow to impinge upon flat, conical or concave shape, thus changing its direction, and then by means of a gradual diverging envelope placed around this shape to change the velocity head of a fluid entering at high velocity into pressure and low velocity at exit. Results of tests are included.

Spain. Hydroelectric Plants of Guadiaro River, Spain (Les usines hydro-électriques du Guadiaro), Adolphe Weber. Schweizerische Bauzeitung, vol. 77, no. 23, June 4, 1921, pp. 257–258, 4 figs. Corshado plant utilizing waterfall of 120 m. (To be continued.)

Sweden. High Power Hydroelectric Installations (Installations hydro-électriques de grande puissance), A. Tétrel. Electricien, vol. 37, no. 1277, June 1, 1921, pp. 241–247, 9 figs. Central station at Trollhättan, Sweden. (To be continued.)

Underground. An Underground Hydroelectric Plant (Un cas particulier d'usine hydroélectrique souterraine), Paul Basiaux. Revue générale de l'Électricité, vol. 9, no. 19, May 7, 1921, pp. 656–657, 1 fig. Tunnel was constructed for diverting flow of water from Diege River, affluent of Dorgogne in France. Total energy utilized is 200,000 hp.

Water-Main Operation. Hydro-Electric Unit Operated from City Water Main, J. B. Holdcroft. Contract Rec., vol. 35, no. 9, Mar. 2, 1921, pp. 207–210, 4 figs. Installation at Port Alberni, B. C., where high pressure and large pipe capacity permitted water-wheel attachment, operating civic lighting plant.

HYDROGLIDERS

Theory. The Hydroglider—Its Theory and Its Future (L'hydroglisseur, sa théorie, son avenir), F. de Pierrefeu. Vie technique & industrielle, vol. 2, no. 18, Mar. 1921, pp. 511–517, 10 figs. Boat gliding along surface of water by action of air propeller.

I

ICE PLANTS

Toronto. Producing Ice in an Up-To-Date Plant, T. H. Fenner. Power House, vol. 14, no. 8, April 20, 1921, pp. 21–24, 7 figs. Toronto plant with output of 80 tons per day.

IGNITION

Theory. Underlying Principles of Electrical Ignition, Benjamin F. Bailey. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 570–576 and 607, 8 figs. Formulas and graphs expressing variations in energy supplied by magneto, produced by changes in engine speed.

INDUSTRIAL MANAGEMENT

Chart of. The Chart of Scientific Management, Robert Stelling. Eng. & Indus. Management, vol. 5, no. 22, June 2, 1921, pp. 622–623, 1 fig. Methods by which economic waste can be eliminated.

Control of Functions. The Control of Function in Industry. Eng. & Indus. Management, vol. 5, no. 21, May 26, 1921, pp. 597–599. Essential features to be considered when planning a scheme for controlling functions, or duties, of a worker in large organization.

Distribution of Work. Factory Management (Die Betriebsleitung des Grossbetriebes), Gustav Wedemeyer. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 482–483. Notes on distribution of work among executive heads.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 16, May 10, 1921, pp. 120–121. Proposal of Works Department of German Federation of Technical and Scientific Societies for instruction sheet for installation and care of transmissions; and for fire-prevention measures.

Measurement of Labor Losses. Production Hours—A New Measure of Management, William Leavitt Stoddard. Factory, vol. 26, no. 11, June 1, 1921, pp. 1287–1291, 1 fig. Plan for accurate measurement of labor losses.

Production Systems. Modern Production Methods—XVII, W. R. Basset. Am. Mach., vol. 54, no. 24, June 16, 1921, pp. 1032–1036, 4 figs. Illustrates method of handling abnormal expense.

Planning and Controlling Production in a French Shop, E. Julien. Am. Mach., vol. 54, no. 21, May 26, 1921, pp. 889–893, 13 figs. Engineering department responsible for bills of material. Cylindrical control board saves room. Calculagraph used in work-distributing department.

Routing Materials. Works Administration, Cecil F. Hammond. Eng. Production, vol. 2, no. 34, May 26, 1921, pp. 647–652, 11 figs. Progress system and its relation to works costing.

[See also TIME STUDY.]

INSPECTION

Systems. The Delco Inspection System, Louis Ruthenburg and R. A. Crist. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 921–926, 4 figs. Methods used by Dayton Eng. Laboratories Co., for inspection of raw materials, purchased parts, tools, equipment and gages, and manufactured product.

INTERNAL-COMBUSTION ENGINES

Cylinder Actions. Cylinder Actions in Gas and Gasoline Engines, Dugald Clerk. Jl. Soc. Automotive Engrs., vol. 8, no. 6, June 1921, pp. 523–539, 24 figs. Account of experiments which have been made to develop theory and establish property of flame-working fluid in internal-combustion engines. Description of Clerk plane-pressure starter.

Detonation. Detonation in Internal-Combustion Engines, H. T. Tizard. Eng. & Indus. Management, vol. 5, no. 18, May 5, 1921, pp. 515–518. Conditions under which different types of fuel ignite. (To be continued.)

The Causes of Detonation in Internal-Combustion Engines, H. T. Tizard. North-East Coast Instn. Engrs. & Shipbuilders, advance paper, 21 pp., 16 figs. From Technical considerations and experimental evidence it is concluded that detonation depends not only on ignition temperature but also on maximum flame temperature and effect of temperature on rate of combustion.

Fuels. The Influence of Various Fuels on the Performance of Internal Combustion Engines—V, H. R. Ricardo. Automobile Engr., vol. 11, no. 151, June 1921, pp. 201–205, 9 figs. Tests on variable compression engines. It was found that when both change in specific heat and dissociation are taken into account maximum temperature obtained with economical mixture strengths is substantially the same of all available hydrocarbon fuels, though it is perceptibly lower in case of alcohol; also that gain in efficiency with increase in compression ratio is very considerably greater than is required by air cycle formula.

Temperature-Entropy Diagrams. Temperature Entropy Diagrams for Gas and Oil Engine Cycles, Guy B. Petter. Engineering, vol. 111, no. 2892, June 3, 1921, pp. 669–670, 9 figs. Examples of method of constructing diagram and notes on its interpretation.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES, DIESEL ENGINES; GAS ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Basic Open-Hearth. Commercially Pure Iron in the Basic Open-Hearth, W. J. Beck. Chem. & Metallurgical Eng., vol. 24, no. 22, June 1, 1921, pp. 965–968, 3 figs. Notes on development of metallurgical process for producing substantially pure ferrite on tonnage basis, without containing excessive amount of gas. Many modifications in rolling mills and galvanizing department were necessary to make finished sheets. Paper read before Am. Iron & Steel Inst.

Pure Iron from Basic Open-Hearth Furnaces, W. J. Beck Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1462–1464, 3 figs. History of developments in production of very low carbon-manganese metal in open-hearth furnaces. Photomicrographs of ingot iron. Paper read before Am. Iron & Steel Inst.

The Development of Commercially Pure Iron in the Basic Open-Hearth Furnace, W. J. Beck. Am. Iron & Steel Inst., advance paper, May 27, 1921, 14 pp., 6 figs.

Electrolytic. "Slip-Lines" and Twinning in Electro-Deposited Iron, W. E. Hughes. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 7, 9 pp., 10 figs. Photomicrographs of etched sections of electrolytic iron, deposited under various conditions, are shown. It is suggested that slip lines are produced in grains by forces of contraction that act during formation.

Oxygen Solution. Cupric Etching Effects Produced by Phosphorus and Oxygen in Iron, J. H. Whiteley. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 12, 13 pp., 10 figs. Investigations to determine whether cupric reagents would detect small variations of phosphorus content synthetically produced in samples of electrolytic iron, also variations of oxygen content produced in iron samples.

Solid Solution of Oxygen in Iron, J. E. Stead. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 10, 5 pp., 6 figs. It is concluded from experiments that when iron is heated in air or oxidizing gases surface layers absorb oxygen which passes into solid solution. When supersaturated oxide falls out of solution, forming separate globules of free oxide which eventually join to form continuous layers.

IRON CASTINGS

Ice Machines. Making Castings for Ice Machines. Foundry, vol. 49, no. 11, June 1, 1921, pp. 419–425, 11 figs. Dense gray castings produced with iron phosphorus. Foundry of York Mfg. Co., York, Pa.

IRON INDUSTRY

Russia. The Russian Coal and Iron Industry, V. Gudkov. Min. & Metallurgy, no. 174, June 1921, pp. 10–13, 2 figs. Location, size and development of iron and coal fields, blast-furnace practice and special features of iron and steel industry.

J

JIGS

Design. Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 54, nos. 21–24, May 26, June 2, 9 and 16, 1921, pp. 905–908, 10 figs., 939–942, 7 figs., 997–999, 7 figs. and 1037–1040, 9 figs. May 26: Design of drill jigs, leaf jigs, clamps, etc. June 2: Typical design of jigs and components; standardization of jig posts and thumb screws. June 9: Bushings. June 16. Drill templets and plate jigs.

L

LABOR

Spain. Labor Unrest in Spain, Anice L. Whitney.

U. S. Dept. of Labor, Monthly Labor Rev., vol. 12, no. 5, May 1921, pp. 154-165. Labor problem presents serious and even menacing possibilities because of revolutionary tendencies of large part of organized labor movement.

LABORATORIES

Aerodynamic. The Adlershof Altitude Testing Plant (Der Aldershofer Höhenprüfstand), K. Fr. Nägele. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 9. May 17, 1921, pp. 129-132, 5 figs. Consists of vacuum chamber with cradle dynamometer; cooling plant with pumps and re-cooling apparatus; motor-driven blowers; motor installation room with small workshop; refrigerating plant for furnishing of cold air; and room for attendants and instruments.

The Depression Chamber at Friedrichshafen (La chambre a depression de Friedrichschafen), G. Gilles. Aeronautique, no. 23, April 1921, pp. 177-179, 4 figs. Aeronautical laboratory chamber for testing machines in rarefied atmosphere.

Industrial. A Modern Works Laboratory. Eng. Production, vol. 2, no. 33, May 19, 1921, pp. 620-622, 10 figs. Details of new laboratory buildings and equipment erected and installed by the Rudge-Whitworth, Ltd., adjacent to firm's ball-bearing works at Sparkhill, Birmingham. Describes new measuring instruments, including the millimike, measuring sizes within capacity of micrometer to within 0.00001 in.; the pyromike, an optical pyrometer for measuring all temperatures from red heat upwards; and oxyscope, for measuring effects of oxidizing and reducing furnace gases upon various metals.

LATHE TOOLS

Circular Forming Tools. Circular Forming Tools (Rundstähle), Richard Nerrlich. Werkstattstechnik, vol. 15, nos. 8 and 9, Apr. 15 and May 1, 1921, pp. 212-217 and 244-250, 50 figs. Advantages of circular over straight forming tools.

LATHES

Automatic. The Herbert Auto-Lathe. Engr., vol. 131, no. 3413, May 27, 1921, pp. 574-575, 4 figs. Automatic lathe manufactured by Alfred Herbert, Coventry, England.

The Schütte Four Spindle Automatic Lathe (Der Schütte-Vierspindel-Automat). Der praktische Maschinen-Konstrukteur, vol. 54, no. 18, May 5, 1921, pp. 77-80, 7 figs. Machine brought out by Alfred H. Schütte, Cologne-Deutz, in 1915, which is claimed to surpass any known American types, and is especially adapted to quantity production of parts.

Precision Bench Lathes. Tools and Methods for Manufacturing Precision Bench Lathes—II, Machy. (Lond.), vol. 18, no. 451, May 19, 1921, pp. 204-207, 9 figs. Machining and inspection methods used in manufacture of T.L.M. bench lathe.

LIGNITE

Briquetting. Plants. Modern Lignite Briquetting Plants (Einige neuzeitliche Braunkohlen-Brikett-erzeugungsanlagen), B. Schapira. Feuerungstechnik, vol. 9, nos. 13 and 14, Apr. 1 and 15, 1921, pp. 113-117 and 125-129, 19 figs. Briquet factories constructed by the Zeitz Iron Foundry and Machine Constr. Corp., Germany.

LIME

A.S.T.M. Committee Report. Report of Committee C-7 on Lime. Am. Soc. for Testing Matls., paper of annual meeting, June 21-24, 1921, 32 pp., 1 fig. Specifications for finishing hydrated lime. Comparative tests on effect of hydrated lime on concrete mixtures. Specifications for quicklime for structural purposes. Chemical analysis of limestone, lime and hydrated lime.

LOCOMOTIVE BOILERS

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Egler. New Open Hearth Furnaces at Brier Hill, George L. Prentiss. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 368–370, 2 figs. Blair Eng. Co's installation under Egler patents. By this process flame is made blow torch rather than Bunsen burner.

Uses Blow Torch Idea in Furnace, George L. Prentiss. Iron Trade Rev., vol. 68, no. 23, June 9, 1921, pp. 1586–1587, 2 figs. Application of blow-torch principle to open-hearth furnaces. Egler patent.

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OXY-ACETYLENE WELDING

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PIPE, CONCRETE

Hume. Making Concrete Pipes by Centrifugal Force. So. African Jl. of Industries, vol. 4, no. 3, Mar.-April 1921, pp. 224–235, 13 figs. Description of Hume process.

PIPE, STEEL

Centrifugal Casting. New Process for Automatic Making of Steel Tubing. Iron Age, vol. 107, no. 20, May 19, 1921, pp. 1300. Patented process for centrifugal casting of steel pipe. Process comprehends using electric melting of metal in conjunction with centrifugal casting and making of steel tubes, including those of alloy steels, such as are used for manufacturing ball-bearing races.

PIPING

Layouts. Steam Pipe Sizes, Alfred Cotton. Power, vol. 53, no. 21, May 24, 1921, pp. 832–836, 7 figs. Determination by pressure drop instead of velocity. Charts for 0 to 1,000,000 lb. of steam per hr. at pressures up to 300 lb. per sq. in.

PISTONS

Aluminum. Aluminum Piston Competition in Germany (Zum Aluminiumkolbenwettbewerb). Oel-u. Gasmaschine, vol. 18, no. 4, Apr. 1921, pp. 57–58. Interest centered especially in the light pistons of the Griesheim Chemical Works made of so-called electron metal, and in aluminum pistons made by Rudolph Rautenbach, Solingen. Technical notes on qualities of aluminum pistons.

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PLATES

Deflection Under Load. The Equilibrium of Rectangular and Elliptic Plates under a Single Load (Ueber das Gleichgewicht von rechteckigen und elliptischen Platten unter einer Einzellast), Hans Happel. Eisenbau, vol. 12, no. 5–6, May 13, 1921, pp. 107–122. Calculations to determine deformation of plates under various conditions.

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PNEUMATIC TOOLS

Electric. Electrically Driven Riveting and Chisel Hammers (Elektrisch betriebener Niet- und Meissel Hammer). Der praktische Maschinen-Konstrukteur, vol. 54, no. 19, May 12, 1921, pp. 78–80, 8 figs. Arrangement consisting of small portable air pump and percussion type tool holder connected by a hose.

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PRESSES

Double-Action Drawing. Double-Action Drawing Press. Machy. (Lond.), vol. 18, no. 451, May 19, 1921, pp. 202–203, 2figs. Press designed by Arnold & Large, Ltd., Wolverhampton, in which a compensating action is incorporated, whereby any variation in thickness of plates above or below that for which machine is set is automatically provided for.

PRESSURE VESSELS

Stresses. Calculating Stresses in Pressure Vessels, William C. Strott. Boiler Maker, vol. 21, no. 6, June 1921, pp. 163–166, 4 figs. Strength of materials used in cylindrical tank construction and allowable external pressures on vacuum tanks. (Concluded.)

PROFIT SHARING

British Works. Profit Sharing in Practice. Eng. & Indus. Management, vol. 5, no. 18, May 5, 1921, pp. 513–514. Scheme of profit sharing adopted at works of W. G. Armstrong, Whitworth & Co., Ltd., Rules of employees' deposit fund in operation at these works.

PROPELLERS, SHIP

Standardization. Propeller Wheel Mold Standardization, Enrique Touceda. Foundry, vol. 49, no. 11, June 1, 1921, pp. 431–435, 7 figs. By employing accurately fitting flasks and rigging, propeller wheels true to size and pitch are turned out in about one tenth of usual time. Molding method of George H. Thatcher & Co., Albany, N. Y. Paper read before Am. Inst. Min. & Metallurgical Engrs.

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PULVERIZED COAL

Combustion. Effect of Preheat and Excess Air on Combustion of Fuel, A. D. Williams. Power, vol. 53, no. 24, June 14, 1921, pp. 960–962, 3 figs. Graphs showing characteristic combustion of pulverized coal.

Developments. Use of Powdered Fuel Under Steam Boilers, Harlow D. Savage. Am. Iron & Steel Inst., advance paper, May 27, 1921, 41 pp., 18 figs. Also in Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1464–1467, 2 figs. Survey of developments in installation of equipment for burning pulverized coal in steam-power plants. Tests and comparative costs. Paper read before Am. Iron & Steel Inst.

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PUMPS

Rotary. A New Principle of Rotary Pump Construction, S. H. Farkas. Chem. & Metallurgical Eng., vol. 24, no. 23, June 8, 1921, pp. 1025–1026. Description of Exeter rotary pump.

PUMPS, CENTRIFUGAL

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Wilfley. The Wilfley Centrifugal Pump, John Goodman. Practical Engr., vol. 63, no. 1786, May 19, 1921, pp. 311–313, 4 figs. Extracts from report on series of tests carried out on new type of centrifugal pump produced by Wilfley Co., Ltd., London, having impeller fitted with hollow trunnion through which suction water passes on its way to impeller passages.

R

RADIOMETALLOGRAPHY

Research. Roentgen Spectrographic Investigations of Iron and Steel, Arne Westgren. Iron & Steel Inst., annual meeting, May 5–6, 1921 paper no. 11, 23 pp., 4 figs. Research at Physical Instn. of University of Lund, Sweden. Investigations have shown that atoms of iron at ordinary temperature and at 800 to 830 deg. cent. are oriented in exactly the same way, a conclusion which is held to prove that iron does not undergo any allotropic transformation at 768 deg. cent.

RAILS

Acid Bessemer. Bessemer Acid Steel Rails, Cecil J. Allen. Ry. Engr., vol. 42, no. 496, May 1921, pp. 182–184. Records of tests.

Failures. Punishment of Rails, James E. Howard. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1375–1376, 3 figs. Report to Interstate Commerce Commission on failure of 75-ton Bessemer steel rail. Attention is drawn to difference, both in original and in effect, of rail hardness produced by cold-rolling action of wheels and by their slipping.

Rerolling. Rerolling Rails in New Ohio Mill, John D. Knox. Iron Trade Rev., vol. 68, no. 20, May 19, 1921, pp. 1384–1387, 6 figs. Rerolling mill containing seven stands of 14-in. rolls.

RAILWAY ELECTRIFICATION

India. The Electrification of Indian Railways. Ry. Engr., vol. 42, nos. 496 and 497, May and June 1921, pp. 185–188, and 1 fig., and 218–222, 14 figs. Advantage of using electric locomotives as compared with steam locomotives in heavily graded sections of North Western Ry. of India.

Switzerland. Electrification of St. Gotthard Line, Switzerland, Hans W. Schuler. Ry. Elec. Engr., vol. 12, no. 6, June 1921, pp. 221–227, 15 figs. Electrified section is 101 miles long and has average grade of 2.6 per cent for 30 miles. Single-phase, 15,000-volt power is used.

The Electrification of the Swiss Railways. Engr., vol. 131, no. 3413, May 27, 1921, pp. 563–564. Survey of developments.

RAILWAY MOTOR CARS

Gasoline-Driven. Gasoline-Driven Motor Omnibus for Railroads. Ry. Age, vol. 70, no. 23, June 10, 1921, pp. 1363–1364, 2 figs. Two car units consisting of motor car and trailer for passenger service on branch lines.

RAILWAY OPERATION

Material vs. Personnel Expenses. How Material Costs Affect Railway Income, Harrington Emerson. Ry. Rev., vol. 68, no. 23, June 4, 1921, pp. 851–854, 2 figs. Material vs. personnel expenses considered upon basis of the equated locomotive day.

Selection and Training of Personnel. The Selection and Training of Personnel for Railroad Service (Auslese und Ausbildung des Personals für den unteren Betriebsdienst), Hans Busse. Archiv für Eisenbahnwesen, no. 3, May-June 1921, pp. 564–581, 2 figs. Recommends following measures for increasing efficiency of operation: Selection and correct classification of employees with aid of psychotechnical adaptability test; improvement in instruction methods; regulation of working conditions according to efficiency; suitable arrangement of working and rest quarters; wide use of technical expedients for facilitating work.

Train Dispatching. New Record Demonstration of Heavy Tonnage Train Handling. Ry. & Locomotive Eng., vol. 34, no. 6, June 1921, pp. 151–155, 7 figs. Experience of Virginian railway in handling trains of 16,000 gross tons on heavy grades in regular train service.

Train Loading. Record Train Loading Features Virginian Operation. Ry. Age, vol. 70, no. 21, May 27, 1921, pp. 1203–1208, 7 figs. Methods used to handle loads of 8000 to 9000 tons in regular course.

RAILWAY REPAIR SHOPS

Welding. Shop Notes from Buffalo. Elec. Ry. Jl., vol. 57, no. 25, June 18, 1921, pp. 1114–1118, 14 figs. Reclamation of material and welding methods at railway repair shop of Int. Ry., Buffalo.

RAILWAY SHOPS

Mechanical Equipment. Revivifying the Railroad Shop, G. W. Armstrong. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 341–345, 8 figs. Notes on installation of mechanical equipment.

RAILWAY SIGNALING

England. Three-Position Signaling in Great Britain Ry. Signal Engr., vol. 14, no. 6, June 1921, pp. 211–216, 10 figs. First installation of this type in England made on Great Western. A. C. apparatus fog repeators and automatic stops used.

RAILWAYS

Narrow-Gage. Development of Narrow-Gage Railways in Prussia (Entwicklung der Kleinbahnen in Preussen). Archiv für Eisenbahnwesen, no. 3, May-June 1921, pp. 607–637. Statistical data.

Short Line Roads. The Transportation Problem and the Short Line Roads. Ry. Rev., vol. 68, no. 23, June 4, 1921, pp. 860–862. Extracts from report of president of American Short Line Railroad Assn.

REAMERS

Manufacture. Solid Reamers for Precision Holes (Feste Reibahlen fur Genaulöcher), Jos. Reindl. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 461–467, 21 figs. As excess of reamer diameter for limit-gage holes, ⅔ to ¾ of the tolerance above lower measurement of hole is accepted as permissible. Writer recommends that hand reamers be tapered at end for a length equal to ¼ the length of flute. Notes on grinding of hand and machine reamers.

Standards. Report of the German Industries Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie), Betrieb, vol. 3, no. 16, May 10, 1921, pp. 227–239, 19 figs. Proposals of Board of Directors for hand and machine reamers (solid adjustable and shell), and pilot shanks.

REDUCTION GEARS

Design. Mechanical Reduction Gears on Warships and Merchant Ships, John H. Macalpine. Engineering, vol. 111, nos. 2890 and 2891, May 20 and 27, 1921, pp. 609–611, and 640–642, 2 figs. Graphs indicating tooth pressure per inch of face. Arguments against introducing flywheel just aft of gear.

REFRACTORIES

Oil-Fired Furnaces. Refractories for Oil-Fired Furnaces and Boilers, W. H. Grant. Jl. Am. Ceramic Soc., vol. 4, no. 5, May 1921, pp. 390–392. Causes of failure of firebrick in oil-fired furnaces.

Tests. Resistance Tests on Refractory Products under Load at Different Temperatures, V. Bodin. Colliery Guardian, vol. 121, no 3151, May 20, 1921, pp. 1454–1455, 3 figs. Account of experiments and table showing resistance figures for various substances tested. (Abstract.) Paper read before Ceramic Soc., Refractory Materials Sect., Paris. See also Iron & Steel Trades Rev., vol. 102, no. 2777, May 20, 1921, pp. 694–695, 1 fig.

REFRIGERATING PLANTS

Steam Engines. Steam Engines for Refrigerating Plants, W. H. Motz. Power, vol. 53, no. 23, June 7, 1921, pp. 916–919, 6 figs. Selection and efficient operation of steam engines for driving ice-making and refrigeration plants. Graphs showing comparative performances of various steam engines.

Wall Insulation. Insulation of Concrete Walls Nolan D. Mitchell. Concrete Age, vol. 34, no. 2, May 1921, pp. 15–17. Tables giving heat conductivity of common wall materials.

Welded Ammonia Containers. Some Tests on Welded Ammonia Containers, E. A. Fessenden. A.S.R.E. Jl., vol. 7, no. 4, Jan. 1921, pp. 281–305, 31 figs. Results of tests made to compare different methods of constructing cylinders for handling anhydrous ammonia in refrigerating plant practice.

RESEARCH

British Association. The British Research Association for the Woolen and Worsted Industries, James P. Hinchliffe. Jl. Royal Soc. of Arts, vol. 69, no. 3575, May 27, 1921, pp. 439–453. Constitution and activities.

Industrial. Governmental Research, George K. Burgess. Trans. Royal Can. Instn., vol. 13, part 1, no. 29, Feb. 1921, pp. 121–132. Discusses organization of industrial research under auspices of government.

Scientific, United States. Funds Available in 1920 in the United States of America for the Encouragement of Scientific Research, Callie Hull. Bul. Nat. Research Council, vol. 2, no. 9, part 1, Mar. 1921, 81 pp.

University of Illinois. The Functions of the Engineering Experiment Station of the University of Illinois, Charles Russ Richards. University of Ill. Bul., vol. 18, no. 24, Feb. 14, 1921, 21 pp.

ROAD CONSTRUCTION

Machinery. Road Building and the Mechanical Engineer, B. H. Piepmeier, R. C. Marshall, Jr. and C. D. Curtis. Mech. Engr., vol. 43, no. 6, June 1921, pp. 386–390, 5 figs. Problems in relation to road-building machinery presented under auspices of Materials Handling Division at Am. Soc. Mech. Engrs. spring meeting. Titles of papers were: Road-Construction Plants; Mechanical Needs in Highway-Construction Machinery; and Planning and Organizing a Road Job for Mechanical Handling of Material.

ROADS, CONCRETE

Reinforced. New Design for Illinois Concrete Highways. Eng. World, vol. 18, no. 6, June 1921, pp. 421–422, 3 figs. Corrugated longitudinal center joint. Bars tie adjacent sections and resist shear.

ROCK DRILLS

Magnetic Analysis. Application of Magnetic Analysis to Rock Drills, Charles W. Burrows. Min. & Metallurgy, no. 174, June 1921, pp. 42–43, 1 fig. Experience in use of magnetic defectoscope. (Abstract.)

Steel. What is the Ideal Drill Steel? Frank H. Kingdon. Min. & Metallurgy, no. 174, June 1921, pp. 47 and 50–51, 1 fig. Answers to questionnaire showed that double-arc, double-taper bit and cross-bit give best service.

Tests. Analysis of Some Drill-Steel Tests, Francis B. Foley. Min. & Metallurgy, no. 174, June 1921. pp. 43 and 46–47, 1 fig. Tests on breakage of shank and bit end. Breakage is attributed to faulty practice in forging and hardening. (Abstract)

ROLLING MILLS

Cost of Rolling Steel. Review of Cost of Rolling Steel in Various Mills, G. E. Stoltz. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 5, May 1921, pp. 99–115 and (discussion) pp. 116–154, 2 figs. 1 on supp. plate. Outlines method of reducing cost of producing steel. Includes tables of power and main drive operating cost of rolling steel, and chart showing comparison of cost of rolling steel on electric and steam-driven reversing blooming mills.

Sheet Mills. Operates Sheet Mill in Indiana, E. F. Ross. Iron Trade Rev., vol. 68, no. 24, June 16, 1921, pp. 1651–1656, 8 figs. Mill galvanizing plant and fabricating shop designed with a view to simplifying handling of materials.

ROPE DRIVE

Belting vs. Manila Rope and the Engineer, Rupert E. Shotts and Harry E. Wade. Eng. World, vol. 18, no. 6, June 1921, pp. 405–409, 4 figs. Graph giving relative cost per foot of drive for rope and belting, using most efficient speeds in each case.

Wire Rope. Power Transmission by Wire Rope, L. J. Dixon. Power, vol. 53, no. 22, May 31, 1921, pp. 893–896, 8 figs. Application and arrangement of system, type and size of sheaves. Rope construction, driving tension, velocities and horsepower transmitted. Idle sheaves and takeup devices.

S

SCALES

Track. 200-Ton Railway Track Scale, Canadian Pacific Railway, H. S. Bare. Can. Ry. & Mar. World, no. 279, June 1921, pp. 289–290, 7 figs. Tapered floor deck is notable feature.

SCIENTIFIC INSTRUMENTS

Design. The Design and Construction of Scientific Instruments, Robert S. Whipple. Engineering, vol. 111, no. 2891, May 27, 1921, pp. 659–662, 12 figs. Presidential address at meeting of British Optical Soc.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW THREADS

Standardization. Committee for Standardization of Screw Threads (Commission pour l'unification des filetages). Bulletin de la Société d'Encouragement pour l'Industrie nationale, vol. 133, no. 4, April 1921, pp. 380–383, 1 fig. Table giving standard dimensions of bolts and screws of from 2.5 mm. to 12 mm. diameter. Adopted by Committee of Union of Electrical Syndicates in France.

SEMI-DIESEL ENGINES

Vegetable Oils as Fuel. Vegetable Oils as Fuel for Semi-Diesel Engines, Eugenio Normand. Shipbuilding & Shipping Rec., vol. 17, no. 21, May 26, 1921, pp. 649–650, 2 figs. Experiments carried out by Ansaldo San Giorgio Works on 20 b.hp. semi-Diesel engines.

SHAFTS

Keyways. Influence of Circular Holes and Keyways on the Strength of Shafts (Einfluss von Löchern und Nuten auf die Beanspruchung von Wellen), L. Föppl. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 19, May 7, 1921, pp. 497–498, 2 figs. Increase

of stress in shafts due to perforations is said to be the same as in a similarly perforated plate. Increase in danger of rupture due to holes and keyways is twice and three times as great.

SHIP PROPULSION

Hernu Propulsion Turbine. Mechanical Propulsion of Ships (Les bateaux a propulsion mécanique), M. Monfier. Nature (Paris), no. 2458, May 14, 1921, pp. 308–310, 2 figs. Description of Hernu propulsion turbine.

Jet Propulsion. The Effective Propulsion of Craft for use on Shallow and Obstructed Waterways, J. H. Gill. Trans. Inst. Mar. Engrs., session 1921–22, vol. 33, Apr. 1921, pp. 57–74, 14 figs. Discussion of jet propulsion.

SHIP PROPULSION, ELECTRIC

U. S. S. Tennessee. Electric Drive and the U. S. S. Tennessee, H. M. Southgate. Elec. Jl., vol. 18, no. 6, June 1921, pp. 239–289, 70 figs. Series of articles describing propelling machinery of U. S. S. Tennessee. Titles are: Motion—$30,000,000 Worth R. A. Bachmann; General Arrangement of Propelling Machinery for the U. S. S. Tennessee, W. E. Thau; The Propelling Motors of the U. S. S. Tennessee, H. L. Barnholdt; The Control Room Circuit Breaker Equipment of the U. S. S. Tennessee, E. K. Read; The Control Equipment for the Propelling Machinery of the U. S. S. Tennessee, M. Cornelius; The Lighting Sets on the U. S. S. Tennessee, J. A. MacMurchy and A. O. Loomis; The Condensing Equipment and Oil Cooling System for the U. S. S. Tennessee, J. H. Smith and A. O. Loomis; The Control of the Secondaries of the Main Propulsion Motors of the U. S. S. Tennessee, W. C. Goodwin; The Stability Indicator, R. T. Pierce; The Main Turbines and Turbine Speed Control for the U. S. S. Tennessee, W. B. Flanders; The Main Generators of the U. S. S. Tennessee, R. E. Gilman and Installation and Maintenance of Automatic Substations, C. A. Butcher.

SOOT BLOWERS

Tests. Some Results with Mechanical Soot Blowers, Robert June. Power House, vol. 14, no. 7, April 5, 1921, pp. 21–24. Survey of recent tests with coal, pulverized fuel and oil.

SPRINGS

Formulas for Design. Formulas for Spring Design. Machy. (Lond.), vol. 18, no. 451, May 16, 1921, pp. 209–211, 4 figs. Formulas used by draftsmen and designers of Briggs Stratton Co., Milwaukee.

SPROCKET CHAINS

Standardization. Proposed Standard Roller-Chain Sprocket. Am. Mach., vol. 54, no. 24, June 16, 1921, pp. 1052–1053, 2 figs. Excerpt from report of Chain Division of Standards Committee of Soc. of automotive Engrs. at West Baden, Ind., May 24, 1921.

SPRUCE

Moduli of Rigidity. The Moduli of Rigidity for Spruce, H. Carrington. Lond., Edinburgh & Dublin Philosophical Mag. & Jl. of Sci., vol. 41, no. 246, June 1921, pp. 848–860, 6 figs. partly on supp. plate. Investigations conducted in College of Technology, Manchester, for British Air Board and Royal Aircraft Establishment.

STACKS

Corrosion. Surrounding Corroded Steel Stacks with Concrete, John V. Schaefer. Power Plant Eng., vol. 25, no. 11, June 1, 1921, pp. 560–561, 2 figs. Experience at South Works, Illinois Steel Co., South Chicago.

STAMPING

Methods. Producing a Stamped Shift Lever Dome, N. T. Thurston. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1441–1444, 11 figs. Dies and method of production.

STANDARDIZATION

Australia. An Engineering Standards Association for Australia. Sci. & Industry, vol. 2, no. 1, Jan. 1921, pp. 43–44. Scheme of organization for Australian Standards Association. Proposal has been approved by committee appointed by Council of Instn. of Engrs., Australia.

STEAM

Entropy. Entropy of Steam, M. J. Eichhorn. Power vol. 53, no. 24, June 14, 1921, pp. 966–967, 1 fig. Nomogram for entropy of steam.

High-Pressure. The Properties of High-Pressure Steam, M. J. Eichhorn. Power, vol. 53, no. 20, May 17, 1921, pp. 782–783, 1 fig. Nomogram for properties of steam up to critical point.

Properties. Properties of Steam (Ueber einige Eigenschaften des Wasserdampfes), Max Jacob Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 22, May 28, 1921, pp. 568–570. Criticisms of German technical—thermodynamical research made by English journal, Engineering, are refuted. In particular, it is shown that the well-known and established equations of state of steam, including the simple equation of Callendar, in the neighborhood of saturation at high pressures, lead to values of specific heat which are contradictory to the experimental results. On the other hand, the specific volume can be obtained from the experimental values of the specific heat, graphically or as shown by Eichelberg, in form of a broadly applicable equation of state.

Superheated. See SUPERHEATED STEAM.

Total Heat. Total Heat of Steam, M. J. Eichhorn. Power, vol. 53, no. 23, June 7, 1921, pp. 936–937, 1 fig. Nomogram for total heat of steam, computed from heat formulas.

STEAM ENGINES

High-Power. High-Power Engines and Heat Utilization (Grosskraftmaschinentechnik und Wärmeausnutzung), H. Schömburg. Wirtschaftsmotor, no. 3, Mar. 1921, pp. 17–19, 9 figs. Describes several such machines which are among the largest of their kind, including two blast-furnace blowing engines by Ehrhardt & Sehmer, Saarbrücken; the largest steam engine built by same firm and various types of turbocompressors.

Uniflow. Uniflow Steam Engines with High-Lift Conoidal Disk Valve and Layshaft of Double Speed (Gleichstromdampfmaschine mit Hochhub-Düsentellerventil und Steurwelle doppelter Drehzahl), J. Stumpf. Zeit des Vereines deutscher Ingenieure, vol. 65, no. 19, May 7, 1921, pp. 492–494, 7 figs. Discusses diminishing the clearances and surfaces of uniflow engines by employing high-lift conoidal disk inlet valves driven by layshaft whose speed is double that of engine. Abstracted from author's book, "Die Gleichstromdampfmaschine," R. Oldenbourg, Münich.

[See also REFRIGERATING PLANTS. Steam Engines.]

STEAM-ELECTRIC PLANTS

Chemical Works. New Power Plant of Monsanto Chemical Works. Power, vol. 53, no. 20, May 17, 1921, pp. 768–773, 7 figs. Power plant in which compound steam engines generate direct current for electrolytic work and discharge their exhaust to mixed-pressure turbo-generators which furnish alternating current for lighting and power.

Chicago Calumet Station. Calumet Station Equipment and Operating Features. Elec. Rev. (Chicago), vol. 78, no. 22, May 28, 1921, pp. 849–851 and 870–871, 3 figs. Details of coal-handling and burning apparatus, generating units, and switching equipment.

Developments. Practices and Tendencies in Steam Generating Plants. Elec. World, vol. 77, no. 23, June 4, 1921, pp. 1311–1314, 4 figs. Tendency is to increase turbine speeds and to improve turbine economy by raising steam pressure. Committee report submitted at conference of Nat. Elec. Light Assn.

Dodge Bros. Dodge Brothers' New Power Plant. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1391–1394, 6 figs. Steam-electric plant built on unit plan, each unit consisting of two boilers and with generating capacity of 10,000 kw.

Dodge Brothers Modern Power Plant, Thomas Wilson. Power, vol. 53, no. 21, May 24, 1921, pp. 841–849, 14 figs. Plant is arranged on unit plan and is to have ultimate capacity of 50,000 kva. Combined natural—and induced-draft cooling tower is mounted 33 ft. above grade over loading platform. To maintain heat balance house turbine is to operate in conjection with synchronous-motor-generator set.

Glasgow. The Dalmarnock Power Station. Engineering, vol. 111, nos. 2891 and 2893, May 27 and June 10, 1921, pp. 635–639 and 650, 38 figs. partly on 4 supp. plates, and 703–707, 21 figs. Glasgow steam-electric plant designed for ultimate capacity of 200,000 kw. Details of 16,000-kw. three-phase generators.

Heat Balance. Heat-Balance Study of Colfax Power Station, W. P. Gavit. Power, vol. 53, no. 21, May 24, 1921, pp. 824–827, 4 figs. Thermal efficiency of Colfax station is 18.46 as compared with 20.2 for ideal station.

Pennsylvania. The Generating Systems of the West Penn Power Company, G. G. Bell. Elec. Jl., vol. 18, no. 5, May 1921, pp. 175–193, 18 figs. Steam-electric plants with capacities of 60,000 kw., 30,000 kw., and 25,000 kw.

Philadelphia. Delaware Power Station—The Philadelphia Electric Company. Power, vol. 53, no. 21, May 24, 1921, pp. 806–817, 14 figs. Steam-electric plant designed for capacity of 180,000 kw. in six 30,000-kw. units, of which two have been installed. Single cylinder turbo-generating units operating at 1800 r. p. m. are used.

Pittsburgh. The Power Stations of the Duquesne Light Company, J. M. Graves. Elec. Jl., vol. 18, no. 5, May 1921, pp. 193–210, 20 figs. Colfax station in Pittsburgh district with present capacity of 60,000 kw.

Toledo. The Acme Power Company Plant, Cyril E. Lewis. Elec. Traction, vol. 17, no. 5, May 1921, pp. 301–305, 4 figs. Power plant at Toledo, Ohio, designed for ultimate capacity of 200,000 kw., including modern generating machinery and coal-handling facilities.

STEAM POWER PLANTS

Central Heating Stations. Modern Tendencies in the Construction of Central Plants (Les tendances modernes dans la construction des centrales), F. Scoumanne. Revue universelle des Mines, vol. 9, no. 3, May 1, 1921, pp. 229–241, 2 figs. Central heating stations. (To be continued.)

Operation. Efficient Operation of Oil Burning Steam Plants, C. H. Delany. Power Plant Eng., vol. 25, no. 11, June 1, 1921, pp. 551–556, 7 figs. Method of establishing standards of efficiency at various loads. Paper read before San Francisco Section, Am. Soc. Mech. Engrs.

Power for Toasting Cornflakes. Power Plant Eng., vol. 25, no. 11, June 1, 1921, pp. 545–550, 11 figs. Details of equipment and operation of steam power plant.

STEAM TURBINES

Developments. Recent Improvements in Steam Turbine Design. Engr., vol. 131, nos. 3410, 3412 and 3413, May 6, 20 and 27, 1921, pp. 482–484, 5 figs., 534–536, 10 figs., and 562–563, 6 figs. May 6: Marine-type geared turbo-generator manufactured by W. H. Allen, Sons & Co., Bedford, England. May 20: Types recently manufactured by Brown, Boveri & Co., May 27: Types built by English Electric Co.

Shaft Glands. Steam-Turbines Shaft Glands, John R. Baker. Power, vol. 53, no. 22, May 31, 1921, pp. 881–883, 6 figs. Methods of packing.

Thyssen-Röder Limit. The Thyssen-Röder Steam Turbineas a Limit Turbine, Karl Röder. Eng. Progress, vol. 2, no. 4, Apr. 1921, pp. 81–82, 3 figs. Reaction drum is fitted with disks without central bore, thus permitting control of volume of hore-pressure steam with small losses due to exhausting.

STEEL

A. S. T. M. Committee Report. Report of Committee A-1 on Steel. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 42 pp., 1 fig. Proposed revisions in standards and tentative standards for steel, welded and seamless steel pipe, carbon steel, rails, cold-drawn steel wire for concrete reinforcement, and boiler tubes.

Alloy. See ALLOY STEELS.

Basic. Deoxidation Phenomena in the Basic Process (Desoxydationsvorgänge im Thomasverfahren), O. von Keil. Stahl u. Eisen, vol. 41, no. 18, May 5, 1921, pp. 605–611, 3 figs. Results of tests carried out in nine large basic steel works presented in tables and charts.

Drill. Drill Steel from Hollow Ingots, P. A. E. Armstrong. Chem. & Metallurgical Eng., vol. 24, no. 22, June 1, 1921, pp. 960–964, 9 figs. Definite effort to produce hollow drill steel with decarbonized interior surface by inserting mild-steel tube in ingot mold, plugging it with sand, casting steel and subsequently rolling to size. Paper read before Am. Min. & Metallurgical Engrs.

Impact Testing. Impact Testing of Notched Bars (Essais de choc sur barreaux entaillés), M. Legrand. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 225–228, 1 fig. Tests conducted by French Permanent Commission. Bars tested were of Martin steel.

New Impact Tests Conducted by the French Standardization Commission (Quelques essais de choc sur nouvelles éprouvettes de la commission de standardisation), M. Léon Guillet. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 221–224. Tests on steel bars subjected to different heat treatments.

Internal-Combustion Engine Valves. Steels for Internal-Combustion Motor Valve, G. Gabriel. Automotive Manufacturer, vol. 42, no. 2, May, 1921, pp. 19–22. Minimum requirements as determined in use of light-weight and airplane engines. Effect of high temperatures on various steel. Metallurgical viewpoints Translated from La Technique Automobile et Aerienne. (To be continued.)

Marine Engineering. Steel from the Standpoint of Marine Engineering, W. H. Hatfield. Jl. West of Scotland Iron & Steel Inst., vol. 28, part 5, session 1920–1921, Feb. 1921, pp. 52–72 and (discussion) pp. 72–78, 17 figs. on 2 supp. plates. Writer concludes that (1) it is desirable to use, wherever possible, ship plates and sections of increased mechanical strength; (2) it is advisable to extend use of some special steels now available for power unit and transmission parts; and (3) it is desirable to increase use of other special steels available for resisting rust and where needed, high temperatures.

Mechanical Properties. Calculation of Mechanical Properties of Steel from its Chemical Composition, Hugh O'Neill. Iron & Coal Trades Rev. vol. 102, no. 2777, May 20, 1921, pp. 700. Formula is developed.

Metallography. Report of Committee E-4 on Metallography. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24, 1921, 16 pp. Proposed tentative methods of metallographic testing on iron and steel.

Molybdenum. See MOLYBDENUM STEEL.

Quenching Cracks. On the Cause of Quenching Cracks, Kôtarô Honda, Tokujirô Matsushita and Sakaé Idei. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 6, 16 pp., 9 figs. It is concluded from tests that in quenched steel certain amount of austenite is generally present intermingled in martensite. Amount of austenite increases as quenching temperature increases. Quenching cracks occur when hardness in central portion is much greater than in periphery.

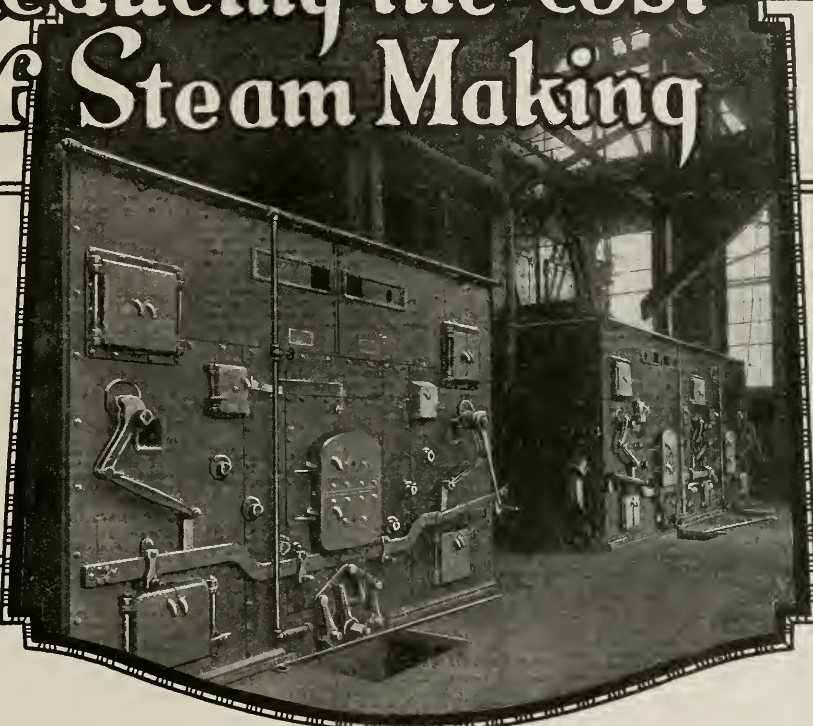
Specifications. French Specifications for Carbon Steels. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1372–1374. Full details for bars, blooms, billets and slabs of other than tool steels. Static, structure and shock, as well as welding tests, required.

Stainless. Stainless Steel, Its Composition and Properties, Elwood Haynes. Iron Age, vol. 107, no. 22, 107, no. 22, June 2, 1921, pp. 1467–1469. Manufacture and uses. Influence of temperature. Limits of chromium content. Paper read before Am. Iron & Steel Inst.

Sulphur Determination. Comparison of Different Methods of Estimating Sulphur in Steel, T. E. Rooney. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 9, 13 pp. Experiments made with carbon and nickel-chromium steels.

Tests. Comparative Tests of Steels at High Temperatures, R. S. MacPherran. Am. Soc. for Testing Matls., paper of annual meeting, June 21–24 1921, 9 pp., 6 figs. Tests made to determine comparative properties of various steels at high temperatures under operating conditions at temperature between 600 to 1000 deg. fahr.

Reducing the Cost of Steam Making



Back in 1907 the New York Air Brake Co. became interested in the possibilities of savings to be made by using

MURPHY AUTOMATIC FURNACES

in place of hand firing methods. A test made on a 150 h. p. boiler, hand fired, showed a cost of 20.39 cents per 1000 lbs. water evaporated. A Murphy was then put in under this same boiler reducing the cost to 14.49 cents per 1000 lbs. of water evaporated.

This *demonstrated saving* together with smokeless operation and low maintenance has led to *three repeat orders* received from this company.

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STEEL CASTINGS

Centrifugal. Testing Centrifugally Cast Steel, George K. Burgess. Iron Trade Rev., vol. 68, no. 21, May 26, 1921, pp. 1443–1447, 15 figs. Examination of several cylinders of various wall thickness and composition showed little segregation of elements and few blow holes. Physical properties of specimens were improved materially by heat treatment.

Manufacture. Checking Troubles in Steel Castings, R. B. Farquhar, Jr. Foundry, vol. 49, no. 12, June 15, 1921, pp. 475–483, 23 figs. Notes on proper pouring, gating and feeding. Paper read before Am. Foundrymen's Assn.

STEEL FOUNDRIES

Electric-Furnace. Steel Foundry Rearranged and Enlarged, Gilbert L. Lacher. Iron Age, vol. 107, no 22, June 2, 1921, pp. 1470–1474, 9 figs. Replacement of cupolas and converters by electric furnace at plant of Chicago Steel Foundry Co.

STEEL, HEAT TREATMENT OF

Drill Steel. Heat Treatment of Rock-Drill Steel, George H. Gilman. Min. & Metallurgy, no. 174, June 1921, pp. 35 and 38–39 and 42, 1 fig. Suggestions in regard to heat-treating practice. (Abstract.)

Methods. Carburizing, Hardening and Tempering High Carbon Alloy Steels in 130 Minutes, R. L. Gilman. Trans. Am. Soc. for Steel Treating, vol. 1, no. 8, May 1921, pp. 445–448. Method is suggested.

Tool Steel. The Prevention of Hardening Crack and the Effect of Controlling Recalescence in a Tungsten Tool Steel, Shipley N. Brayshaw. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 1, 86 pp., 26 figs. Research carried out on tool steel containing about 1.1 per cent of carbon and 0.8 to 0.9 per cent of tungsten. Changes that occur during halts in heating and cooling were investigated in number of bars which, after soaking for various periods of time at temperatures near critical points, were quenched in water. Results suggested that, both in heating and in cooling, changes Acl. 2.3 and Ar 3.2.1. take place in stages which may be separated one from another if sufficient time is allowed for process.

STEEL, HIGH-SPEED

Hardness. Relation of the High Temperature Treatment of High Speed Steel to Secondary Hardening and Red Hardness, Howard Scott, Trans. Am. Soc. for Steel Treating, vol. 1, no. 9, June 1921, pp. 511–526, 18 figs. Based on study of microstructure, hardness, density, magnetic properties and thermal characteristics of a typical high speed steel.

STEEL MANUFACTURE

Direct Processes. Making Steel Direct from Ore. Iron Trade Rev., vol. 68, no. 20, May 19, 1921, pp. 1375–1376. Comparison of Basset and Jones processes. Basset process maintains higher temperature in furnace by introducing preheated air and carbon and chemical reactions differ to some extent.

New Method of Manufacturing Cast Iron and Steel in France, Paul H. Cram. U. S. Dept. of Commerce, Commerce Reports, no. 130, June 6, 1921, pp. 1330. It is stated that Basset Steel Works, after having concluded successful experiments in 100-ton furnace, will construct 12 Basset furnaces for direct manufacture of steel having total daily capacity of 3000 tons.

Steel Direct from Ore by Moffat Process, W. F. Sutherland. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1450–1452, 3 figs. Reduction in metallizer and conversion into steel in electric furnaces.

The Canadian Steel Industry and the Direct Process, Noel Statham. Iron & Steel of Canada, vol. 4, no. 4, May 1921, pp. 91–98, 3 figs. Bourcoud open-cycle direct process and its economical possibilities under present conditions of Canadian iron and steel industrial development. Process consists in reducing iron ore with gases at sufficiently high temperature, transferring reduced metal to electric furnace where it is melted, and subsequently to another electric furnace where it is finally refined.

Electric-Furnace. Electric Furnaces for Making Steel—IV, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 6, June 1921, pp. 381–385, 6 figs. General features and advantages of Ludlum furnace and of Vom Baur furnace. Classification of electric steel-making furnaces.

Open-Hearth Practice. A Radical Change in Open-Hearth Practice, George L. Prentiss. Iron Age, vol. 107, no. 22, June 2, 1921, pp. 1479–1481, 7 figs. Making blow torch of ports in Egler furnace at plant of Brier Hill Steel Co., Youngstown, O. resulted in increased efficiency.

Processes. Manufacture of Steel from Raw Materials to Finished Product—Remarks on Heat Treatment and Fatigue Failures, W. R. Shimer. Trans. Am. Soc. for Steel Treating, vol. 1, no. 8, May 1921, pp. 423–435, 85 figs. Photomicrographs.

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Electric Drive. Steel Works Motors, W. W. Wood. Beama, vol. 8, no. 5, May 1921, pp. 440–444, 3 figs. Three-phase versus direct current. No definite rule is laid down, but three-phase motors are preferred.

England. British Iron and Steel Centers, Joseph Horton. Iron Trade Rev., vol. 68, nos. 20 and 23, May 19, and June 9, 1921, pp. 1388–1390 and 1392, 3 figs., and 1590–1592 and 1597–1598, 5 figs. May 19: Manufacture of pig iron and steel in Middlesborough District. June 9: Steel mills in Sheffield.

France. The Devastation of France. Engineering, vol. 111, no. 2892, June 3, 1921, pp. 670–674, 23 figs. partly on 4 supp. plates. Reconstruction of steel mills.

Fuel Economy. Heat Conservation in Steel Works Operation (Die Wärmewirtschaft im Eisenhüttenbetrieb), A. Schulze. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 19, May 7, 1921, pp. 487–491, 3 figs. Measures for low-temperature heat conservation are discussed and examples given to show how saving can be effected.

Pig-Casting Machine. Pig-Casting Machine and Iron Storage. Iron Age, vol. 107, no. 21, May 26, 1921, pp. 1384–1385, 2 figs. Equipment at Hamilton works of Steel Co. of Canada includes quenching pit and station for transferring iron between ladles.

Power Plants. Modern Steel Works Power Plants, Walter N. Flanagan. Iron Age, vol. 107, no. 23, June 9, 1921, pp. 1555–1559, 4 figs. Centralization and economy of unit stresses. Attention to details urged as source of savings. Paper presented before Am. Iron & Steel Inst.

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Chain-Grate. Recording Ash-Pit Loss from Chain Grate Stokers, E. G. Bailey. Mech. Eng., vol. 43, no. 6, June 1921, pp. 381–385, 12 figs. Recording device consists of thermometer bulb filled with nitrogen and connected through capillary tube to mercury U-tube, one leg of which is open to atmosphere and carries a float to which recorder pen is attached.

Draft Resistance. Draft Resistance of Underfeed Stokers, Alfred Cotton. Power, vol. 53, no. 22, May 31, 1921, pp. 874–875, 3 figs. Graphs constructed from results obtained in experiments.

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Strength. The Strength of Submarine Vessels, W. R. G. Whiting. Engineering, vol. 111, no. 2891, May 27, 1921, pp. 662–664, 12 figs. Diagrams and formulas for determining stresses developed in submerged submarine. Paper read before Instn. Naval Architects.

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Cold Swaging. Cold Swaging—I, Fred R. Daniels. Machy (N. Y.), vol. 27, no. 10, June 1921, pp. 930–934, 8 figs. Also in Machy. (Lond.), June 2, 1921, pp. 257. Application of swaging process and its effect on quality of metal. Study based on experience of Torrington Co., Torrington, Conn.

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TABULATING MACHINES

Census Tabulating. Census Tabulating Machine. Engr., vol. 131, no. 3412, May 20, 1921, pp. 532–533 and 535, 3 figs. Hollerith patented machine.

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Design. The Roundhouse Up to Date, Harold C. Prentice. Ry. Mech. Engr., vol. 95, no. 6, June 1921, pp. 337–340, 4 figs. Survey of developments in design of locomotive terminals.

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Chicago. Proposed Improvement of Chicago Railway Terminals. Eng. News-Rec., vol. 86, no. 20, May 19, 1921, pp. 845–847, 2 figs. Report of Chicago Railway Terminal Commission.

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Torsion-Bending. Alternating Stress Testing Machine. Engr., vol. 131, no. 3412, May 20, 1921, pp. 550, 2 figs. Slow-speed machines giving 200 cycles of combined bending and torsion per minute.

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Training. Training Toward True Time Standards, C. B. Tyson. Factory, vol. 26, no. 12, June 15, 1921, pp. 1402–1406, 5 figs. Course of study developed at New York Shipbuilding Corporation plant.

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Oil-Well. Manufacturing Oil-Well Tools in Texas, Fred H. Colvin. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 932–938, 24 figs. Production systems of manufacturing bits, cutter, etc.

Press. The Design and Construction of Press Tools—IX. Eng. Production, vol. 2, no. 36, June 9, 1921, pp. 691–693, 4 figs. Drawing dies for cartridge cases.

TUBES

Seamless, Manufacture. Making Seamless Steel Tubes. Eng. Production, vol. 2, no. 35, June 2, 1921, pp. 675–679, 13 figs. Description of process involved.

TURBO-GENERATORS

Ventilation. Practice in Use of Electrical Apparatus. Elec. World, vol. 77, no. 23, June 4, 1921, pp. 1314–1316. Closed-circuit system of ventilating turbo-generators coming into favor. Tendency toward greater use of electrically driven auxiliaries. Data on oil-circuit-breaker performance. Committee report presented at conference of Nat. Elec. Light Assn.

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Manufacture. Milling Slender Castings, Franklin D. Jones. Machy. (N. Y.), vol. 27, no. 10, June 1921, pp. 935–937, 5 figs. Fixtures used at Smith Premier Works of Remington Typewriter Co. for holding slender parts without springing.

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VENTURI METERS

Accuracy. A New Hydraulic Paradox. Engineering, vol. 111, no. 2891, May 27, 1921, pp. 639–640. Relative velocities at metering inlet and at throat.

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Piece-Time System. Compensation Piece-Time System (Das Ausgleich-Stückzeit Verfahren), Adolf Lauffer. Betrieb, vol. 3, no. 16, May 10, 1921, pp. 484–492, 6 figs. Wage method taking into consideration possibility of shortening individual working periods.

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Railway Shops. Saving Materials in Railroad Shops, Frank A. Stanley. Am. Mach., vol. 54, no. 22, June 2, 1921, pp. 943–944, 7 figs. Methods of recovering lining metal from worn car journal bearings, also old bolts and air hose.

[See also BONUS SYSTEMS.]

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Steel. The Welding of Steel in Relation to the Occurrence of Pipe, Blowholes, and Segregates in Ingots, H. Brearley. Iron & Steel Inst., annual meeting, May 5–6, 1921, advance paper no. 2, 17 pp., 12 figs. Microscopical examinations.

[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; ELECTRIC WELDING RESISTANCE.]

WELDS

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MECHANICAL ENGINEERING

Volume 43 September, 1921 Number 9

Power-Plant Evolution

A Discussion of the Decrease Brought About in the Cost of Producing Electric Power, and of the Possibilities of Further Increasing Plant Efficiencies by the Use of Higher Steam Pressures, Air Preheating, Improved Methods of Feedwater Heating, Etc.

By C. F. Hirshfeld,[1] Detroit, Mich.

Few people who are not directly interested realize the tremendous extent to which both modern industrial life and modern family life are dependent on electric energy, or electric power as it is more commonly called. The revolutionary changes in industrial methods which followed the introduction of the water wheel and steam engine have been treated extensively in literature, and almost every one who reads and thinks knows that the entire social structure of today rests, ultimately, on these prime movers. The part played by electric power, however, has not been so widely advertised and is not so well appreciated.

It is practically impossible to obtain accurate and complete data of the electrical power output of the country but it may be stated that the per capita consumption of central-station power has increased from 23 kw-hr. in 1900 to 435 kw-hr. in 1920. These figures represent the growth over a fairly short period and are indicative of the rate at which electrical power has come into use in the country as a whole. As a matter of fact, however, they do not tell the whole story, because much of the electric power used by street railways is not included and because the total population of the country has been used as the divisor. Since the greatest use of power is in the large and small industrial centers, division by the total population of the country gives too small a figure.

To indicate the significance of this feature Fig. 1 is presented. This figure refers to the city of Detroit, which has had a most remarkable growth, and it is therefore not properly representative of all industrial centers, indicating a somewhat extreme case.

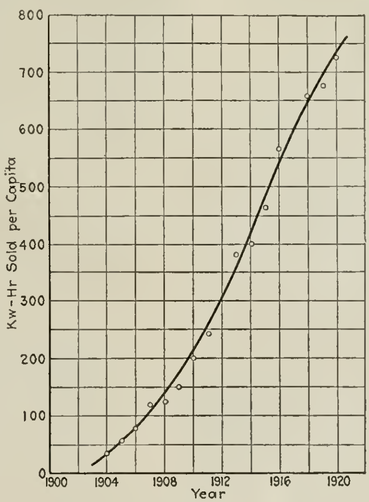

Fig. 1 Increase in Consumption of Electric Power in Detroit Between 1903 and 1920

Obviously the production of power by central stations is one of the important items in modern life, and the increasing extent of its use has reacted upon the industry of power generation in a most remarkable way. In the case of fuel-burning stations, to which these observations are confined, the development of more economical apparatus, the improvement of load factor, and the refinement of operating methods have all been such that there has been an almost continuous decrease in the cost of production per unit of output. It should be understood that this decrease results not only from the more economical use of fuel, but also from better use of capital and labor. It is of course common knowledge that the selling price of electrical energy has recently risen in practically all parts of the country. This has been due to abnormal prices of all materials, supplies, and labor, as well as to the attitude of labor toward its work. These things are probably all temporary, and it is expected that their effects will disappear in due time.

Three things have had a predominating influence in bringing about these results, namely—

a Improved load factor

b Increasing size and efficiency of steam turbo-generators, and

c The introduction of efficient mechanical stokers.

It is difficult to give average values for the purpose of showing load-factor improvement because conditions vary greatly from place to place and time to time. However, it will help somewhat to point out that as a central electric supply changes from a pure lighting to a combined lighting and power supply, the load factor changes from something of the order of 10 per cent or less to a value between 50 and 70 per cent. Obviously capital charges per unit of output in the first case are extremely heavy when compared with capital charges in the second case.

The size and efficiency of steam turbo-generators are, of course, readily expressed in numerical form. Fig. 2 is given to illustrate the marvelous developments which have occurred within two decades.

The introduction of efficient mechanical stokers has had two quite different effects. The boiler-room thermal efficiency has been increased to a remarkable degree and the size of units has grown tremendously. In 1900 most central stations were equipped with boilers containing not over 5000 sq. ft. of heating surface. This size has been increased gradually until now units containing between 12,000 and 24,000 sq. ft. are in common use. Paralleling the increase in thermal efficiency and in size, there has been an increase in the efficiency of use of boiler-room labor. It is now possible for one fireman to take complete charge of 5000 rated boiler horsepower.

Limit of Development Along Old Lines Practically Reached

At the present time we seem to have reached very close to the limit of ultimate development along the lines which have been followed during the past two decades. This statement, however, is not meant to imply that there is no further room for improvement in central stations as they now exist. Obviously, no central station not built within the past year or two can contain all the latest developments. Almost all central-station companies operate one or more old plants which could be improved by reconstruction. In many cases this reconstruction can be economically justified and is being carried on or is contemplated. Nor does it mean that we are unable to build more efficient plants than those just completed.

The real significance of the statement is this: Since about 1900 we have pursued a fairly consistent sort of development along fairly definite lines. During the entire period further possible improvements were always visible and one could predict with a reasonable degree of certainty that each suceeding year would produce certain definite modifications and advances. Now we seem to have reached a point where marked increase of economy in the use of money, labor or fuel can be made only by radical changes of some sort.

[1]Chief, Research Department, The Detroit Edison Company. Mem. Am. Soc.M.E.

Presented at a meeting of the Cleveland Section of The American Society of Mechanical Engineers, March 1, 1921. Slightly abridged.

Rather curiously we arrived at this point in the evolution of the art at just the time when there was the greatest need of conservation in the use of capital, fuel and labor. The driving force furnished by the excessively high prices for money, fuel and labor which have characterized the last two or three years would have been sufficient to cause improvements of tremendous magnitude had we known just what direction to take. Unfortunately we found ourselves at a sort of parting of the ways, and the best brains in the industry in this country and in Europe have been, and are, trying to map the road to be followed in the immediate future.

Out of the work already done have come several very definite indications, but the author cannot feel that any of them promise enough to justify us in concluding that they mark the way. Rather are they to be considered merely as the finishing touches to the existing type. It is his belief that we are just polishing off the steam-turbo-generator type, and that while we may be forced to continue doing so for quite a few years, we are essentially marking time while waiting for a new, epoch-making design, invention or development.

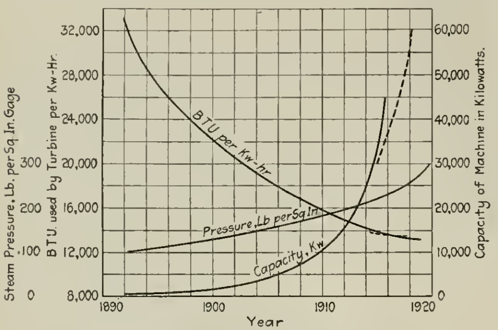

Fig. 2 Steam-Turbine Progress Since 1892
(Dotted lines refer to compound machines.)

There is nothing now in sight which promises any change so revolutionary as the introduction of the steam turbine or the stoker, but this must not be interpreted to mean that the author does not believe something of this sort is coming. He feels perfectly certain that development will be even more rapid in the future than it has in the past and that, as a result, the allowance for obsolescence should be made higher in the future rather than lower. With the foregoing paragraphs to serve as an introduction we may now enumerate and possibly evaluate the changes now occurring and those which are apt to occur in the near future.

All engineers who are familiar with the theory of steam engines and other heat engines know that theory indicates increasing thermal efficiency as upper and lower temperatures of the working substance are moved farther apart. In the case of the steam turbine this is equivalent to saying that the thermal efficiency will improve as the temperature of the steam reaching the unit is raised and as the back pressure, and therefore the temperature of steam leaving the unit is decreased.

We already have many stations operating with maximum steam temperatures of 600 deg. fahr. or higher and we are rapidly approaching a temperature of 700 deg. A value between 700 and 800 is generally considered to be the highest that should be used with the metals and alloys and the types of construction now available. In the opinion of the author 700 deg. fahr. is about as high as we can safely go at present.

At the other end of the temperature scale, we are now operating our best plants with an average back pressure throughout the year of about one inch of mercury, and there does not seem to be any possibility of greatly improving this performance.

Economic Possibilities in Use of Higher Steam Pressures

With the temperature limits thus definitely set and already practically attained, engineers have begun to consider seriously the possibilities of using higher steam pressures without exceeding the upper temperature limit. It is commonly known that the temperature of saturated steam increases with pressure, but the form of the curve connecting pressure and temperature is not generally appreciated. Such a curve is given in Fig. 3. It is obvious that temperature increases very rapidly with respect to pressure at low pressures, but that this relation is reversed at high pressures. At present a few central stations are using, or are being constructed to use, a pressure of from 300 to 350 lb. per sq. in. The curve of Fig. 3 shows that saturated steam at such pressures has a temperature well below 450 deg. fahr. If we assume it will be possible to utilize pressures as high as, say, 500 lb. per sq. in. in the near future, we will reach a saturation temperature only a little higher than 450 deg. fahr. To attain steam with a saturation temperature of only 600 deg. we should have to utilize a pressure of almost 1600 lb.

It is quite obvious that if we are to operate with the highest permissible temperature we must use superheated steam, even if we increase the maximum pressure to the highest imaginable limit. The curves of Fig. 4 are presented to indicate the theoretical possibilities of higher pressures.

It will be observed that the theoretical efficiency of the cycle increases with increasing pressure for both saturated and superheated steam. It will also be observed that at the temperatures to which we seem to be restricted the gain resulting from increasing the pressure from 200 lb. per sq. in. to 300 lb. is greater than for the next 100-lb. increase, and so on up to the highest pressures shown. Moreover, the maximum efficiency shown is not so much higher than the indicated for pressures and temperatures now in use that radical increase of pressure and temperature holds great promise.

A modern plant with steam pressure between 200 and 225 lb. and with a steam temperature of about 600 to 650 deg. fahr. can produce power at a cost of about 19,000 B.t.u. in fuel per net kilowatt-hour. If the same ratio between actual results and theoretical efficiency of cycle holds for higher pressures and temperatures, we should be able to produce a kilowatt-hour for about 17,500 B.t.u. with steam at 400 lb. and 700 deg. fahr. Taking probable extreme limits and assuming 600 lb. and 800 deg. fahr., the cost of a kilowatt-hour would be about 16,000 B.t.u.

Such figures are certainly worth striving for, but unfortunately they do not tell the whole story. First, the cost of equipment will certainly increase with pressure and, to a certain extent, with temperature. Increased thermal efficiency will therefore certainly be partly offset by increased capital charges. Second, the ratio of actual to theoretical turbine efficiency should decrease with increasing pressure, so that the thermal gain to be derived from high pressures must be discounted to a certain extent. Third, the increased boiler pressure means increased flue-gas temperatures

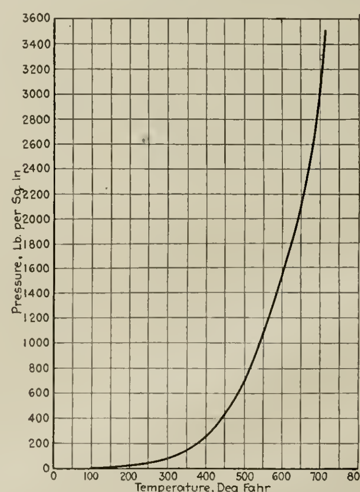

Fig. 3 Variation of Temperature of Saturated Steam with Pressure

and this must result in offsetting part of the calculated improvement. If this increased loss is prevented by the installation of a device like an economizer of air preheater, we have increased capital and operating charges to consider.

It is the author's opinion that it will be quite a while before we resort to pressures higher than 400 lb. and that fuel will have to cost much more than is probable for the immediate future, while capital must, if anything, cost less to justify exceeding such a value. Against this is to be set the fact that we are now using or preparing to use 350 lb. in this country and that in England they have already exceeded 400 lb.

Ferranti's Proposed Turbine Cycle—The Emmet Mercury Boiler

Many years ago S. Z. Ferranti suggested an interesting modification of the turbine cycle. He proposed to add heat during the early part of the expansion so as to maintain the steam at a constant temperature during that part of the cycle. Practical difficulties led to a modification which has to most people obscured the original suggestion. In the modified form the steam is permitted to expand in the same way as it is now customary, but is completely withdrawn from the turbine at different points, reheated, and returned to continue the expansion. In theory this cycle promises an improvement of about 10 per cent over the cycle now in use. If actually used in an operating plant it is probable that not over 5 to 6 per cent improvement could be shown. Against this would be chargeable increased capital costs and increased operating complications.

It is rumored that this cycle in a simplified form is to be used in a new English plant now under construction. It has actually been used in experimental apparatus, and according to reports the results were satisfactory.

Another interesting suggestion emanates from W. L. R. Emmet. Many binary cycles have been proposed and thermal savings can be calculated for most of them, but the one suggested by Emmet seems to be the most promising. He proposes the use of mercury as one working substance and water as the other. The mercury is vaporized in a fuel-fired boiler something like a steam boiler, is expanded in a small turbine and condensed in a device which may be called a condenser-boiler. This device transmits the latent heat of vaporization of the mercury vapor to the water, converting it into steam which is used in a turbine in the ordinary way. Mercury boils at 677 deg. fahr. under atmospheric pressure and at 457 deg. under a pressure of 2 in. of mercury. It thus is ideally fitted to extend the upper temperature limit without introducing prohibitive pressures. It also has such other physical characteristics that a comparatively cheap turbine can be used.

This proposal of Mr. Emmet's is by all odds the most promising of the binary types and it seems to be the only one that warrants serious consideration at the present time. It promises a return of about 40 per cent more power from a given quantity of fuel, and this without a prohibitive increase in investment.

Results Effected by Employment of Mechanical Stokers

Turning now from a consideration of the turbine room to the boiler room, the introduction of the efficient and flexible mechanical stoker has reacted in two different ways. It has made it possible to obtain much higher boiler-room efficiency day in and day out, month after month, and it has made it possible to drive boilers at much higher ratings than were even dreamed of a comparatively short time ago. Increasing the quantity of steam which can be produced from a given equipment naturally reduces the overhead charges per unit of steam output.

Now the power producer does not care whether his power becomes cheaper because of more efficient use of fuel or because of more efficient use of capital. Consequently there is evident an increasing tendency to overstoker boilers and to drive them at high average rates. This is quite proper if it is not carried too far. Unfortunately the thermal efficiency of boiler units decreases with increasing output above a certain point, and if the rate of evaporation is carried far enough a point is reached at which decreased thermal efficiency and increased maintenance more than balance the savings in capital. The point at which this occurs differs with the character of equipment, the price of capital, the price of coal, the load factor and other considerations, but under average central-station conditions the most economical point will generally be found below 200 per cent of normal rating if economizers are not used. The addition of economizers naturally raises the proper value. It is probable that the cost of capital and apparatus will ultimately come down to prewar figures or very nearly to such figures, and it is equally probable that the cost of fuel will not. Under such circumstances the economic balance will probably be found to occur at a lower average rate of evaporation than some designers have expected.

Economizer Problems

One of the principal losses occurring with high boiler ratings results from high flue-gas temperature. This loss can be partly recovered by the use of economizers. However, economizers cost money to install, money to maintain and money to operate, and the waste is not therefore entirely recoverable. Some designers of power plants appear to give inadequate weight to some of the costs incurred in the practical operation of economizers.

It is rather interesting to note in passing that despite the increase in the price of coal during the past six years, the situation with respect to the installation of economizers has not materially

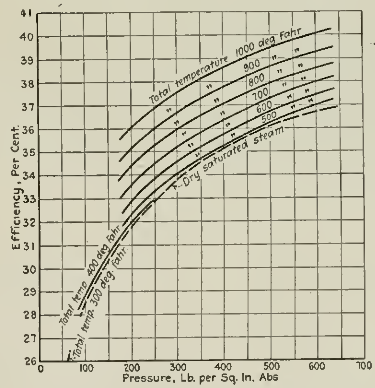

Fig. 4 Efficiency of Complete Expansion Cycle as Used in Steam Trbines (Back Pressure. 1 in. Hg.)

changed. The author knows of cases in which quotations on economizers increased during the same period at such a rapid rate that despite the increasing cost of coal the installation of economizers could not be justified. This is probably a transient situation; the cost of economizers may be expected to drop to a point which will place them in a much more advantageous position than that occupied before the war.

But here we are faced with another complication. Economizers until quite recently were made of cast iron exclusively. As the steam pressure in use has risen more and more, engineers have begun to question the propriety of using cast iron for such apparatus. It seems certain that all will agree that if we adopt pressures like those we are now considering, cast iron will be ruled out unless we operate economizers at a pressure much below the boiler pressure. This introduces undesirable complications.

Such considerations have led to the construction and use of wrought-steel economizers. These can be built with factors of safety equal to those used in boiler construction; they are practically as satisfactory as cast iron with respect to corrosion on the gas side, but are much more apt to corrode on the water side. In fact, it is possible to cause failure of steel economizer tubes by corrosion on the water side within a year.

In modern plants such corrosion is generally due to dissolved oxygen and can be prevented if proper precautions are taken to keep the boiler feed sufficiently free of this gas. There are now several well-recognized methods of doing this.

Air Preheaters

Within the past few years another device has been introduced for conserving heat otherwise lost in flue gases. This is the air preheater. Air used for combustion must be heated to furnace temperature from the temperature with which it enters the furnace. Ordinarily this is done in the furnace at the expense of heat liberated by the fuel. That part of this heat which is required to raise the temperature to a value equal to that with which the flue gases leave the boiler is wasted through the boiler damper.

If a large fraction of this heat could be conserved by transferring it from flue gases to entering air by means of an air preheater, a fuel saving of 10 per cent or more could be made. It does not seem probable that any such complete transfer can be effected in a real case, but some fraction of it is certainly attainable. It appears as though a saving of 3 to 5 per cent might prove possible.

However, this device also introduces problems of its own. It can be built comparatively cheaply, but its use involves additional flues and fans and power for driving the fans, so that the gross thermal gain in any case will be partly offset by increased thermal expenditure and increased capital charges. Further, it seems certain that air preheaters will present new cleaning and maintenance problems which will also yield items of expense which must be balanced against the gross thermal saving.

In addition to all these considerations we have another which may prove of still greater importance. We do not yet know the limiting temperature to which it is permissible to raise the air. The air supplied for burning fuel on the grate or stoker passes through that device and serves to cool it by removing heat which is radiated and conducted to it. It is certain that we can use air temperatures higher than those now common, but whether we will find 150 deg. fahr. or 300 deg. or 500 deg. to be the upper limit, is still unknown. The author is inclined to think that the upper limit will vary with the type of stoker and it is obvious that it will vary with the rate of combustion.

Feedwater Heating

Great improvements have been made in the character of boiler feedwater used in the large plants of the country in the past decade. In the early days we used for boiler feed or make-up water anything which was readily attainable. If the scale deposited in the boiler was of such character as to cause too much trouble, we treated the water chemically before use. But we still concentrated a chemical solution in our boilers, had to blow down at frequent intervals and were forced to shut down and thoroughly clean them out periodically.

We have now greatly improved this practice in the case of plants using surface condensers. In such plants the greater bulk of the water evaporated in the boiler is used over and over, being contained in what one might call a practically closed circuit. There is a certain loss from leakage, blowdown, spillage, etc., but this can be kept down to a value between 1 and 2 per cent of the total boiler feed by careful management. The make-up required to make good this loss is now commonly distilled and enters the system as a vapor, leaving dissolved salts behind in the evaporator.

With a plant operated in this way there is practically no deposit in the boiler. As a result blowdown losses are practically eliminated. Of still greater importance, however, is the fact that the expense of shutting down, opening up the boiler and turbining the tubes is almost completely done away with. In this case the improvement results not so much in a thermal gain as in decreased labor and maintenance charges and better use of invested capital.

Much thought has also been given recently to different methods of obtaining auxiliary power and to different methods of heating the feedwater. These factors are closely tied to the use of economizers and air preheaters, and that method which is best under one set of conditions is not necessarily usable with a different type of plant.

We seem to be settling down to two different types, although the whole subject is as yet admittedly in a state of flux. In the one type steam-driven house generators are used to supply some or all of the auxiliary power. The steam exhausted heats the feedwater in heater-condensers operating at such a vacuum as to give a feedwater temperature sufficiently low for advantageous use in economizers. In the other type the feedwater is heated by steam withdrawn from the main unit. This heating is preferably done in stages, and if the idea is carried to the limit, it results in the introduction of a cycle which is theoretically more efficient than the simple, so-called Rankine cycle now in use. Unfortunately, if this arrangement is carried to the ultimate limit it yields feedwater with a temperature higher than can be used advantageously in economizers. It also has another disadvantage from the view point of the central station. Auxiliary power must logically be taken from the main bus and continuity of service is correspondingly jeopardized.

Utilization of Low-Grade Fuels

No consideration of the evolution of power plants would be complete without a reference to the work which is being done in an effort to make available for use the poorer grades of fuel. Stokers are continuously under development and we are already obtaining very promising results with fuels which only a few years ago were practically unusable. Further, many attempts are being made to introduce pulverized fuel into central-station boiler rooms, and one large new plant is being completely equipped for the use of such material. Much is promised by the pulverized-fuel advocates in the way of increased thermal efficiency, decreased labor charges, and ability to use poorer grades of coal. As yet the case is not proved, but the experience of the next five years should bring out the facts. Personally, the author believes that the preparation of the fuel for the burner must be greatly simplified and cheapened before pulverized coal can compete with good stokers under central-station conditions in most sections of the country, but it must be confessed that many engineers in the industry do not share in this view.

So much for the trend of the times in power-plant design. It will now be of interest to attempt to evaluate all the possible improvements in sight.

Future Possibilities in Plant Efficiencies

If we assume that we will continue to use steam turbines and other equipment of the present types, but that we will increase pressure and temperature to the limit and will introduce all possible heat-saving devices, we can lay down on paper a plant which should deliver a net kilowatt-hour for between 14,000 and 15,000 thermal units. This would correspond to overall thermal efficiencies of the order of 24 or 23 per cent. Our best plants of the present day give values of 18 to 19 per cent.

The author is certain that with the fuel prices which are to be expected in this country in the immediate future, such thermally efficient plants would not represent the best engineering or economic solution of the problem. The investment would in his opinion be higher than could be justified. On the other hand, he does expect to see a figure between 16,000 and 17,000 attained in the very near future.

In a number of cases of economizer installations made during the last few years it has been found that the fans were of too small capacity to handle the desired overloads. This has apparently been due in large measure to amounts of excess air much beyond what was expected. Some engineers figure 10 to 20 per cent air infiltration in an economizer setting alone, and there is often a large amount passing into the boiler setting, especially in a multiple header boiler. It is also frequently the case that smoke flues are far from tight, especially at riveted and expansion joints. One plant reports the infiltration between a large boiler and cast-iron economizer to be relatively small (about 500 to 2000 cu. ft. of air per minute), but the infiltration through the economizer casing and stack uptake to be greater, ranging from 4000 cu. ft. with air leaks cemented up to 20,000 cu. ft. in an extreme case. Another station, with steel-cased economizers, reports negligible infiltration. The result of high excess air is, of course, to increase the volume of the flue gases and also the draft required. As modern fans have definite draft-volume-speed characteristics, the results are often to throw the fan performance beyond proper limits.—From 1921 Report of the Prime Movers Committee of the National Electric Light Association.

Report on Elimination of Waste in Industry

Committee Authorized by American Engineering Council and Appointed by Herbert Hoover Points Out Wastes and Recommends Steps for Elimination

This report is the first work undertaken by The Federated American Engineering Societies in rendering public service. It discloses losses and waste due to the restraint and dissipation of the creative power of those who work in industry. It lays the foundation for knowledge of the destructive influences which have too much controlled in the past. From this knowledge will grow the conviction that mental and moral forces must be added in a much larger degree to the physical resources now employed if industry is to serve all who are dependent upon its continuous and effective operation.

The Committee believes that this study of waste in industry will prove of lasting benefit to the industries studied and to the public which uses their products. It hopes further that the benefits will be farther reaching, and will extend to other industries by stimulating similar studies and outlining the methods by which they can be made. The Committee believes that such additional studies will prove of great value and that through intelligent application of conclusions reached American industry will take another long stride in advance. In expressing these beliefs the Committee recognizes that many of its findings and recommendations have previously been pointed out by individual engineers, but this report is the first instance of a collective or group endorsement of a general analysis of the sources and causes of waste and recommendations for its elimination.

THE preceding paragraphs appear in the preface of the Report of the Committee on Elimination of Waste in Industry. This Committee was authorized by the American Engineering Council, the executive board of The Federated American Engineering Societies, soon after its organization in the fall of 1920, and on January 12, 1921, Herbert Hoover, as President of the American Engineering Council, appointed its members. At present the Committee consists of the following men: J. Parke Channing, *Chairman*, L. W. Wallace, *Vice-Chairman*, L. P. Alford, George D. Babcock, Wm. R. Basset, F. G. Coburn, Morris L. Cooke, Harrington Emerson, Ira N. Hollis, Herbert Hoover, Edward Eyre Hunt, C. E. Knoeppel, Robert Linton, Fred J. Miller, H. V. R. Scheel, Sanford E. Thompson, John H. Williams, and Robert B. Wolf.

The Committee determined to gather quickly such concrete information as might be used to stimulate action and lay the foundation for other studies. It was believed that a limited, yet carefully studied, volume of findings obtained through a rapid intensive study would not impair the value of the facts disclosed or the validity of the recommendations based thereon, so within five months the Committee completed the assay of waste in six branches of industry and on June 3 presented a summary of its findings to the American Engineering Council. The final report was released for publication on July 15 and printed copies are expected to be issued about the middle of September.

There were three outstanding difficulties in the study of industrial waste: the extent of American industry, the fact that there is no accepted management or labor terminology, and the lack of a method of weighing the performance of industry. The impossibility of making a comprehensive study of the nearly three hundred thousand industrial plants grouped in the census into fourteen major classes is obvious. Neither time nor funds were available for such a task, and even if it might have been attempted, it is doubtful if the results would have been commensurate with the expenditure. Therefore the decision was reached to make a study of a group of representative plants in several industries, whose operation directly affects the daily life of every one. The lack of standardized terminology and of units and methods of measurement was overcome by preparing a standard method of investigation to be used in each branch of industry and in the plants in which intensive studies were made.

The limitations of the study in the industries selected are indicated in the following tabulation:

Branch of In'ustry	No. of Plants Investigated	No. of Plants Furnishing Additional In'ormation
Building Industry	73	33
Men's Ready-Made Clothing Manufacturing	9	—
Boot and Shoe Manufacturing	8	25
Printing	6	19
Metal Trades	16	17
Textile Manufacturing	13	—

The plan of study followed in each of these six branches of industry was this: At the outset the members of the Committee prepared an analysis of those factors and operations in industry in which waste might be expected to be discovered, provided a comparison was made between average practice and the best known practice. From this analysis a trial questionnaire was prepared to secure information and quantitative data to permit of comparing the record of one plant with another.

This trial questionnaire was then used in making a study of one plant in each industry. The results of these trial studies were then brought together, compared, reviewed by the Committee and, as a result, a revised questionnaire and an evaluation sheet were prepared, to be used in making the studies upon which this report is based.

This revised questionnaire, as used with suggested modifications based on the experience accumulated in its use in the field studies, forms an important part of this report. Wherever it has been used, plant managers have shown marked interest, which has led the Committee to include it in the printed report.

The printed report will be a book of about 130,000 words, divided into three sections: the first, a summary, which will include a statement of the sources and causes of waste with recommendations for waste elimination; the second, the engineers' field reports in the six industries investigated; and the third, general reports on unemployment, strikes and lockouts, legal machinery for adjusting disputes, industrial accidents, health of industrial workers, eye conservation, and purchasing and sales policies. all of which support from a broader point of view many of the specific findings presented in the field reports and for this reason give a more general background for many of the recommendations offered.

Section I, the summary of the report, is presented in abstract below, the omitted material being explanatory or corroborative of the statements printed.

Summary of the Report

IN making the studies upon which this report is based and in preparing the report itself there has been no purpose or desire to place blame upon any individual, group or class. The wastes revealed are the result of methods, tactics, practices and relationships of long standing in industry and the Committee has merely desired to indicate the main opportunities for eliminating waste and to show whose opportunity or responsibility it may be to adopt proper measures for such elimination.

No attempt has been made to write an academic definition of waste or to speculate in regard to ultimate savings. For the purpose of this report no attempt has been made to consider all economic wastes. Rather, in the Committee's investigations *industrial waste has been thought of as that part of the material, time and human effort expended in production represented by the difference between the average attainments on one hand and performance actually attained on the other as revealed by the detailed reports.* In assaying waste in industry the Committee has undertaken to evaluate this difference. Thus it has established no theoretical standard of performance or excellence, but has developed a method of measurement to determine the degree of effective use of those factors within which it was believed waste might be discovered. It has conceived that a given practice is not wasteful until a better has been revealed, and that the value of a newer practice, or the amount by which it is an improvement over an earlier one, can only be determined by units and methods of measurements.

SOURCES AND CAUSES OF WASTE

Waste in industry is attributable to:

1 Low production caused by faulty management of materials, plant, equipment, and men

2 Interrupted production, resulting from idle men, idle materials, idle plants, idle equipment

3 Restricted production intentionally caused by owners, management, or labor

4 Lost production caused by ill health, physical defects and industrial accidents.

Relative Responsibilities. Management[1] has the greatest opportunity and hence responsibility[2] for eliminating waste in industry. The opportunity and responsibility of labor is no less real, though smaller in degree. The opportunity and responsibility chargeable to outside contacts cannot be so clearly differentiated or evaluated. The relative measure of these is shown by the quantities in the following table which come from the composite evaluation sheets in the engineers' field reports:

Industries	Responsibility Assayed Against Management, Points[3]	Labor, Points	Outside Contacts,[4] Points	Total Points
Men's Clothing Mfg.	48.33	10.50	4.95	63.78
Building Industry	34.30	11.30	7.40	53.00
Printing	36.36	16.25	5.00	57.61
Boot & Shoe Mfg.	30.25	4.85	5.83	40.93
Metal Trades	23.23	2.55	2.88	28.66
Textile Mfg.	24.70	4.70	19.80	49.20

From the preceding table are derived percentage values for each of the agencies against which responsibility is assessed, as follows:

Industry Studied	Responsibility Assayed Against Management, Per cent	Labor, Per cent	Outside Contacts,[2] Per cent
Men's Clothing Mfg.	75	18	9
Building Industry	65	21	14
Printing	63	28	9
Boot & Shoe Mfg.	73	11	16
Metal Trades	81	9	10
Textile Mfg.	50	10	40

The quantities presented above justify the following statement: Over 50 per cent of the responsibility for these wastes can be placed at the door of management and less than 25 per cent at the door of labor, while the amount chargeable to outside contacts is least of all.[5]

In every industry studied there are outstanding examples of good management, but the bulk of the industry does not approximate this standard. In the clothing industry, for instance, one plant was rated by the engineers 57 points higher than the worst one studied and 42 points better than the average.

The following table gives a comparison, for each industry studied, of the total number of points assessed as waste in the best plant investigated, compared with the average of all the plants:

Industries	Points Assayed Against Best Plant Studied, Points	Average of All Plants Studied, Points	Ratio of Best to Average
Men's Clothing Mfg.	26.73	63.78	1 : 2
Building Industry	30.15	53.00	1 : 1¾
Printing	30.50	57.61	1 : 2
Boot & Shoe Mfg.	12.50	40.83	1 : 3
Metal Trades	6.00	28.66	1 : 4¾
Textile Mfg.	28.00	49.20	1 : 1¾

These tables present the consensus of opinion of the engineers engaged in field studies to the effect that the average of management is much below the standards set by certain individual executives who have achieved notable success.

It must not be assumed, however, that these points or ratios are valid in comparing the waste in one industry with that in another. They are useful only in making a comparison of waste in plants within the industry where they were assessed. Further, the quantities disclosed by the evaluation sheets are only a part of the findings dealt with in this report.

Waste Due to Low Production

Faulty Material Control. In certain industries the waste of materials is a serious drain on production, a fact which is revealed by a comparative study of plants in the same field. The methods of control which are common in the shoe industry account for the greatest loss in shoe production, with the possible exception of seasonal demand and production. The loss from idleness in shoemaking occasioned chiefly by waiting for work and material amounts to some 35 per cent of the time. The average building contractor has no calendar of operations except the dates of starting and finishing a job. He largely regulates deliveries on materials by visits to the job, or through statements received from the job superintendent. Still another waste from inadequate material control comes from the speculative purchasing of raw materials.

Faulty Design Control. The defective control of design results in a major waste, since it prevents standardization of product. Standardization of the thickness of certain walls might mean a saving of some $600 in the cost of the average house. Standardized mill work, such as window frames, doors and other similar items, would reduce the cost. In the printing trades there is wide variation in flat-bed cylinder presses; there are more than six hundred types of folding machines. Formerly each type foundry cast its type on a more or less different body, and although the change from the old system to the point system involved an expenditure of some $3,000,000 by the type founders, it is universally conceded that this expenditure has been saved many times over. Such examples point the way to further efforts.

Another source of waste through inadequate design control comes through defective drawings, specifications and tolerances.

Faculty Production Control. The lack of adequate methods of production control is evident in every industry studied. It is one of the outstanding weaknesses.

In the men's clothing industry it is found that at least ten hours per week per man is thrown away on energy-wasting and time-wasting work resulting from lack of shop methods, while an additional two or three hours per man per week is wasted in unnecessary work. Fixing the value of annual output in the men's ready-made clothing industry at $600,000,000, it should be relatively easy to save three-quarters of a million dollars a day, an increase of 40 per cent in effectiveness.

The lack of production control is not a question of large versus small plants. In the metal trades, for example, the engineer declares that the size of the plant does not necessarily determine its efficiency, for some of the large plants as well as some small ones show a large waste factor.

Lack of Cost Control. The majority of the industrial plants studied lack a knowledge of costs and have no cost control. Therefore there is no adequate method of judging fairly and accurately when improvements are needed and when waste is occurring. Not having the facts prevents prompt correction of defects. The above conditions are disclosed, for example, in the report on the metal trades.

Lack of Research. While certain industries are ahead of the rest in plant research, the need for more intensive research activity is apparent in every industry. One industry which is backward in this respect is clothing. In the majority of men's clothing plants nothing approximating research is practiced to improve materials, processes, equipment or product. The assertion probably will not be challenged that there is not a single individual throughout the entire industry who is solely engaged in research, and is thus without operating duties.

In the shoe industry there is lack of information as to market demands in this country and abroad. In all the leather industries there is need for scientific research to aid in predicting the kinds and quantities of leather required.

Faulty Labor Control. With perhaps two or three exceptions, shoe shops have no departments maintaining modern personnel relations with the employees. In the shoe industry the cost of training an inexperienced man for cutting upper leather in a well-managed shop is $576; for a semi-experienced man, $450; and to

[1] The term "management" as used in this part of the report refers to the agency (owners or managers) which exercises the management function in industry. This function is defined in a report approved by the Management Division of The American Society of Mechanical Engineers as:

"Management is the art and science of preparing, organizing and directing human effort applied to control the forces and to utilize the materials of nature for the benefit of man."

[2] The "responsibility" of a given agency as here used does not mean moral responsibility as ordinarily understood, but only that responsibility which arises from the undeniable fact that a given cause of waste can be removed only by a particular agency. "We measure responsibility not by the thing done, but by the opportunities which people have had of knowing better or worse."

[3] The relative responsibilities have been evaluated in "points." A theoretical total of 100 points represents all possible waste. As no plant is or could be entirely wasteful, the number of points assigned in any case must be less than 100.

[4] The public, trade relationships, and other factors.

[5] Adjusted by field engineer to a basis comparable with the other field evaluations.

install an experienced man in a different shop costs $50. For the average shop these figures are unquestionably low.

The average labor turnover for the year 1920 in the metal-trades plants covered (wherever records were kept, which was the case in less than half of the plants), was 160 per cent—figured in most cases as the ratio between the number of "separations" and the average number of employees on the payroll. The highest turnover was 366 per cent.

The building trades have given little consideration to the subject of labor turnover. In construction work it is particularly difficult to estimate the extent, because the actual percentage of turnover constantly varies as the building progresses and the number of men is increased and later decreased. Employment managers are rarely employed even upon the largest jobs, and "hiring and firing" is at the will of the foreman or superintendent.

Another fault in labor control is improper or inadequate rate setting. In negotiations and controversies between employer and operator in the shoe industry, what stands out is the lack of knowledge of facts which can be used as a basis for setting rates.

Ineffective Workmanship. Still another loss resulting in low production arises from inefficient workmanship. For much of this management is responsible through failure to provide opportunities for education or special training. Management cannot, however, do more than provide these facilities, and experience has shown that it is difficult to interest workmen in training courses which are designed to increase effectiveness. Further, much ineffective workmanship arises from lack of interest in work or lack of pride in good workmanship. The field reports give no evaluation of spoilage, which is one of the measures of this form of waste.

Faulty Sales Policies. The cancellation of orders is a condition peculiar to certain industries. It is especially acute in the clothing industry. Purchasers buying on long-time contracts return unsold goods at the end of the season, and claim and receive credit. The evil is general in the clothing and allied industries. It is common practice for manufacturers to oversell the dealers and oversell their own manufacturing capacity. They make and deliver what they can, and cancel the rest of their orders. The manufacturers follow the same bad custom in dealing with the textile mills.

The committee realizes that before there can be a material reduction in the sum total of waste in industry, much earnest, painstaking work must be done. The solution of such a problem is not one of hours or days but of years. Fundamental changes in our economic, financial, managerial and operating concepts and practices will be required. There will be need of both coöperative and individual effort. As regards groups, each must frankly face its own responsibility and meet its own duties. Each individual—plant executive or worker—must discover his own opportunities and then accept responsibility for performance. To such a one, the Committee on the Elimination of Waste in Industry suggests that the methods developed for investigating and compiling the information as revealed in this report be utilized in individual plants to show the way for betterment and improvement.—WASTE REPORT.

Waste Due to Interrupted Production

Idle Men. The amount of idleness or unemployment in industry can only be evaluated through rough estimates. There is no national machinery for collecting the facts. In the best years, however, even the phenomenal years of 1917 and 1918 at the climax of war-time industrial activities, when plants were working to capacity and when unemployment reached its lowest point in 20 years, there was a margin of unemployment amounting to more than a million men. This margin is fairly permanent; seemingly one or more wage earners out of every forty are always out of work.

During periods of industrial and business depressions, unemployment reaches its greatest amount. Such depressions appear more or less regularly at 7- or 10-year periods and each brings its increase in unemployment and wastage of the productive capacity of industry.

In January 1921 a nation-wide survey of employment made by the U. S. Employment Service of the Department of Labor showed that there were 6,070,648 workers then employed in industry as compared with 9,402,000 in January of 1920, a decrease of 3,331-352 or approximately 35.5 per cent. This survey covered 35 states and 182 industrial cities and centers and may be considered as fairly reflecting conditions at that time.

In addition to minimum and climacteric unemployment, many essential industries show a high unemployment or idleness once a year or oftener. Practically all industries are in a sense seasonal. To present a few examples: The clothing worker is idle about 31 per cent of the year; the average shoemaker spends only 75 per cent of his time at work; the building-trade workman is employed only about 190 days in the year or approximately 63 per cent of his time; the textile industry seemingly has regular intervals of slack time; during the past 30 years bituminous-coal miners were idle an average of 93 possible working days per year. In the brick, chemical and glass industries the percentage of full time worked was 85, 84 and 87, respectively. In most years the percentage of lost days is much larger.

Intermittent unemployment brings other wastes. One consequence is a concrete but fallacious industrial philosophy that there is only so much work to be done and that the sensible course of action is to retard production to make employment last throughout the year, or to uphold prices.

Another form of unemployment comes from open conflict between management and labor. Here it should be said that in the past, at least, the amount of waste from the general run of strikes and lockouts through loss of wages and curtailment of production has been less than is popularly supposed. That these disturbances do produce unemployment is true, but in the industries studied they do not of themselves appear to constitute a major source of reduced production. The ramifications of such strikes with their attendant and indirect losses the Committee has been unable to trace.

Since most strikes occur in seasonal employments, it can be deduced that output is not necessarily penalized, for it is often possible to make up the losses incurred by strikes through increased production at other times.

More coal was mined in 1910 than in 1911, although the former year witnessed many protracted strikes involving large numbers of employees. The year 1912, with 47 per cent of the entire labor force out on strike and with an average loss per man of 40 days, showed an increased output of coal per man per day and per year, and six days' more employment than in the year 1911, which, it will be remembered, was relatively strikeless.

In addition to the direct loss of time, however, there is a loss incurred through retarded production previous to and immediately following strikes.

Wages and hours have always been the chief cause of strikes. There has been a marked falling off in the relative number of strikes for this cause in recent years as compared with 1898-1905.

Jurisdictional disputes, that is, strikes by the members of one trade against the performance of work which they regard as belonging to their craft by members of some other craft or trade, are relatively unimportant. In the building trades jurisdictional quarrels represent one-quarter of the total number of strikes.

Idle Material. The waste of idle material through deterioration, obsolescence and carrying charges is large, particularly where there are great inventories of both raw material and finished goods. Unbalanced production is another notable cause of idle materials and consequent waste.

Idle Plants and Equipment. Unsound production policies result in wasteful overequipment. Clothing factories are built 45 per cent larger than is necessary; printing establishments are from 50 per cent to 150 per cent overequipped; the shoe industry has a capacity of 1,750,000 pairs of shoes a day, and produces little more than half that number; throughout the metal trades, standardization of products would permit of large reductions in plant equipment.

Standardization of machine sizes would make possible the use of one machine for a greater variety of different jobs.

It has not been possible in this assay to estimate the amount of idle equipment, nor the accompanying waste through maintenance and depreciation charges.

Waste Resulting from Restricted Production

Restrictions By Owners and Management. Some of the evils of restricted production are chargeable to owners and management. In the building trades the contractors, builders and supply dealers have restricted production by maintaining high prices, collusion in bidding, and unfair practices. At times there has been collusions between employers and labor, tending to raise prices unduly. The waste from these causes cannot be measured in this study.

Restrictions by Workers. Restrictions of individual output for which workers are responsible are susceptible of measurement. They are of two kinds. On the one hand, when workers are scarce. the less conscientious workers become independent and slacken speed, whereas when workers are plentiful, they work with greater diligence and care for fear of unemployment. On the other hand, the dread of unemployment is so pronounced that employees engaged in seasonal enterprises frequently restrict production in order to make employment last longer; some workers, moreover, through consideration of their fellow-employees, limit production to provide work for them, a practice which ultimately results in an economic loss.

The tools of the engineer are standard weights and measures, scientifically established. He cannot serve industry unless he can set standards for production and can measure work performed. Many unions now oppose the use of such standards. Practically all of the printing unions oppose these devices. The rules of the craft unions in the building trades also object to many labor-saving devices, and thus contribute to waste in that industry.

The restriction of the number of apprentices is a common rule. The rule requiring that members of one craft union shall not encroach upon the work of another results in large waste and little benefit. Unions frequently require three or four skilled employees to perform various operations on a plain job which a single worker could satisfactorily do by himself. Union carpenters are forbidden to lay bricks, union plumbers are forbidden to do carpentering work, and so forth. Unions are also charged with restricting the use of machinery.

A union rule in newspaper printing requires that all advertising matter coming into the plant in electrotype form must be reset by the compositors. This useless work is sometimes done weeks after the advertisement has appeared.

Waste Caused by Lost Production

Ill Health. In discussing public health conditions there is no clear distinction between the standing of the 42,000,000 persons classed as gainfully employed in the United States and those specifically engaged in industry. The 42,000,000 men and women gainfully employed probably lose on an average more than eight days each annually from illness disabilities, including non-industrial accidents —a total of 350,000,000 days. Of the 500,000 workers who die each year, it is probable that the death of at least one-half is postponable by proper medical supervision, periodic medical examination, health education, and community hygiene.

Assuming that the average life has, aside from all spiritual and human values, an economic value to industry of not less than \$5000, and assuming that the special diet, care, and medical attention required by a man chronically ill costs \$3 per day, it has been estimated that the economic loss from preventable disease and death is \$1,800,000,000 among those classed as gainfully employed, or over \$700,000,000 among industrial workers in the more limited meaning of the term.

Defective Vision and Defective Teeth. It is estimated that 25,000-000 workers have defective vision requiring correction. It is the experience of a number of plant executives that the correction of sub-standard vision brings increased quality and quantity of production, sufficient to pay for the cost. A very large proportion of workers have defective teeth and mouth infection, and other serious physical defects which reduce their effectiveness.

Industrial Accidents. In 1919 there occurred in industry about 23,000 fatal accidents, about 575,000 non-fatal accidents causing four weeks or more of disability, and 3,000,000 accidents causing at least one day's disability. The time lost is estimated to be 296,000-000 days, giving an economic loss to the country of about \$853,000-000 for the year 1919. This does not include the costs to employers and employees for medical and surgical aid and hospitals' bills, and the overhead expenses of insurance.

RECOMMENDATIONS FOR THE ELIMINATION OF WASTE IN INDUSTRY

In preparing this third part of the summary, the Committee has endeavored to interpret responsibility in terms of what might be done to eliminate waste in industry. The policies and methods recommended are such as are already in successful use in the industries and plants investigated.

Responsibility of Management

Improvement of Organization and Executive Control. Planning and control should be adopted as fundamentals of good management. For the most part they have not as yet penetrated the mass of American industry.

Production Control. Conscious production control tends to reduce or eliminate waste by shortening the total time of production. Material schedules should be installed and used. Work in process should be planned in advance by methods which will insure its timely delivery to the machine or operation where it is needed, so that there will be no idleness between jobs.

Balancing Productive Capacity and Demand. The sound relation between capacity and demand is shown only as a wise policy is adopted in regard to planning, routing, and scheduling work, and as improved shop methods are put into effect.

Development of Purchasing Schedules. There should be the same coördination of the purchasing function and careful control of material purchased and not yet received as is given to material already in the plant.

Elimination of Cancellations and Curtailment of Returns. The practice of cancellation of orders between manufacturer and customer should be eliminated and there should be a curtailment of the privilege of returning goods ordered and received.

Correlation of Production Schedules with Sales Policies. Production schedules should be based on a carefully formulated ales policy determined from an intensive study of markets, thus stabilizing production.

Inspection. The aggregate annual wastage of human effort and goods from spoiled and defective work is appalling. The indirect losses, which are harder to detect and measure, are often greater than the direct losses.

Maintenance of Plant and Equipment. Upkeep of plant is conducive to maximum production, as it assures that equipment and machinery will be continually in a condition to operate.

Uniform Cost Accounting. In controlling production and in judging fairly and accurately when and where progress and improvement are being made, the lack of a good cost-control system is necessarily a source of much waste.

Methods of Wage Payment. Methods of wage payment should be adopted, equitable and just in their basis, and insuring a proper relationship between effort put forth and results achieved by all who participate in the enterprise.

Standardization of Product. Products should be standardized, consistent with progressive development of manufacturing.

Standardization of Materials. Materials should be standardized to the fewest practicable kinds, sizes and grades.

Standardization of Equipment. At least the details of equipment, including machines and tools, should be standardized so as to permit of the widest interchangeability and maximum usefulness consistent with improvements in design and invention.

Performance Standardization. Performance standards should be developed as a valuable aid to planning and production control.

Management and Workers. Management has a definite responsibility in selecting, upgrading and in maintaining personnel. Experience indicates that the best results can be obtained when employment and personnel direction develops a sense of mutual interest in production on the part of management and workers.

Prevention of Accidents. Management has a definite responsibility to prevent industrial accidents. Systematic preventive measures can and should be inaugurated.

Research. The need for knowledge obtained by industrial research was manifest in every industry studied.

Responsibility of Labor

Increasing Production. The need for facts instead of opinions stands out everywhere in the assay of waste from intentional restrictions of output. No service which workers can render can be socially more valuable than that of studying the needs of the industries in which they earn a livelihood, and allying themselves with the technicians who serve with them to increase production which will inure to the ultimate benefit of all.

Standardization of Work. Labor should coöperate to prepare for and even demand the determination of and use of performance standards.

Changing Rules Regarding Restrictions. Labor should change its rules regarding restriction of output, unreasonable jurisdictional classifications, and wasteful methods of work, thereby removing some sources of waste.

Improving Health and Reducing Accidents. Labor is responsible no less than management for improving the health of the workers and for preventing accidents in industry.

Improving Industrial Relations. Inasmuch as the organization of personnel relationships in industry can only be accomplished through the coöperation of both employer and employee, labor should assist in such work of organization and in maintaining and utilizing the structure developed.

Responsibility of Owners

The owners of industry, through the banking function or otherwise, share in the responsibility for eliminating waste in industry. They have the duty particularly of assisting in stabilizing production.

Responsibility of the Public

Need of Public Interest. In the study of industrial waste, there can be no setting apart of the public as a separate group. A campaign to increase the productivity of industry cannot be conducted without widespread interest and support.

Style Changes. In certain industries the consuming public is to a degree responsible for seasonal fluctuations because of the eagerness with which it accepts or adopts changes in style.

Distribution of Demand. The public can assist in stabilizing industry by accepting a sensible distribution of demand throughout the year.

Community Coöperation With Industry. Public and semi-public agencies can assist by definitely encouraging and supporting the efforts for elimination of waste. Bodies such as local chambers of commerce and other civic and community associations can bring influence to bear through local conferences with the different branches of industry.

Opportunity of Trade Associations

Trade associations should be formed in those industries lacking comprehensive organizations. They should promote programs for the standardization of cost-accounting methods, the introduction of standardized material specifications, the establishment of production standards, the standardization of equipment, and the standardization of finished products.

Opportunity for Governmental Assistance

National Industrial Information Service. A national industrial information service should be established to furnish timely, regular, and complete information on current production, consumption and available stocks of commodities, supplementing the work of private agencies.

A National Statistical Service. A national statistical service should be established and maintained covering employment requirements and conditions throughout the country.

Principles for Adjustment and Settlement of Labor Disputes. A body of principles for the adjustment of labor disputes should be accepted which can be developed with experience.

Public Health Policy. The reports dealing with health, prepared in connection with this study by a group of physicians, declare for an aggressive, continuous, national public health policy.

National Program for Industrial Rehabilitation. The national program for industrial rehabilitation should be encouraged. It should offer opportunities for the education and placement of those having physical and mental defects as well as those handicapped by industrial accidents or by war. Formerly such incapacitated men were treated as if they had no economic value. Many striking examples, however, have led to the conviction that many such men can be so trained as to make them useful workers. Comprehensive efforts for their vocational rehabilitation are being made through the coöperation of Federal, State, industrial and commercial agencies.

Nation-Wide Program of Industrial Standardization. A nation-wide program of industrial standardization should be encouraged by the Government in coöperation with industry. In the standardization of design of product, methods of procedure and number of models, there rests a large opportunity for the reduction of waste.

A special service which the Government can render in this connection is the standardization of its own demands. Several government departments have their own paper specifications, for example, with no relation to each other, or to any standard brand. These departments might well take the first step by standardizing the paper they use on the basis of a selected list of well-known brands.

It is not sufficient, however, to attempt to standardize the product of a given industry, for almost every industry is so dependent upon others that they too must coöperate. The Federal Government could call together the representatives of the trade associations of interdependent industries and in coöperation form committees for this purpose. The opinions or decisions of such committees might from time to time be promulgated as standards of practice.

Revision of Federal Laws. Where Federal laws interfere with the stabilization of industry, they should be revised in the interests of the whole people.

The largest area of waste lies in the periods of slack production and unemployment, due to the ebb and flow of economic tides between booms and slumps. Studies of industries as a whole show that we usually expand our equipment at the periods of maximum demand for products instead of doing our plant expansion during periods of slack consumption. While it cannot be expected that all industry could be so stabilized as to do its capital construction in slack periods, there are some industries which could be led in this direction by coöperation with the Government and coöperation among themselves.

As a striking example, in a seasonal industry such as coal mining, no adequate solution regarding stabilization can be found except through organized coöperation of operators, labor, railroads and large consumers. Under existing laws as to combinations, such coöperation cannot be carried out. Therefore, we believe that federal legislation is necessary permitting such coöperation under competent government authority.

Duty of Engineers

The duty of engineers is a part of all the responsibilities previously stated in different recommendations.

Engineers come in contact with and influence every activity in industry, and as a body possess an intimate and peculiar understanding of intricate industrial problems. They are in a position to render disinterested service, and their peculiar responsibility is to give expert judgment wherever engineering training and technical skill are needed to reach a just decision.

This report brings forward certain pressing problems concerning the solution of which engineers should hasten to assist. The assays of waste show first the need of definite and quantitative industrial information on a multitude of points. Science has pushed ahead in some directions; it lags behind in others. The duty of the engineer is preëminently a duty to enlarge the boundaries of knowledge. His lifelong training in quantitative thought, his intimate experience with industrial life, leading to an objective and detached point of view, his strategic position as a party of the third part with reference to many of the conflicting economic groups, and above all his practical emphasis on construction and production, place upon him the duty to make his point of view effective.

It is peculiarly the duty of the engineers to use their influence individually and collectively to eliminate waste in industry.

Die Sinking and Metal Patternmaking by Automatic Machine

By JOSEPH F. KELLER,[1] BROOKLYN, N. Y.

WHILE the term "die" is very comprehensive and elastic and is applied to an endless variety of tools, it is to be understood that the methods discussed in the present paper have to do with such dies as are used for stamping, forging, embossing, pressing, etc.; that is to say, such dies as contain the negative or positive of the product to be formed or decorated.

Among the industries to which such dies or molds are a fundamental necessity are the following: Arms and ammunition; aluminum ware; automobile parts; brass goods; buttons; compositions such as celluloid, bakelite, hard rubber, etc.; cutlery; die casting; drop forging in steel, bronze, brass, etc.; electrical appliances, glassware, pressed or blown; hardware; harvesting machinery; horseshoes; jewelry; lighting fixtures; medals; metal wares in general; paper goods; silver, flatware and hollow ware in all its branches; surgical instruments; toys, dolls, etc.; tractors; valves and fittings.

When the enormous expansion and development of the industries enumerated is borne in mind, the greatly increased demand for dies and die production is readily understood. Quantity output of uniform quality is possible only with machine-tool and die methods, and every manufacturing industry is forced to resort more and more to such methods to offset high labor costs and unprecedented operating expense.

How, then, are the world's die requirements to be satisfied? How, in fact, are the present demands being met? The answer here, as it has been to so many other industrial questions, is, by machinery.

The Various Methods Employed in Die Sinking

The die-making problem has been solved by a development of the carving machine, often conveniently, if inaccurately, spoken of as operating on the pantograph principle—that of the guide or tracer following the undulation of a pattern, causing the corresponding movement of a cutting tool, and thereby reproducing the pattern in the material on which the cutter operates. The greatest difficulty encountered in this work was to retain sensitiveness in combination with heavy cutting.

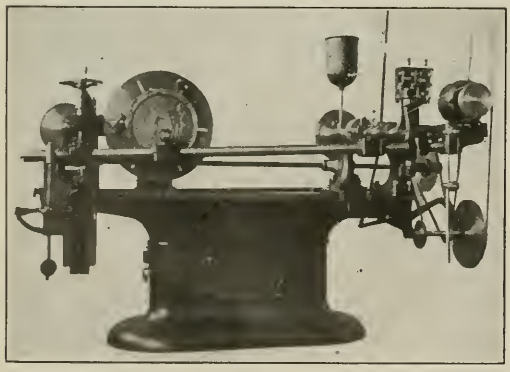

Fig. 1 Small Motor-Driven Reducing Machine Cutting Die for a Medal

Other methods such as machine etching, hot sinking, cold typing, etc., have come up from time to time. Some proved to be quite alluring at the beginning with the usual resultant disappointments after certain inherent difficulties began to be better understood.

The machine-etching method in connection with an electric current, long ago abandoned, is now generally conceded to have been of no practical value.

Hot sinking on the order of the Champney process is still in use to some extent, but its field of application is gradually growing less with the improvement and development of the more positive cutting method.

Cold typing or hubbing has been until recently very limited in scope and could only be used where a small amount of stock was to be upset. An attempt at deep sinking is always accompanied by the risk of splitting, which is usually apparent; or of destroying the steel structure. This latter condition is frequently not noticed until the die has been hardened and put into use.

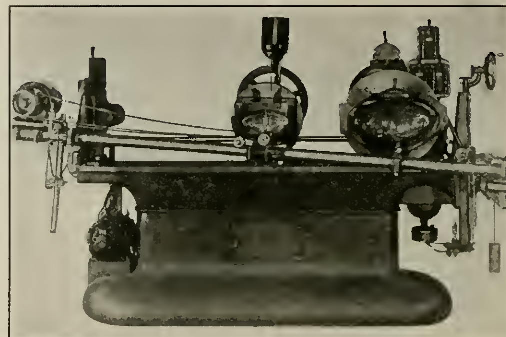

Fig. 2 Large-Size Motor-Driven Reducing Machine Cutting Die for an Ornamental Bowl

In connection with the die-sinking machine, however, the typing method has proved very practicable, and especially useful for silver flat ware, for dies for composition products, and for die casting with multiple inserts, also for many kinds of drop-forge work—in fact, wherever a number of accurate and interchangeable die reproductions are wanted.

The best practice is to cut on the machine a die from an intaglio and a type from a relief model. The die is finished and hardened. The type is then easily fitted to the die and hardened. Subsequent dies are cut on the machine and finished with types with the aid of very little bench work. Although a moderate amount of pressing is done in hydraulic or other presses, so little stock is upset that the steel surface is left in its previously homogeneous state.

In the case of the automatic die-sinking machine, as the model is always his guide, much less skill is required on the part of the operator, although at times it is advantageous to manipulate the hand feeds. The machine follows the master whether hand-operated or running automatically.

Thus the great importance of a method which makes of die sinking an ordinary machining operation. A method by which a pattern is automatically copied in the steel block makes production of dies almost as simple a proposition as if it were a question of making a cast die of iron or bronze.

Automatic Die-Sinking Machines

For convenience of description, automatic die-sinking machines may be divided into two classes: reducing and reproducing—on flat or cylindrical surfaces. Though developed for and applied to many diversified uses, they have all in common the feature of normally automatic operation controlled by pattern or guide.

The reducing machine, or reducing lathe as it has sometimes

[1]Gen. Mgr., Keller Mechanical Engraving Co., Mem. Am.Soc.M.E.

Abstract of a paper presented at the Annual Meeting, December 1920, of The American Society of Mechanical Engineers. All papers are subject to revision.

been called, in some form seems to have been the first really automatic machine employed for making dies and molds. In the earlier development these were for a long time confined to coin and medal work and later to such lines as called for work of rather artistic and intricate nature, such as jewelry, silverware and later builders' hardware, etc.

Fig. 3 Machine Work Only, Not Retouched

Fig. 1 shows a small motor-driven reducing machine cutting the die for a medal, and Fig. 2 a large machine of the same type. Both are three-dimension machines in which the tracer follows the details of a large model or pattern to be reproduced in a given smaller size in intaglio or relief.

The lever (or bar) has its fulcrum at one end and is so supported that it has perfect freedom of motion in and out of the various depths of model or pattern and up and down across its face. The third dimension is taken care of through the movement (in this

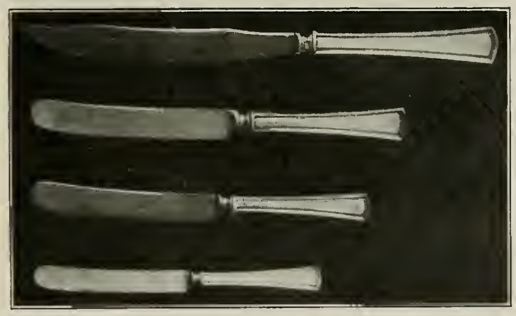

Fig. 4 Work Done on Reducing Machine: A Variety of Sizes Cut From One Large Model

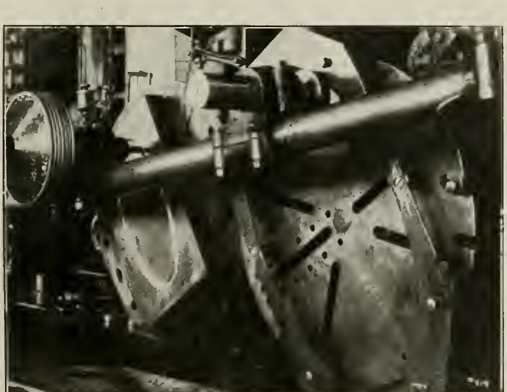

Fig. 5 Reducing Machine Milling an Oval

case rotation) of the pattern and work. These are supported on faceplates carried on spindles and supported in brackets on the bed of the machine. These two spindles are worm-and-gear-driven at the same speed and rotate in the same plane. The worms are carried on a splined wormshaft at the back of the machine.

It will be seen that the work, being located nearer the fulcrum than the model, must necessarily be smaller and in exact ratio as the distance from the center of the work spindle to the fulcrum is to the distance between the model and fulcrum. For convenience in locating the work spindle a scale running from the fulcrum center to the model spindle center is applied to the bed of the machine. As this scale is divided into 1000 equal parts, the use of a very simple formula readily indicates the proper location for the work spindle.

In these machines the model position remains fixed. The work spindle is movable and readily adjusted to any position between fulcrum and model, the point nearest the fulcrum producing the smallest size and the size increasing relatively as the model is approached. The cutter bracket must naturally be adjusted to a point in line with the center of the work spindle.

The free end of the bar is supported on a roller on a screw-controlled saddle at the end of the machine opposite to the fulcrum. With every revolution of the faceplates the cutter bar is moved a predetermined distance. The bar feeds either up or down, depending on the nature of the work. Roller support of the bar helps to keep the friction down to a minimum. A spiral course is traversed by the tracer point and completely covers the surface of the model.

It will here be seen that a speed-controlling device is required so that the tracer may travel over all points of the model at a uniform speed. If the speed selected is correct near the center, it would be too fast at a point on the model further away and the tracer, on account of inertia of the bar, would not reach but would skip the deepest points in the pattern.

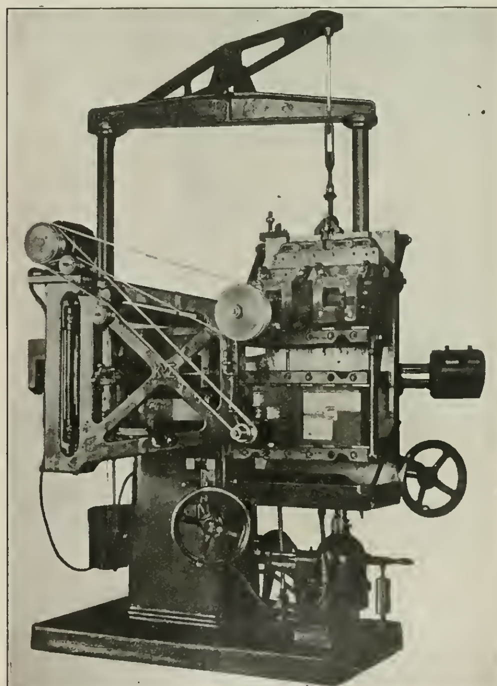

Fig. 6 Sensitive Duplicating Machine Capable of Fairly Heavy and Deep Cutting

The device employed for this purpose is directly connected through gearing to the drive motor and transmits the power to the worm shaft through the friction of two circular disks with cork inserts which are in contact through the action of a spring when the machine runs at the required speed. As soon as there is a tendency to run faster, the friction disks are separated through the action of a ball governor.

For work of a rectangular or elongated outline an oscillating mechanism was found necessary and developed. This is now accomplished either by reversing the drive motor through a reversing switch or by means of a reversing jaw clutch. In either case the control is through two adjustable dogs carried on the gear driving the model spindle.

Figs. 3 and 4 show specimens of work done on reducing machines; those in Fig. 4, illustrating a variety of sizes, are cut from one large model.

Fig. 5 shows a reducing machine cutting an ellipse. The work comes from the machine exactly to size and much better than when done in a lathe with elliptical chucks, with the added advantage that the machine is not confined to geometric figures as any shape can be cut in this way. Boiler plate about $^1/_8$ in. thick is used for templets.

The bar is suspended and so counterbalanced that the roller on the tracer is always bearing upward and in contact with the model. In this case the regular feed is not used. Size is controlled by using an oversized tracer for the first cut.

Duplicating Machines

The duplicating machine is used in all the lines previously noted which do not call for dies with very fine detail or of highly ornamental design, and in which the detail of the model can be reached with a tracer which need not be very sharp at the point.

The models are easier to make than in the case of the reducing machine, and very frequently there is a model already in existence. Old dies are frequently used as models. Where a piece has been broken off, the gap is filled up with brass or solder.

The fields of usefulness for duplicating machines are much the same as for reducing machines. In addition, however, they are now very generally used in the making of metal patterns and core boxes.

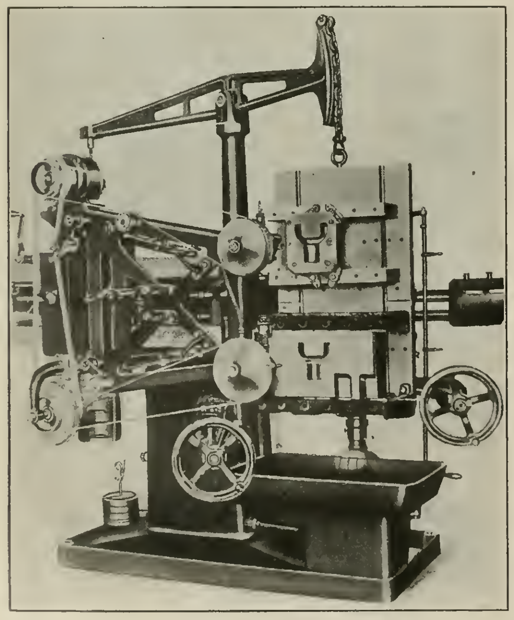

Fig. 7 Heavy Type of Duplicating Machine

Fig. 6 shows a duplicating machine that is quite sensitive and yet capable of fairly heavy and deep cutting. For convenience in counterbalancing the work table travels up and down in a vertical plane, and a saddle supporting a fulcrumed cutter bar moves either right or left at right angles to the plane of travel of the work. The tracer is held in position against the model by means of weights connected to the bar over pulleys.

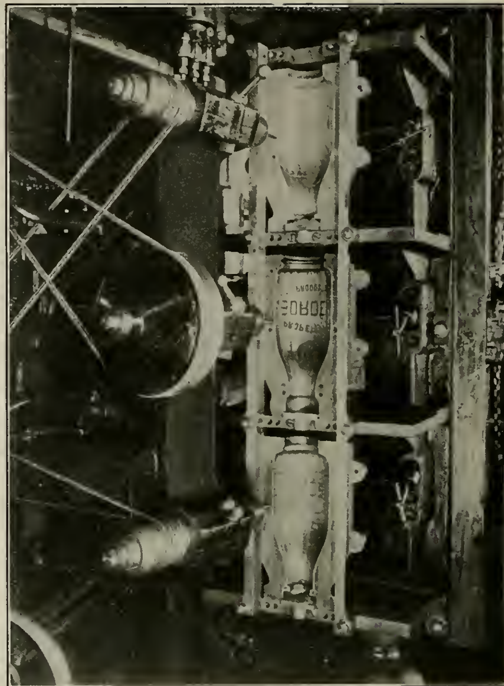

Fig. 8 Portion of Bottle-Mold or Core-Box Machine

Fig. 9 Fixture for Holding Two Dies and Two Models in one Setting

On this type of machine the cutter and tracer points are alike in size.

The design of the cutter bar and its proper support are of great importance—minimum weight, maximum strength, and above all, sensitiveness. For light work, very carefully made roller bearings are used, with a ball bearing to take up the thrust. For heavy work, pivot centers carefully ground and lapped work best.

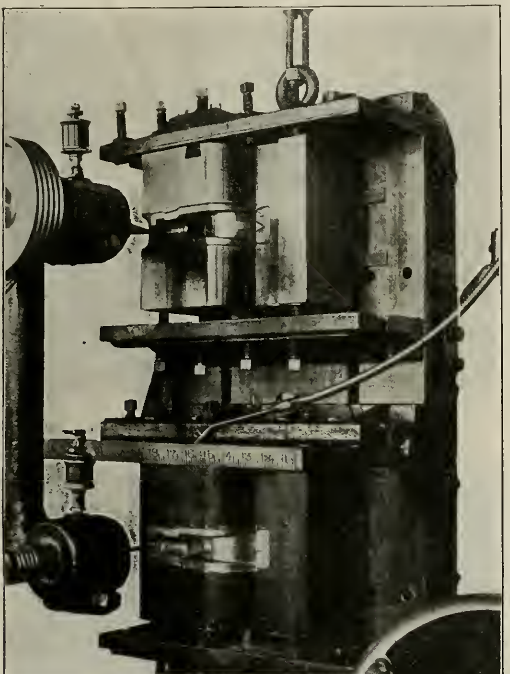

Fig. 10 Using a Die as a Master

It should be noted here that the model and work are carried on *one* rigid member and the cutter and tracer also on *one* member. There is no change in relation between model and work or tracer and cutter; therefore the accuracy of the result.

Fig. 7 shows a machine the same as that of Fig. 6 in principle and general design but heavier. It is really an automatic milling or profiling machine, but when operated by hand it works very much like the well-known hand-operated die-sinking machines, with the great advantage, however, that the operator always has the pattern to follow. For this reason there is less skill required. The hand feed is used principally for hogging out and setting up the work. In every case the pattern is always followed by the tracer.

Thus by this method the greatest difficulties of die sinking have been overcome. Irregular surfaces present no difficulties.

This machine is capable of heavy cutting to practically any depth of a 12-in. die, and it will machine die blocks up to 27 in. by 16 in. face by 12 in. deep. As the machines run automatically a large part of the time, one man can tend a number of them, the operation being quite simple. In many shops they have been operated in shifts for 24 hours a day.

Fig. 8 shows a portion of a bottle-mold or core-box machine which is similar to those just described but has a centrally located model and cuts two pieces of work simultaneously, one above, the other below, the model. It has variable-speed drive motors automatically controlled to take care of the conditions within the cavity calling for a sudden change of speed. The work table swivels automatically so that the feed may start at the surface at one side of a mold with a half-round cavity and finish at the surface at the opposite side, the work table changing its position in relation to the tracer and cutter automatically but very gradually.

These machines work very rapidly as compared with the old hand methods, cutting a pair of bottle molds in from one to six hours, the molds leaving the machine accurately matched and requiring comparatively little hand work. They are equally rapid on metal core boxes.

A fixture for holding two dies and two models in one setting and which facilitates setting up, is shown in Fig. 9. It is especially useful in quantity production in connection with drop-forge die work. All dies of this class have two sets of matched edges, which are planed square to each other. The dies are placed on the fixed lower jaw resting on the matched edges and brought forward until their faces touch the stops. They are also moved endways either to the right or left until the matched edges touch a side stop.

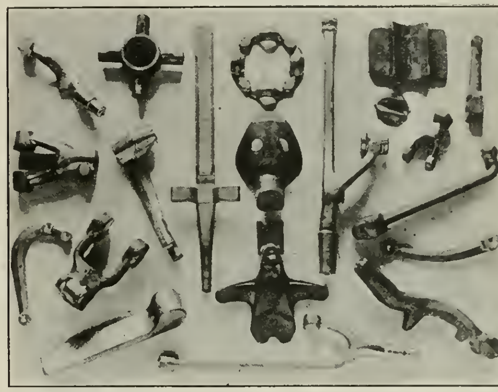

Fig. 11 Forgings Made from Dies Cut in a Duplicating Machine

The models are held in the same way. The setting-up is quickly done and the corresponding cavities match with accuracy.

Most dies cut on a duplicator or automatic die sinker require a moderate amount of hand finishing (scraping, polishing or chasing), depending on the class of work. There are many cases where dies can be put in use as they leave the machine, without any hand finishing (see Fig. 10). This is well illustrated in the sample forgings shown in Fig. 11.

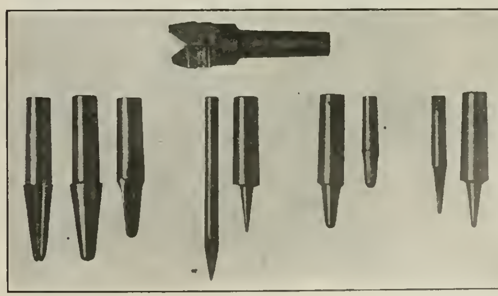

Fig. 12 Cutters, Mills and Tracer Points Used

The cutters used in these machines are quite simple and are of three distinct types as shown in Fig. 12: the diamond point, up to about $^1/_{16}$ in. diameter at the point, made of round stock much like a flat drill; the round-nose fluted end mill, from $^1/_{16}$ in. in diameter at the point up to practically any size and having two or more flutes, depending on the size; and the formed end mill, used occasionally for spotting, or hub cutting as it is sometimes called.

Until recently hard-metal models have been used on the machines to resist the pressure of the tracer point made necessary in order

to keep the cutter in the work. The reduction of this pressure, so that models of cement, plaster, soft metal or other comparatively soft materials may be used, has been accomplished by means of an electrical control of the cutter.

In the electric-control method the cutter bar is positively operated by means of a lead screw, which in turn is under control of the tracer. The tracer is so constructed that the pressure on the master is only a few ounces, thereby permitting the use of the soft masters. But the cutter bar is positively controlled by the lead screw so that the pressure which can be brought to bear on the cutter is limited only by the strength of the cutter and the capacity of the machine. The in-and-out movement of the cutter bar being entirely dependent on, and controlled by, the action of the tracer on the lead screw, also permits the use of straight-flute mills and the cutting of straight-sided cavities.

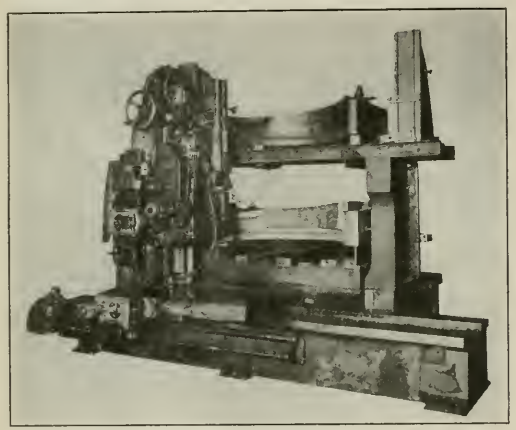

Fig. 13 Machine Capable of Taking Heavy Cuts on Large Dies and Provided with Electrically Controlled Tracer for Use with Models of Wood, Plaster or Other Soft Materials

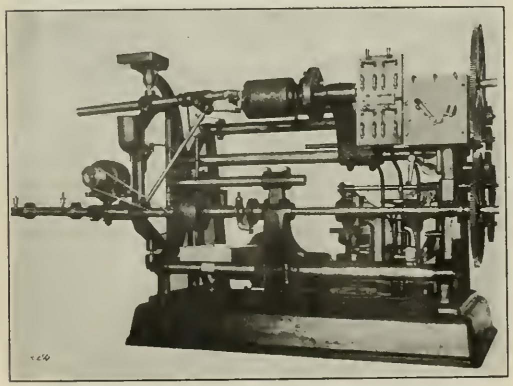

Fig. 14 Roll-Cutting Machine

This method of electrical control has also made possible the construction of much larger machines capable of heavy cuts on large dies.

Fig. 13 shows a machine of this type operating on automobile fender dies. This style of machine is built to cut the largest dies that can be used for auto bodies, fenders, axles, crankshafts, bath tubs, etc.

On account of the weight of the work it is fastened to the machine bed and remains in a fixed position. The head carrying the cutter and tracer travels back and forth in front of the work and model in a horizontal or vertical plane. The tracer and cutter travel in and out, taking care of the depth of die through the action of the electrically controlled tracer.

Advantages and Relative Cost of Machine-Cut Dies

The first question that is usually asked is: What is the percentage of saving as compared with hand work? And the second is: How much hand finishing do machine-cut dies require?

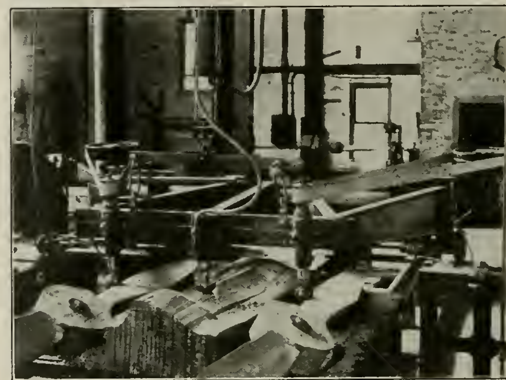

Fig. 15 Propeller-Carving Machine

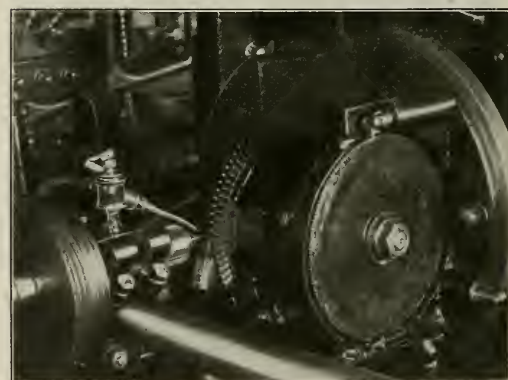

Fig. 16 Machine for Cutting Buckets on Turbine Wheels

The amount saved with the use of automatic die-sinking machines is translated into figures with difficulty on account of the vastly varying conditions. In most cases it is considerable: the more difficult, the greater the saving over hand work. The average is over 50 per cent and in many cases as much as 80 per cent. Some of the other advantages are:

Having dies when required
Speed
Difficult dies no more trouble than simple ones
Reduced overhead
Convenience in replacing broken dies
A small flexible die department, adjustable to slack periods and peak-load requirements
Uniformity of product.

A method which can afford to disregard what would otherwise be considered prohibitive difficulties, permits the manufacturer to design his dies purely from the production point of view, instead of being limited by considerations of die costs.

In connection with a large Government program it was possible to eliminate a restriking and bending operation by making a rather

(Continued on page 606)

Variable-Speed Motors in Finishing Plants

The Saving in Fuel Resulting from Their Substitution for Independent Steam-Engine Drives, as Shown in the Analysis of the Power Problems of a Typical Finishing Plant

By WARREN B. LEWIS,[1] PROVIDENCE, R. I.

THE perfecting of the adjustable-speed, direct-current motor has wrought a revolution in the engineering economics of the cotton-cloth-finishing business far greater than would at first appear to be attributable to any advantage which might be derived from the substitution of electric for mechanical drive. Twenty years ago the stationary, constant-speed electric motor found its application principally in small shops or in departments of larger shops where convenience was the predominating factor. A few years later any proposal to substitute electric drive for mechanical drive met with a demand for proof of greater efficiency in transmission, and several years elapsed before prospective purchasers would admit that the use of electric drives would produce economies outside of the field of simple engineering economics.

The adjustable-speed, direct-current motor opened up a field in which mere mechanical efficiency was not of prime importance, and established a record for productivity that no other variable-speed device could attain. Since that time the adjustable-speed motor has been considered primarily as a variable-speed device which, by reason of its simplicity, perfection of speed control, etc., has outrun all of its competitors. In this paper it is proposed to show that the usually accredited advantages of the adjustable-speed, direct-current motor are not paramount in its selection for driving certain classes of machinery used in the cotton-cloth-finishing business, but that it has made possible a reduction in production costs that are most striking.

Nature of Power Problems in Finishing Plants

In the manufacture of cotton cloth the power problems are of the simplest character. In the finishing business, however, they are most complex. Finishing plants use large quantities of power, heat and water, and so great are these as factors of cost that the very location of a finishing plant is determined by proximity to ponds or streams which will furnish millions of gallons a day of clean water, and adequate facilities for the transportation of fuel, greater in weight than the total weight of the product shipped out.

If one takes occasion to visit the many finishing plants in New England (exclusive of those which have in the last few years rebuilt their power plants in accordance with the most modern ideas—and these are very few in number) he will find a great number of small engines, either belted, geared or otherwise connected to machines which operate throughout a considerable range of speed; and one or more large engines exhausting to the atmosphere or running condensing, driving through the usual line and countershafts machines which operate at constant speed. He will find numerous drying machines using steam at pressures of from 5 to 10 lb., individually driven by the before-mentioned small engines, the exhaust steam from which passes into the machines and furnishes the heat for drying. Small engines driving machines which, in themselves, do not require heat, will probably be exhausting into a main which will be connected also with drying cylinders, furnishing the steam which those cylinders require in excess of that furnished by the engine which drives them. He will notice numerous blower systems furnishing hot air for drying purposes; and in many cases the heating coils of these blower systems will be supplied with live steam. He will notice numerous dye tubs, jigs and vats which are periodically filled and emptied; and which, more often than not, are supplied with cold water which has to be heated to the boiling point with live steam.

If he comments at all upon the use of so many small engines, he is sure to be told that the arrangement is a most economical one, inasmuch as all of the exhaust steam from these engines is used in drying processes, and that nothing is to be gained by substituting some drive which uses less steam per horsepower. Having the engineering mind, however, he will speculate on the heat being discharged from the larger engine, either to the atmosphere or to a condenser, and doubt whether the arrangement is as economical as its owner thinks it is. He will at once realize that the actual brake horsepower required for the entire plant does not balance with the heat being discharged from all of the engines, and that there is very evident room for improvement; and he will arrive at the final conclusion that the small engines are justifiable solely as a means of obtaining varying speeds and not as motive power for producing power as a by-product.

In practically every case a survey of the plant will show that the heat exhausted from the main engines is entirely wasted, except for such as may be used in feedwater heaters. Complete analyses of many of these older plants show that from 3 to 5 lb. of coal are used per pound of cloth finished, which indicates at once the importance of the transportation problem and the extent to which the cost of fuel enters into the total cost of finishing.

As far as electric drives are concerned, the constant-speed machines in a finishing plant may be disposed of briefly, as the problem is very simple and varies only in degree from that which applies to any manufacturing process where the power required to drive the machines should cost a minimum. The same arguments apply, such as lower transmission losses, ability to reduce losses to zero when machines are not in operation, ease of control, cleanliness, etc.

If a perfect balance can be maintained between power requirements and the demands for heat, then there is little more to hope for in that particular direction; or, if in the production of power all of the heat units passing away from the engine can be utilized, then also the desired goal has been reached. Again, if all of the power required can be produced and the heat discharged from the engine be sufficient for process purposes, then the condition is still better because it is always possible to introduce live steam with the least possible loss between the boiler and the point of use. The adjustable-speed motor has not only made this condition possible, but has actually realized it in plants which have become completely electrified.

Motors as Variable-Speed Devices

The adjustable-speed motor is an ideal speed-changing mechanism. The degree of variation which may be obtained is greater than in any mechanical device, the ease with which the variation may be obtained is ideally simple, and the efficiency is high. Consider it not as a motor, replacing some other form of motive power, but as a speed-changing device introduced between a relatively efficient prime mover and the machine to be driven. Originally designed primarily for machine-tool operation, it was designated as a constant-horsepower motor, inasmuch as it was generally operated at high torque when running at low speed and at low torque when operating at the higher speeds. As a matter of fact, at the lower speeds its rating was somewhat decreased owing to the poorer cooling effect with low armature speeds, and the greater heating of the fields with full voltage applied to them. A four-to-one motor, rated at 10 hp. between the speeds of 400 and 1600 r.p.m. would perhaps be better rated at 8 hp. from 400 to 600 r.p.m., and at 10 hp. from 600 to 1600 r.p.m. at the same temperature rise.

As applied to finishing machinery, however, the adjustable-speed motor is more nearly a constant-torque motor. With few exceptions, it is coupled to a machine which requires a fairly definite torque which does not vary. The horsepower developed by the motor therefore varies with the speed; and if the torque was exactly constant, the horsepower would then vary directly with the speed. This means that the motor operates at its rated horsepower at the

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[1] Consulting Engineer, Mem. Am.Soc.M.E.; President Providence Engineering Society.

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highest speed, and at a low horsepower at low speeds. This has both advantages and disadvantages. At the low speed the torque being no greater than at high speed, the reduced armature heating offsets to a certain degree the heating in the fields due to the full field current. On the other hand, at high speeds the armature takes maximum current when the field is weak, which magnifies commutating troubles. The commutating and compensated field motor has practically eliminated this trouble, however, so that these motors will develop full horsepower at the maximum speed continuously and give perfect service.

It has been found that in 90 per cent of the cases a two-to-one motor will give all of the speed variation that is necessary for general use; while below the normal speed, lower speeds may be obtained for threading up, cleaning, etc., by the use of armature resistance, which, by reason of the low horsepower used for so small a proportion of the time, does not affect materially the overall economy of the plant. This makes possible the use of a smaller and more efficient motor for the usual working ranges.

Note that the losses in an adjustable-speed motor operating under constant-torque conditions decrease nearly proportionately with the horsepower, and then consider this adjustable-speed motor as a device placed between the machine to be driven and the main power unit which will develop a horsepower on about one-third of the steam required by the small engine. Combine the load of all of the adjustable-speed motors on to one generating unit, and the result will be a fairly uniform load and practically a uniform steam economy in the prime mover. Compare this with the varying load of the individual small engines in which the heat efficiency is constantly varying, and it requires very little imagination to see where we are being led.

Analysis of a Typical Finishing Plant

Applying now the general principles set forth in the foregoing to a concrete case, the author will attempt to analyze a finishing plant having a capacity of about three thousand pieces of finished goods per day, two-thirds of which are printed and the other third finished as plain white goods and dyed goods. This is an assumed plant for several reasons; but the principal one is that it is fairly typical from the engineering standpoint.

For the purposes of this paper the equipment of such a plant may be divided into two groups, namely, machines which operate generally at constant speed, and those which operate at varying speeds. The latter being the most important to consider, may be enumerated as follows:

	Max. Hp. of Unit	Max. Hp. of Equipment
Three singers	6	18
Two mercerizing equipments	25	50
Three sets of white cans	10	30
Two sets of dyehouse cans	10	20
Six printing machines with their drying cans	30	180
Five complete tentering equipments	12	60
One continuous steamer	20	20
Two aging boxes	7.5	15
One set of starch cans	15	15
Two open soapers with their drying cans	30	60
		468

Each of these machines will be driven by variable-speed motive power, i.e., 27 individual steam engines or 27 electric motors, and their total maximum requirements will be, as given in the preceding table, 468 hp. when operating at their maximum speeds.

Under no circumstances will all of these machines be running at maximum speeds simultaneously, and therefore requiring maximum power. Extensive experience with this class of machinery has proved that the load factor, as it might be termed, is about 50 per cent, and that while any one or even a number of machines may be operating at maximum speeds simultaneously, others will either be operating not at all or at low speeds.

The constant-speed machines in this same plant will require 600 i.hp. if the machines are driven from lineshafts, of which about 50 per cent will be friction losses. If driven with individual motors, the load will be about 250 kw. This great difference will not be due entirely to the difference between mechanical and electrical losses of transmission, but in great part to the fact that the constant-speed machines will be operated more or less intermittently.

A condition is assumed here which was almost universal up to the advent of the adjustable-speed motor, namely, that the twenty-seven variable-speed machines are driven with twenty-seven small steam engines and the constant-speed machines driven through line-shafting from a simple non-condensing engine. The boiler plant consists of a number of horizontal return tubular boilers, and the average output is 70,000 lb. of steam per hour, about one-third of which is delivered as live steam to processes where high-pressure steam is used.

Condensation in Steam Piping

There are many hundreds of feet of live- and exhaust-steam pipes around this plant, necessitated by the fact that the small engines and process machinery are widely distributed and steam must be delivered to them and exhaust steam taken away from the former. Numerous charts taken from boiler-feed meters will show that the condensation in the steam-piping system will be 10,000 lb. of steam per hour for every hour that steam is on the system, which may and frequently does mean twenty-four hours a day. No material reduction can be made in this loss, except through the removal of all of the piping that is not actually essential to the driving of the machines.

The substitution of the adjustable-speed motor makes it not only possible to eliminate this part of the piping system, but to reduce the sizes of pipes carrying live steam to processes. It is seldom that live steam at a pressure of over 50 lb. is required in the processes; and therefore, with the elimination of the engines, the drop in pressure between the boilers and the processes can be madd 50 per cent or more. Or, still better, the boilers may be divided into two batteries, one group being operated at 150 lb. or more ane delivering steam to the main unit and boiler-feed pump, while the other group may be operated at pressures of from 80 lb. down. As a considerable variation of pressure in steam for process purposes it is not detrimental, advantage can be taken of the heat stored in the furnaces and in the water within the boilers, so that during periods of heavy drafts the fires will not have to be pushed to maintain steam pressure, while at the slacker periods heat will be stored up.

This has been done in several plants with the result that the evaporation per pound of coal for the group of boilers furnishing live steam for processes has been very much improved. This again, has been possible through the introduction of the adjustable-speed motor in place of the small engine.

The heat distribution under the conditions stated may be shown by diagram as in Fig. 1, in which the area of the circle corresponds to a boiler output of 70,000 lb. of steam per hour at 100 lb. gage pressure, feedwater being taken from any source of supply at an average temperature of 100 deg. fahr. and heated to an average temperature of 170 deg. fahr. The question may immediately arise as to why a temperature of 210 or 212 deg. fahr. is not assumed; and the answer is that in practically none of these older finishing plants is the feedwater even heated to a temperature of 170 deg. fahr. This is probably due to the fact that a heater with sufficient surface to raise the temperature of the entire boiler feed from 100 to 210 deg. fahr. would be very large; and with the usual exercise of false economy, heaters of about one-half of the needed capacity are used.

Referring to Fig. 1, the area of the segment A represents the amount of steam which is condensed in the piping system. This figure is taken from actual boiler-feed charts in four plants of approximately the productive capacity of the one that we are considering. The area B is the amount of steam taken by the main engine and is based on 25 lb. of steam per i.hp-hr. The area C is the steam delivered to the small engines. The area D is the steam used as live steam in the processes. Segment B is divided to show the amount of heat which is recovered in the feedwater and the heat which is lost. Segment C shows that of 23,000 lb. of steam delivered to the small engines, 20 per cent is entirely lost in condensation, while the remainder may be used for drying purposes.

Steam Requirements for Drying

The drying operations in this plant will require that each yard of goods be dried three times and will require $1^1/_2$ lb. of steam per pound of cloth dried. The three thousand pieces will average in weight 10 lb. per piece, and the hourly rate of steam used for drying will be 13,500 lb. From the main engine 10,000 lb. of steam per hour are available, and from the small engine 18,400 lb., a total of 28,400 lb., or more than twice that required. While as a matter of

engine doing the constant-speed work, it is apparent that the most economical type of engine would have been the logical thing to have used.

The diagram as presented represents the best condition in that the driers are operating simultaneously with the engines. As a matter of fact, more often than not some of the driers will not be in operation, having completed their day's work before the end of the working day, or not being in use at all in some of the departments, with the result that the steam exhausted from the small engines will not be reduced in so great a proportion as will the uses of low-pressure steam, and a still greater proportion will be wasted. This is particularly aggravated when the printing department is busy and the dyehouse is not, inasmuch as printing machines always exhaust steam greatly in excess of the requirements in that department.

Segment *D* of Fig. 1 presents possibilities for some use of low-pressure steam, which, however, were seldom taken advantage of in the older plants, and not always in those which have been rejuvenated. In those processes where it is necessary to heat water up to the boiling point, water may be preheated to a temperature of 160 or 170 deg. fahr. and stored in tanks, from which it may be drawn for use in the dyehouse or in the boiling process. That this has not been done more generally is probably due to the fact that the cost of hot-water heating and storage systems is high, and there are difficulties in conveying hot water which are not easily surmounted. It is far better, therefore, to be able to use all of the exhaust steam for direct heating.

This leads up to the general statement that the whole problem of producing power in a finishing plant has been attacked from the wrong end. Analyzed properly, one should first determine the amount of low-pressure steam which can be used economically, and then so design the power plant as to derive all of the power required in the process of producing the low-pressure steam. If it is possible to produce all of the power from the minimum demand of exhaust steam, then the most economical balance will have been attained, because live steam may be introduced through a pressure-reducing valve with practically no loss.

Now for the analysis of this same plant rebuilt in accordance with the statement which has just been made, viz., that the power is to be produced from the steam which can subsequently be passed on to processes with the least loss.

If the plant is to be electrified throughout, the constant-speed motor load will be 250 kw. and the adjustable-speed motor load 210 kw. No attempt will be made to discuss the relative merits of a.c. or d.c. generation, this being determined by individual conditions; but for this particular plant it is assumed that a.c. motors are used for the constant-speed work, a motor-generator set to give 230-volt d.c. current for the adjustable-speed work, and a 500-kva. generator which may be either turbine- or engine-driven.

The drying operations in this plant require 13,500 lb. of steam per hour at about 5 lb. pressure. The steamer can use 1500 lb. of exhaust steam per hour if it is clean. The two soapers will use 100 gal. of water per minute, which in the old plant has been heated to a temperature of about 170 deg. fahr. by introducing live-steam pipes into the soaper boxes, requiring 5000 lb. of steam per hour. This work can be done with clean exhaust steam, or it can be done in part by collecting all of the condensation from drying cylinders and pumping it into the soaper boxes, instead of back to the boiler-feed heater. This is merely a matter of comparative expense and ease of control.

To heat the feedwater to 210 deg. fahr., 3500 lb. of steam per hour will be required, this figure being derived as follows: The live steam for processes has been reduced from the former requirement of 22,000 lb. to 15,500 lb., requiring that water be taken from an original source and which may be assumed to have an average temperature of 60 deg. fahr. The remainder of the steam (which will be shown later to be 26,000 lb.) will be made from feedwater which has been collected from the various driers at a temperature of 160 deg. fahr., and this being clean water, it can be returned to the boilers.

The total low-pressure steam uses, then, are 23,500 lb. per hour, exclusive of the steam required to heat the buildings, which, taken

any effect upon the design of the power plant.

To operate this plant 460 kw. of electric energy and 23,500 lb. of exhaust steam per hour will be required. A simple, non-condensing, Corliss, releasing-gear engine, direct-connected to a 500-kva. generator will, between the limits of one-half and full load, develop a kilowatt with 42 lb. of steam at 150 lb. initial pressure and 5 lb. back pressure. A 500-kva. steam turbine will operate at the same steam economy.

The turbine has the advantage of giving oil-free exhaust steam. With some precautions the simple non-condensing engine can be used, the chief problem being to remove the oil from the exhaust steam, through the use of properly designed separators. If the plant is already equipped with a good economical reciprocating engine, it would be perfectly good engineering to keep it in service.

To supply 460 kw. at 42 lb. of steam per kw. will require 19,320 lb. of steam, and 90 per cent of this can be delivered to apparatus that can use low-pressure steam at 5 lb. pressure. This will provide slightly less than 17,500 lb. of steam, whereas 23,500 lb. are required. This is a condition which should be very much sought for. If a set of drying cans using a large amount of exhaust steam is stopped for a time, whereas the power required to drive them represents, with the electric drive, comparatively little steam,

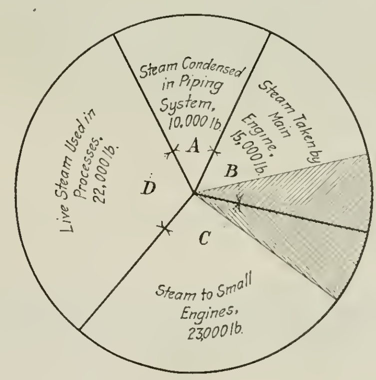

Fig. 1 Heat Distribution in an Engine-Driven Finishing Plant

then there will still be a deficiency of exhaust steam in the whole system, and it is always possible to introduce live steam.

The Coal Saving Effected

In this plant the steam-driven units are confined to one prime mover, and the author would even use a power-driven boiler-feed pump, holding perhaps a steam pump as a reserve unit.

The steam used in this plant, excluding that required for heating buildings, which is a very small amount, totals 43,500 lb.; 23,500 lb. will produce all of the power and low-pressure steam required, 5000 lb. represents condensation, and 15,000 lb. the live steam used direct other than that introduced into the exhaust-steam system. This is a reduction of 26,500 lb. of steam per hour required to operate the plant, and it is easily seen that with an average evaporation of 9 lb. of water per pound of coal over a period of 2700 working hours, this will reduce the coal consumption 4000 tons a year; and this is not the whole of it, by any means.

Reduction of Losses Due to Condensation

Finishing plants do not start up at a specified time in the morning and shut down at a specified time in the afternoon, as do many manufacturing plants. It is the rule rather than the exception that some machines will run overtime, requiring that full steam pressure be maintained on the entire piping system for the benefit perhaps of two or three small engines. It is also the rule rather than the exception that a full steam pressure is maintained on the high-pressure piping system twenty-four hours a day, with the possible exception of Sundays, entailing excessive condensation

losses of more than one-third of the steam which can be accounted for as entering into actual production. With the entire elimination of a large part of the live-pressure steam pipes and a reduction in the sizes of those remaining, not only will the condensation losses be decreased, but it will be possible to shut off the live-steam system entirely when steam at that pressure is not required for high-temperature and boiling operations. Boiling operations carried on at night can be served from a comparatively small live-steam main run directly from the boiler house.

In a certain plant where no printing or dyeing is done, and where the losses through condensation are therefore less than would be found in a plant carrying on all branches of the business, the average boiler load, from 7 o'clock in the morning until 4 o'clock in the afternoon, production being comparatively low, was about 22,000 lb. of steam per hour. For the rest of the twenty-four hours it averaged somewhat more than 8000 lb. per hour. Holiday and Sunday charts in this same plant show about the same amount of water fed to the boilers per hour for the full twenty-four hours. In this case only about one-third of the steam can be accounted for as being directly chargeable to processes.

On another occasion when the plant was somewhat busier, the boiler load was fairly constant at about 30,000 lb. of steam per hour from 7 o'clock in the morning until half past 5 o'clock in the afternoon. From 10 o'clock at night until 6 o'clock in the morning the average rate of feed was 8000 lb. per hour as before.

The maximum boiler load in this particular plant is about 35,000 lb. of steam per hour, so that it is at once apparent that the constant loss of 8000 lb. over twenty-four hours is a very large proportion of the total steam. The remedy for this is to eliminate every foot of pipe which is not absolutely essential and keep steam out of that part of the piping system where it is not needed after the day's work is over.

Influence of Losses on Production Costs

The influence of these constant losses upon the cost of production can be well illustrated by plotting production in yards per week against pounds of coal per yard of cloth finished. Such curves make it at once apparent that as the production increases the amount of coal used per yard decreases at a rapid rate, and probably reaches a minimum when the plant is being pushed to its very limit of capacity. The coal in this case represents nearly the entire mechanical costs, exclusive of repairs, viz., power, heat, light, cost of pumping water, drying and boiling operations, and, in fact, everything which ultimately has to be accounted for in the coal pile. While the adjustable-speed motor can hardly be credited with all of the saving which it has been possible to make in finishing plants, its introduction has made the other things simple of accomplishment. Maximum production on any machine must be the offset to rising labor costs. Finishing machines, operated at varying speeds, are subject to many interruptions, and are started and stopped, or slowed down and speeded up, many times a day. With small engines speeds are rather indeterminate. If a set of driers is slowed down and then speeded up again, there is very little assurance that the speed will be brought back to the maximum permissible at the time, because the eye of the operator is the only speedometer available. With the adjustable-speed motor and its predetermined-speed push-button controller, the running speed is always returned to one definite speed after a slow-down, and a fair degree of assurance is substituted for guesswork.

In some of the processes there are two, and sometimes three, individual machines which have to run in synchronism, the cloth passing through one after the other continuously. With the old mechanical drive the small engine constituted the motive power and the several machines were driven through a series of shafts, bevel gears, pulleys, cone pulleys or Reeves drives, so that the speed could be adjusted to fine limits between the several elements, and then all travel at the same speed.

With the adjustable-speed motor an individual motor can be attached to each element, all operated from one controller, and the speed will be varied uniformly and all elements started and stopped together. This is now the generally accepted method of driving such ranges. If it is desired to operate one element of the range for some particular purpose (as is by no means unusual), then the other motors can be disconnected and the individual machine driven with its own motor.

If the author appears to have been enthusiastic in his presentation of this topic, it is because he has seen the steam consumption of finishing plants reduced to one-half those which previously obtained, and the savings in the cost of fuel pay a very handsome return upon the cost of not only substituting the electric drive but for making all of the other changes in mechanical equipment which could be properly grouped with it.

The Microscopy of Textiles

By FREDERICK J. HOXIE,[1] BOSTON, MASS.

The microscopy of textiles has not been developed to the extent to which its usefulness entitles it. Methods of imbedding, sectioning and staining yarns and cloth must be developed which will hold the material firmly in its original position while the manipulation is being carried on, as the different parts of the textile are in no way connected when sectioned. For example, the sectioning of yarn so as to show not only the relative position of the fibers, but also the location and arrangement of the starch with reference to the fibers. Mounting and photography also present problems requiring special study, with reference to the diffraction of light.

Imbedding. Celluloid solutions are useful for imbedding, but have the disadvantage of requiring complete dehydration of the fibers before they can be successfully applied. This dehydration renders the fibers hard and difficult to cut into thin sections. Paraffin has the disadvantage of being somewhat opaque and showing crystals if it is not removed before the sections are used for photographing. If it is removed, great care must be exercised to keep the fibers and starch in their original positions. Gelatine and glue, which are miscible with water, have useful possibilities, as the water in the colloidal material of textile fibers is essential to their physical and chemical structure and its removal may make important changes in the appearance of this structure with reference to the diffraction of light as well as its behavior with reference to imbedding media. Freezing may be serviceable, but, so far as the author knows, it has not been much used in connection with textiles.

Sectioning. A specially arranged microtome is desirable in order to cut the thin, smooth sections which are necessary for successful photography. Thick sections do not photograph well, as the difference in the refraction of the materials causes a lens action which confuses the detail, particularly in high-power work. Considerable study and experience is necessary in the selection and sharpening of the razors in order to secure good thin sections.

Photographing. As an auxiliary to successful micrographic study, photography is practically necessary as it not only keeps an accurate record of the observations but facilitates comparison of several similarly treated specimens. In order to carry out microphotography successfully, considerable study must be given, not only to common photographic methods such as exposure and development but also to the use of colored light by means of color screens or prisms in order to get the required detail and contrast. In many cases red light, while incapable of giving the fine detail of shorter-wave-length light, has the advantage of giving a stronger contrast which is important in demonstrating surface characteristics of goods or fiber. This applies particularly to photographs of cloth at moderate magnification (less than 100 diameters). Such micrographs are particularly useful in showing defects in weaving and dyeing. In such photographs the angle at which the light is applied is important in bringing up characteristics of the surface of

[1] Engineer and Special Inspector, Assoc. Factory Mutual Insurance Cos., Boston, Mass. Mem. Am.Soc.M.E.

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cloth, especially when mercerized, the appearance of silk.

With the use of red light it is of course necessary to use panchromatic plates with either special dark-room illumination or no light at all in the dark room.

The arrangement of the camera on the microscope where much high-power work is to be done is of special importance. The author has a camera about twelve feet long with the ground glass in the photographic dark room. Three rods extend from the side of the ground glass to the microscope with handles conveniently located in the dark room. One of these is attached to the fine focusing screw of the microscope, the other two to the mechanical stage so that the specimen can be readily moved back and forward and up and down, the focus being adjusted while the operator remains before the image on the ground glass, which can be comfortably examined and adjusted with external light excluded from the dark room. Up to 1000 diameters photographs can be made with reasonable success with no eyepiece, but the author has recently been making experiments with an eyepiece and magnification up to 4000 diameters. With such high magnification it is

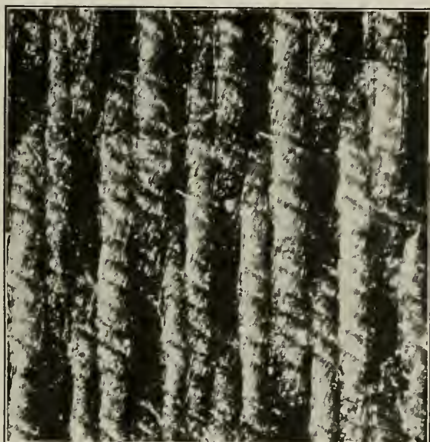

FIG. 1 VENETIANS FINISHED WITH A SCHREINER CALENDER, SHOWING THE DIFFERENT ARRANGEMENT OF THE TEETH WITH REFERENCE TO THE LINES OF THE FIBERS IN ORDER TO GET DIFFERENT FINISHING EFFECTS

difficult to get satisfactory detail, but it may be possible to improve this by using short-wave-length monochromatic light. This, however, makes it difficult to focus the image on the ground glass, as it is difficult to get such light of sufficient brilliancy to clearly impress the eye. A powerful nitrogen tungsten light with condensers makes a convenient illumination.

A useful application of the microscope to the study of cloth is the observation of the effect on the appearance of the goods caused by the uniformity of twist as well as the absolute twist. This is clearly shown by the angle at which the fibers cross the direction of the yarn. This gives a good method of direct measurement of twist if it is not so small as to make the yarn flat and, in this case a fair estimate can be made by making a proper allowance for the flatness.

Very few stains have been studied with reference to textiles. Iodine is commonly used for showing the starch. Polarized light and common textile dyes doubtless have possibilities in studying the inner structure of the fiber. Some common dyes penetrate the fiber only slightly and the yarn scarcely at all, thus causing decided variations in the appearance of the finished goods. This is clearly apparent in photographing dyed yarn sections at high magnifications. Another practical application of the microscope to cloth finishing consists in observing the effect of the angle of the Schreiner teeth on the appearance of the goods and irregular mercerization from various causes, clearly shown in sections.

which are now a matter of mystery can, by photomicrographic records, be brought into the realm of fact, and much of the chance in textile manufacture which has possibilities of expensive misunderstandings can be eliminated.

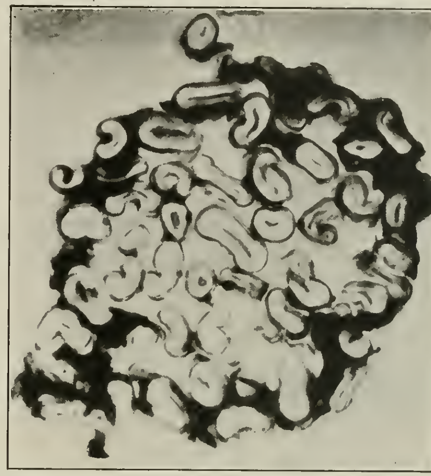

FIG. 2 SECTION OF 120-WARP YARN, SHOWING THE PENETRATION OF STARCH USED FOR SIZING

The general practical value of textile microscopy should cause the technique to grow rapidly and should bring about lively interest

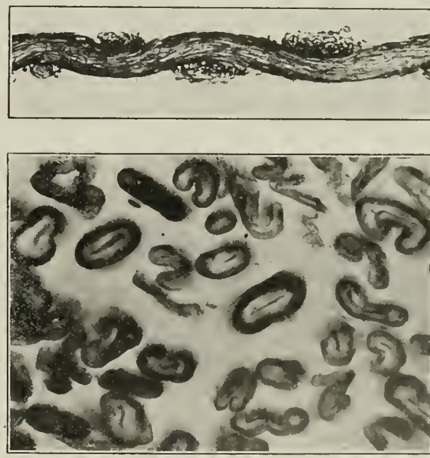

FIG. 3 SECTIONS OF RED COTTON YARN DYED WITH PARA NITRANILINE, SHOWING THE MORE COMPLETELY DYED FIBERS ON THE OUTSIDE OF THE YARN AND THE LESS COMPLETELY DYED FIBERS INSIDE, ALSO VARIATION OF PENETRATION OF DYE IN INDIVIDUAL FIBERS

and profitable discussion which will doubtless center about schools and colleges in which the study of textiles is carried on, and can very properly be developed in the botanical departments of colleges where such departments already exist.

Figs. 1 to 3 give some idea of a few of the possibilities in the application of microscopy to the problems of the textile manufacturer and finisher.

Winding as Related to the Textile Industry

Modern Methods Employed in the Preparation of Filling Yarn and the Saving in Weaving Costs Resulting from Their Employment

By GEO. W. FOSTER,[1] PROVIDENCE, R. I.

OUTSIDE of the electrical field, winding is almost exclusively a textile process of intermediate or preparatory form, and it can be definitely classified as an art of transferring fibrous, thread-like material from a small-capacity container to one of determined form having larger capacity, the fundamental idea of such transfer being to provide long lengths of inspected yarn or thread of other intermediate or final processes, in order to establish a more effective and continuous operation of the same.

The science of winding rests in the principle of ratio between a revolving element, as represented by a package, and a reciprocating element, as represented by a traverse guide, and it is through establishing a correct speed relationship between the two elements that yarn or thread is laid in binding spirals to form a self-sustaining body of material.

While winding was understood in England fifty years ago, yet it could hardly be classified as an art until the year 1890, at which time we started to build winding machinery in this country, and it can be truthfully claimed that real development in the art and its application to the textile industry date from that period, to the credit of American engineering genius and American progressiveness.

Types of Winding Machines

Winding can be classified under two heads, and is represented by two types of machines, one known as the friction or drum-driven (where the package is revolved by surface contact with a cylinder or drum), and the other as positive-driven (where the package is revolved by force applied to its axis). The difference between the two types lies principally in the manner in which the yarn or thread is laid throughout the package, it being obvious that in one case, where the package is frictionally driven, the ratio between the package and the traverse guide is constantly changing, with a resultant change in angle of the thread being laid, while in the other case, where the package is positively driven, the ratio between the package and the guide remains constant, which results in a continuous winding precision of predetermined form.

In the foregoing the author has simply endeavored to outline the art in general. What is of greatest concern is the relation of the art to the industry, and its manifold applications for economic gain.

Winding Yarn for Outside Consumption

Winding machines were first developed for that branch of the industry manufacturing single and plied yarns for outside consumption, and second, for that branch of the industry where the wound product is used as a supply to improve qualities and cheapen costs of subsequent processes within the mill.

Conical packages may be taken as a concrete example with which to illustrate the entire field of winding which applies to that branch of the industry making yarns or threads for outside consumption.

In the early days knitting yarns were spun on mule frames into cop-like form, it being the practice to pack in a case five or six thousand of these small cops for shipment to the hosiery and underwear trade. As a cop weighing only three to four hundred grains was too small and uncertain a supply to use direct, the customer was obliged to rewind the yarn he had purchased on to what was known as a bottle bobbin, in order to get long lengths of material for his knitting machines.

This proved to be a very unsatisfactory and expensive method, for not only did it call for numerous handlings of many small containers, but the very handling and shipping of so delicate a product tended to destroy its form and usefulness. The inevitable result was a considerable loss in valuable time and valuable material, which resulted in friction between manufacturer and consumer, as to which one should stand the loss.

Today the manufacturer takes his yarn from mule or frame direct to a winding machine where the yarn from fifty to a hundred spun cops or bobbins is pieced together to form one continuous inspected thread. The conical package into which this length of thread is formed is then carefully wrapped and sometimes sealed in paper, compactly packed in a case and shipped to the knit-goods manufacturer. The customer opens his case, draws off the paper wrapping, and finds instead of a mutilated cop a perfectly formed supply of great length, which can immediately be utilized for his requirements, there being no waste and no handling process. This amounts to an economic gain; it cannot be otherwise.

For this branch of the industry many various types of winding machines are being made to wind nearly every conceivable kind of material of fibrous or thread-like nature; cotton, worsted, woolen, linen, silk (real and artificial), jute, sisal, hemp, asbestos, paper, braid, tape, and even human hair from China representing some of the materials wound for commercial purposes or outside consumption. The product of the machines that wind these various materials vary from a small quill of fine weaving silk weighing possibly 250 grains, to a parallel-tube package of ½-in.-diameter cord or rope weighing 70 lb.

As the author sees it, the most interesting phase of winding lies in its functional relationship to subsequent processes in yarn and cloth manufacture, or in other words, a direct application of the art for inside absorption rather than outside consumption. The development of winding as an art for this branch of the industry has been no simple matter, but a long up-hill fight, for it has not been a question of meeting outside commercial demands which a mill agent or treasurer can readily understand, but rather a question of coping with inside conditions which are always difficult to change in the face of precedent, practice and self-satisfied management.

One of the greatest engineering problems rests in the ability of our textile engineers to convince mill agents and mill treasurers (particularly the latter) that "there is as much in picking up as there is in digging," and that the longer road to the objective is oftentimes the more attractive and profitable; furthermore, that applying engineering principles to industry for economic gain as well as material profit is much more creditable than gaining these profits through adjustments with labor and strictly commercial activities.

It is not the intention of the author to convey the impression that winding as a preparatory process will effect the millennium in the textile industry, for it is only one issue to the point; however, it has been established that winding processes substantially improve qualities, reduce costs and make jobs attractive for men and women who work and buy.

The three elements in a weaving process are the machine, the material and the human, and it is the coördinate relationship of the three that directly affects production, cost and quality.

In weaving, two elements are embodied, the warp and the filling. Warp yarns formerly were, and now are, prepared in long lengths for weaving, by first spooling, then warping, and finally slashing, thereby presenting to the loom thousands of yards of thoroughly inspected material, representing one of the two elements referred to. The other element—the filling—has only recently been given the same careful preparatory treatment accorded to the warp, the practice in the past having been to perpetrate the error avoided in the warp by injecting into the filling process two or three hundred grains only of uninspected material, which by the law of averages and proportion is negative to the warp element with which it is to be mated.

To offset as far as possible this unequal condition and inconsistent practice, a positive-driven type of winding machine was developed to wind filling with compact precision from mule cops or

[1] Universal Winding Co.

Paper presented at the Spring Meeting of the Textile Division of The American Society of Mechanical Engineers, Providence, R. I., April 12, 1921. Slightly abridged.

frame bobbins on to a paper or wooden container holding two or three times the amount of yarn usually presented to the loom, the process of winding improving the filling, even as the preparatory processes improve the warp, with the result that both material elements are presented to the loom in maximum lengths of equal completeness.

In order that it may be fully appreciated just how this treatment of the filling affects the machine and human factors in the weaving process, and its ultimate effect on the two outstanding economic problems previously referrred to, a comparison of past practices with present methods will be made.

Past Mill Practices and Present Methods Compared

In past mill practice the amount of yarn wound on a mule cop or frame bobbin seldom exceeded 350 grains, and if the mill were weaving 40-in. sheeting, 80 x 80 square, 30s warp, 40s filling, the loom running at 160 picks per minute, the amount of 40s single filling consumed per loom per week would equal 14 lb.

Under these conditions a weaver would be given eight plain looms to run, the total job consuming 112 lb., or 704,000 grains of filling, every 48 hours. Dividing the total grains consumed by the grains wound on one cop or bobbin, proves that the eight looms must stop 2240 times weekly for filling changes, and that the weaver must charge and change shuttles an equal number of times, providing the yarn on every cop or bobbin runs its entire length without breaking. As a matter of fact, the total number of interferences would equal 2400 instead of 2240, due to imperfections in the yarn, sluffing from the containers, and the amount of material usually left on the cop or bobbin butt.

By direct comparison, this mill, winding and preparing its 40s single filling, would present to the loom a bobbin containing 875 grains, or 4200 yd. of inspected material, with a result that the eight looms would only stop 896 times instead of 2400, the weaver charging and changing shuttles 896 times against 2400 in 48 hours, there being no additional interference through imperfections, sluffing, etc. The difference in loom stoppages between the two methods equals 1504 interruptions weekly, amounting to a considerable saving in machine and hand time.

Ordinarily, seven or eight seconds is ample time to charge and change a shuttle with bobbin filling, and 14 to 16 seconds the time to charge and change cop filling; however, this does not hold true if the weaver is occupied mending warp, and it is quite possible for looms to be stopped minutes instead of seconds if the weaver is not in a position to make the filling replacement. In this connection it must be borne in mind that 875 grains of inspected filling will run 22 consecutive minutes in a loom weaving 40-in. goods at 160 picks per minute; consequently, when a weaver is mending warp the remainder of the job is more likely to be running.

If 1504 represents the actual reduction in the filling changes, and eight to sixteen seconds the time lost per change, figures prove that 3 hours out of 48 hours would be saved, as compared with frame-spun filling, and 6 hours as compared with cop filling. While this saving fairly represents the additional time allotment for operatives, it does not represent the complete saving in machine time. For illustration, saving 3 to 6 hours of the operative's time, plus the greater continuity of loom motion, represents the improvement for estimating increased loom efficiency.

Saving in Machine and Operative Time by New Methods

In actual mill practice this saving in machine and operative time results in an increased loom efficiency of 10 to 20 per cent, as compared with frame- or mule-spun filling, which is equvialent to adding that percentage of looms to a mill equipment without initial cost or yearly operating expense.

With long lengths of prepared filling loom jobs are increased from 50 to 100 per cent, depending on the style of goods being woven. On the 80 x 80 style sheeting previously referred to, a weaver running twelve looms would only charge and change shuttles 1344 times weekly, as against 2400 times on eight looms with a 350-grain spun supply.

Under this improved condition, a weaver running twelve looms would only charge and change 36 shuttles per hour, less than 10 per cent of the 60 minutes being occupied in this respect. Furthermore, it has been definitely determined that the higher loom efficiency previously accounted for is not lost when the job is increased in reasonable proportion to the saving in hand time. Increasing a loom job 50 per cent naturally increases operative productivity in like proportion, plus the higher efficiency of each loom, figures and facts proving that the physical burden, or hand time, on the 12-loom job is considerably less than the burden or time on the 8-loom job, where continuous filling changes are constantly interrupting both machine and operative.

In the foregoing the effect of a preparatory process on the machine and operative factors in the weaving process has been discussed and it now remains to show how prepared filling improves quality and saves waste in materials.

As far as improvement in quality is concerned, it is obvious that the fundamental principle in cloth construction calls for the greatest continuity of loom motion that it is possible to establish. Mispicks, thick and thin places, loops and cracks in the selvage are the results of filling changes which interrupt the harmony of loom motion and it follows that any method effecting a 60 per cent reduction in these changes must operate for refinement and quality. Furthermore, slubs, bunches, and soft and thin places in yarn are likely to be woven into the cloth unless removed in a preparatory process.

Filling waste made in weaving is the source of enormous losses in the textile industry, amounting to millions of dollars annually. The author ventures to say that when mule-cop filling is used 8 oz. of waste represents the loss per loom per week, and when frame bobbin filling is used 4 oz. would be a conservative estimate.

Few mill men like to admit their losses in this respect, and it is difficult to convince them that this waste represents a loss considerably in excess of cost value.

During the latter part of the war, when 100s single yarn was selling for $4 per lb., a certain mill weaving average 100s single filling on mule cops was making, according to their waste account, 7 oz. of cop waste per loom per week, and as they operated 4000 looms, the total loss amounted to 87,500 lb. per year. If the cost value of 100s single yarn equaled $2.50 per lb. and the value in cloth equaled $4.20 per lb., this mill lost $218,750.00, plus a possible profit of $148,750.00, totalling $367,500.00; deducting the amount of $10,500.00 received for waste, the net loss, as the author prefers to figure it, was $357,000.00 per year. It is fair to assume, however, that 87,500 lb. of waste cannot be collected and salvaged without considerable expense.

Similar losses, by degree, appear in all weaving processes, and are caused by constant filling changes brought about through short lengths of imperfect and impaired material being injected into the process, and it will be generally agreed that this fairly represents an economic loss.

When filling yarns are wound and prepared for weaving, one-half of one per cent waste is made in the winding process, but no waste whatsoever is made at the loom; consequently valuable materials are woven into cloth for a greater turnover.

When filling yarns are spun for a winding instead of a weaving process, it is usually the practice to spin a greater amount of material on the cop or bobbin by either changing the builder motion on the mule, or by changing the size of ring on the frame. Taking the 40s single filling previously referred to as an example, past practice would spin this count on a $1^3/_8$-in. ring, each bobbin containing 350 grains of material.

The present method would be to spin this number on a $1^5/_8$-in. ring, each bobbin containing 875 grains, or an amount equal to the quantity wound for the shuttle. This equal condition would establish a simple transfer process at the winder, cheapening the cost of that operation. It would also effect a 2 per cent increase in spinning efficiency, due to the reduction in doffing changes, and it follows that bobbin equipment and bobbin transfer changes would be reduced all along the line by the lesser number of containers involved.

As the author sees it, the ideal combination for spinning 30s single warp and 40s single filling for 80 x 80 square cloth, would be to equip all spinning frames with $1^5/_8$-in. rings, warp bobbins and filling wind throughout. This would insure great flexibility of spinning equipment, and as it is claimed, the application of filling wind builders to warp frames would insure a 5 per cent increase in spinning production as compared with past practice.

Under this arrangement bobbins containing approximately 875

grains of warp yarn would be delivered to the spooler, there to be inspected, pieced in long lengths and wound for the warping process. (Incidentally, production at the spooler would be increased at least 25 per cent by the overend delivery from filling wind warp bobbins.)

At the same time, bobbins containing 875 grains of filling yarn would be delivered to the filling winder, there to be inspected, pieced in long lengths and compactly wound for the shuttle. Under these conditions, and only so, can warp and filling yarn be truly mated in a weaving process.

Application of Principle of Preparation to Automatic Weaving

While the author has so far applied the principle of preparation to plain loom weaving, it is not be to inferred that the proposition has less value for looms where the filling is automatically supplied.

Applying a similar treatment to the filling process in automatic weaving, it is interesting to estimate that a weaver running 16 looms with a 350-grain spun supply, must magazine weekly 4800 containers, the automatic features being obliged to function an equal number of times in the transfer of these bobbins from magazine to shuttle. By direct comparison, with 875 grains of wound inspected filling on a bobbin, a weaver would only magazine 1800 containers per week on the 16-loom job.

It is interesting to estimate that if 875 grains of 40s single filling runs 22 consecutive minutes in a loom, a magazine of 24 bobbins would constitute a day's supply. It is obvious that the amount of "feeler" waste made in a week would be reduced in proportion to the difference in bobbin changes; consequently the expense of reclaiming the waste from the bobbins would be lessened in like degree

Bobbin equipment and bobbin replacement expense would be greatly reduced when one bobbin contained 875 instead of 350 grains of material.

It is not contended that rewound filling would effect any appreciable increase in automatic loom efficiency as compared with frame-spun filling; there would, however, be a considerable saving in the hand time, which could be utilized for increasing operative productivity.

As compared with mule-spun filling, it is contended that a preparatory process for automatic-loom weaving will effect all the advantages heretofore outlined in the foregoing plain-loom analysis. Fixing charges and repair expenses on looms, either plain or automatic, are bound to be lowered through a 60 per cent reduction in shuttle or bobbin changes.

A recent application of the preparatory process to worsted weaving brought out some very interesting facts. High-grade worsted serges are usually woven on 3 & 1 box looms, it being the practice to constantly mix the filling by changing the shuttle every other pick, in order to prevent a wavy appearance in the fabric, due to slight variations in the filling yarns. Until recently the practice has been to place in each of the three shuttles a spun bobbin containing approximately 400 grains of filling, totaling 1200 grains in the three shuttles. As the looms were wide and the filling rather coarse, interruptions for filling changes were numerous; consequently, a weaver could only run two looms, while the efficiency of the looms seldom exceeded 80 per cent.

When this proposition was taken hold of, it was found that the same shuttles would easily accommodate a wound bobbin containing 1200 instead of 400 grains of filling (providing this amount of material was compactly wound); consequently, each loom is supplied with 3600 grains, over half a pound of filling yarn in one charging operation, with the result that a weaver now operates six looms instead of two at an efficiency of 95 per cent instead of 80 per cent. The whole situation is pregnant with interesting details.

No figures have been submitted as regards the cost of filling preparation, neither have any of the enumerated savings been reduced to dollars and cents; for in view of the fact that many mills have adopted the preparatory process outlined, and the fact that the method calls for so many readjustments all along the line, the author questioned the advisability of including in this paper any values of a definite nature. He would say, however, that the cost of filling preparation, like the cost of warp preparation, is more than absorbed by the economies superinduced through its use.

In conclusion, he would emphasize the fact that serious competitive conditions will have to be met from many quarters unless the restrictive rules of working, which necessarily limit output, are neutralized by the adoption of such legitimate aid as may be secured in producing quality and volume.

Utilization of Low-Grade Cotton and Staple Waste

By ELWIN HOLBROOK ROONEY,[1] PROVIDENCE, R. I.

In an average American cotton crop 50 per cent will be low middling to strict middling, about 15 per cent better than strict middling, while 35 per cent will be below low middling. About one-half of this low-grade cotton is unspinnable unless it can be cleaned. The other half, although spinnable, has been considered so unprofitable due to the loss in waste, the low efficiency of production, and the character of the finished product that it has been thought better to purchase a higher grade of raw material.

The total annual production of this low-grade cotton amounts to three to four million bales. In addition to this there are one-half to three-quarters of a million bales of staple waste. By proper utilization of this low-grade cotton and waste we could increase our supply for standard goods, such as osnaburgs, prints, heavy ducks, carpet warps, twines, etc. by about 20 per cent, or enough to supply more than five million spindles.

There is no excuse for a mill to class its card strips and comber noil as waste, because this waste, so-called, can be cleaned by machinery which separates the cotton from foreign matter, reclaims the stronger fiber, and raises the grade up to that of the original bale. If this reclaimed waste is properly mixed with cotton in a Butler mixer, it cannot be detected in numbers up to and including 40s count. This saving may equal $7^1/_2$ to 10 per cent of the total investment.

The utilization of the low-grade cotton is of considerable financial advantage, as one cent saved on the purchase price is equivalent to $2^1/_2$ per cent of the investment in the spinning plant, based on the prewar cost of about $25 per spindle. Some plants in 1920 made profits from 5 to $7^1/_2$ cents per lb. by cleaning this cotton.

The problem of using this low-grade cotton and staple waste is divided into two parts; first, that of properly cleaning it, and second, of mixing it. If improperly cleaned and poorly mixed, it will spin very badly, and the production will be low. However, machinery is being built today in this country which can properly clean and reclaim any low-grade or staple waste made from cotton above ordinary grade.

Today there are several theories in vogue with reference to cleaning cotton. One is that of trying to develop a modified air blast in combination with Crighton openers, automatic feeders, condensers and trunk systems. Another is known as the reginning process, and still another the Gordon cleaning system. Beating may weaken the fiber, but there is no danger of this in blowing. However, it is impossible to clean cotton with air blasts, and the author believes it must be done by machine. If this is so, a card licker-in or comber half-lap injures the fiber less than any other method and has been used more widely and successfully in cleaning cotton than any other. It is the only one which has been successful in separating foreign matter, such as leaf, mote, etc., from the fiber.

There is a great deal of low-grade cotton in ordinary grades running down into what is known as type cotton, storm cotton, bollies, gin cuts, reds, blues, etc. Much of this cotton is strong in

(Continued on page 606)

[1] Treasurer, Gordon-Hay Company, Providence, R. I.

Condensed from a paper presented at the Spring Meeting of the Textile Division of The American Society of Mechanical Engineers, Providence R. I., April 12, 1921.

Water Treatment for Boilers

Various Methods of Water Softening—Treatment for Excessive Concentration of Soluble Salts in the Boiler—Corrosion of Boilers and Economizers Due to Decomposition of Organic Compounds at the High Temperatures Accompanying Present Steam Pressures and Superheats, etc.

By JULIAN S. SIMSOHN,[1] PHILADELPHIA, PA.

THE subject of water has been generally regarded in the past as a problem for the chemist, so that the difficulties in its use for boiler purposes have hitherto been passed to him, and, based on his analyses and recommendations, chemicals are added in an effort to prevent scale and corrosion, with more or less success.

There were engineering features, however, that should have been considered—questions of boiler circulation, variations in operating conditions, temperatures and boiler pressure—and it was the realization that all these are necessary in the consideration of water for boilers that has placed the problem outside the realm of the chemical laboratory and over into the field of the chemical engineer.

Since the earliest history of boilers, scale formation has always been a source of difficulty and waste, but with low ratings the scale accumulation was quite limited, and that which did form was largely of a porous nature and quite easily removed. Its insulation value made its appearance felt on the coal pile, but the low cost of fuel up to comparatively recent years gave rise to the attitude that the scale situation was not of major importance in power-plant practice.

Modern operating conditions, however, have created new considerations, and high overrating of boilers and intense furnace temperatures, together with the high cost of fuel, have placed water among the important factors in the economical operation of the power plant.

Composition and Properties of Water

From the chemical standpoint water is a colorless, tasteless liquid which is a compound of two parts hydrogen and one part of oxygen, by volume. The nearest approach to it in nature is in the form of rain, which is the condensation of vaporous clouds. As it falls from the clouds as rain it dissolves the atmospheric gases, oxygen and carbonic acid, and, gathering itself together in streams and rivers, it makes manifest its great erosive powers and solvent qualities. It is this rain water with approximately 15 cc. of carbonic acid and 30 cc. of oxygen per gallon that is slowly dissolving away the bedrock of the Schuylkill River, and in such quantities that in the 150 million gallons of Schuylkill water which Philadelphia uses daily, there are more than 50 tons of this rock invisibly moving through the city mains, with a proportion for each boiler. A typical analysis of filtered Schuylkill River water is as follows:

	Parts per Million
Magnesium carbonate	23.0
Calcium carbonate	1.0
Calcium sulphate	66.5
Silica	6.4
Iron oxide and alumina	2.0
Incrusting Solids	98.9
Sodium sulphate	9.8
Sodium chloride	8.2
Organic and volatile matter	5.1
Non-incrusting Solids	23.1
Total Solids	122.0

The mud in the raw river water has been removed by filtration so that suspended solids are not shown in this analysis. The temporary hardness, namely, the carbonates of magnesium and calcium, is represented by only 24 parts per million, while the permanent hardness, namely, the calcium sulphate, is present in much larger quantities. It is important to realize that in most filtration plants alum or aluminum sulphate is utilized in flocculating and coagulating the finely divided particles of mud. While this naturally improves the physical characteristics of the water and permits the tap supply to be clear and colorless, it nevertheless has a very marked effect on the water for boiler use.

Aluminum sulphate itself is a soluble salt and its efficacy as a coagulant depends upon its conversion to aluminum hydrate, the flocculent precipitate, in the following manner:

$$Al_2(SO_4)_3 + 3Ca(HCO_3)_2 = 2Al(OH)_3 + 3CaSO_4 + 6CO_2$$

Therefore, if an analysis of unfiltered river water be compared with an analysis of the same water after it has passed through an alum filter, it will be seen that, though the total hardness remains the same, the permanent hardness will be greater in the filtered water and the temporary hardness will be correspondingly reduced.

The Removal of Temporary Hardness

Temporary hardness can be largely reduced by boiling the water for a few minutes, which will render it more or less opaque; on cooling, a white precipitate will be formed, consisting of a mixture of carbonates of magnesium and lime almost insoluble in hot water. Permanent hardness (sulphate of calcium), however, is unaffected by heat and forms a dense, hard scale difficult to remove.

Therefore, the larger the amounts of alum added at the filtration plant, the more complex becomes the feedwater problem. It is far preferable for plants operating on river fronts to filter their own supply than to introduce into their boilers water with high permanent hardness with its increased scale-forming qualities and correspondingly high cost of chemical treatment. Well waters are usually harder than river waters.

It is not always practical or feasible to depend upon a feedwater heater for the removal of temporary hardness, for the same effect can be obtained chemically by the addition of either caustic lime or soda, which absorb CO_2 as shown by the following formulas:

$$Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$
$$Ca(HCO_3)_2 + 2NaOH = CaCO_3 + Na_2CO_3 + 2H_2O$$

Neither heat nor caustics, however, have any effect on the sulphate or permanent hardness, and the precipitant for the sulphates of lime and magnesia is soda ash, or sodium carbonate.

Various Methods of Water Softening

The oldest form of water softening, i.e., the Clark soda-lime process, depends upon the removal of the temporary hardness by means of lime in accordance with the reactions already discussed and the removal of the sulphates in accordance with the following formula:

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

The outgrowth of this principle is the modern chemical water softener, which is nothing other than an external settling tank with such mechanical improvements as to permit suitable means of mixing the chemicals and facilitating sedimentation.

In certain cases the discontinuous principle is used, in which the water is permitted to react with the chemical by standing until the reaction is completed. The precipitated lime and magnesium are allowed to settle and the supernatant softened water drawn off. In other cases the continuous principle is used, where the water and chemical enter at one point and the precipitation takes place along the path of the water.

The completion of any chemical reaction depends upon two factors: temperature and excess of the precipitating agent. In other words, 10 per cent excess soda ash will soften the water much more rapidly than a 5 per cent excess. Further, with any definite amount of soda ash the reaction will be much more complete at 200 deg. fahr. than at 60 deg. in the same length of time. We may expect to find the use of heat, particularly when exhaust steam is available, of decided advantage in water softening (see solubility curves, Fig. 1).

[1] Consulting Chemical Engineer.

Presented at a meeting of the Philadelphia Section of The American Society of Mechanical Engineers, January 25, 1921. Slightly abridged.

If, therefore, at 200 deg. satisfactory results can be produced with less excess of soda ash, the hot process is advantageous in not only cutting down cost of chemicals used, but also in preventing a more rapid excessive boiler concentration. In very hard waters with, say, 10 grains of lime per gallon and upward, an external treatment is always advisable, but there are many cases where chemicals could be introduced directly into the feedwater heater or the suction of the pump and produce very excellent results with practically no cost for installation. For example, the Delaware River water with about 3 or 4 grains of lime per gallon does not offer much field for the external water softener, which under the best circumstances could only remove about half of the hardness.

Here is the history of boiler cleaning on a 700-hp. boiler at the power station of one of Philadelphia's public utilities:

Aug. 10, 1914	bored 14 rows—entire boiler for inspection
Sept. 23, 1914	bored 2 bottom rows
Dec. 19, 1914	bored 2 bottom rows
Jan. 31, 1915	bored 2 bottom rows
Mar. 12, 1915	bored 2 bottom rows
Apr. 18, 1915	bored 2 bottom rows
May 23, 1915	bored 2 bottom rows
June 30, 1915	bored 2 bottom rows

Aug. 30, 1915, finished boring 336 tubes and 24 nipples. Time consumed, 176 hr.; weight of scale taken out of boiler, 708 lb.

Personal follow-up treatment of boiler feedwater began March, 1, 1916. No mechanical softener was used and chemicals were fed by gravity into the feedwater heater.

Sept. 9, 1916, finished boring 336 tubes and 24 nipples. Time consumed 143 hr.; weight of scale taken from boiler, 258 lb.

Sept. 20, 1917, finished boring 336 tubes and 24 nipples. Time consumed, 21 hr.; scale removed, 92 lb.

Oct. 14, 1918, boiler inspected by Hartford inspector and found in good condition. No tubes bored in 1918.

Oct. 30, 1919, boiler inspected by Hartford Inspector and found in good condition. No tubes bored in 1919.

Oct. 25, 1920, boiler inspected by Hartford Inspector and found in good condition. No tubes bored in 1920.

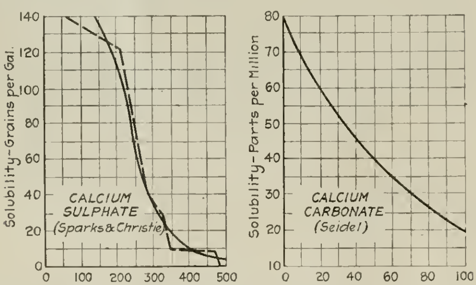

Fig. 1 Temperature-Solubility Curves for Calcium Sulphate and Calcium Carbonate

Prior to March 1, 1916, besides boring the entire boiler annually the two bottom rows were turbined at intervals of approximately six weeks, in spite of the fact that excessive amounts of caustic and soda ash were being used.

Since March 1916, by the use of proper precipitating agents and by varying both the quantity and quality of chemicals to meet variations in the analysis of the raw water, the percentage of returns and other operating conditions, the record has been one of constant improvement with no turbining during the last three years. Such results can only be obtained with the complete coöperation of the chief engineer and a strict adherence to the formulas prescribed and the blowdowns and refills advised.

The so-called "exchange" principle of water softening is based upon a remarkable discovery by Dr. Rudolph Gans, who found that when hard waters are passed through zeolites they are changed in character and become softened. These zeolites are sodium-aluminum silicates and are found in nature as such and can be closely imitated by synthetic compounds. A number of these artificial substitutes are claimed to be superior to the natural zeolites, but this is still a matter of dispute.

All, however, operate on the same general principle, namely, the exchange of lime and magnesia salts for sodium. The magnesia and lime sulphates are converted by this method into sodium sulphate as in the Clark process, but the temporary hardness or bicarbonates of lime and magnesia become sodium bicarbonate. This conversion, while completely eliminating all hardness to the zero point, is of extreme importance in boiler operation, since a certain amount of the carbonic acid from sodium bicarbonate is eliminated by the heat of the boiler and the remaining sodium carbonate concentrates by evaporation.

In waters of high temporary hardness it is necessary to remove a considerable portion of this temporary hardness by preliminary treatment with lime, which makes the process then a combination of the Clark and zeolite processes.

Another absolute method for scale prevention depends upon the process of distillation. It is carried out in the multiple-effect evaporator, making use of the familiar principle of conserving the latent heat of steam and utilizing the steam from the first effect to boil the water in the second. This method has found considerable use in plants where the make-up water is very small and where the elements of expense need not be considered.

In all these cases, however, expense, either of installation of operation, must not be permitted to be the governing factor in the selection of suitable water-softening methods, and the fact that a zeolite softener might be satisfactory and advisable when operating on Delaware River water, is no indication that it should be applied in the treatment of the boiler condition where Schuylkill water is the source of supply.

The complications which arise in the solution of the water problem and the variations which occur in the operation of any plant make it evident how hopeless are boiler compounds in solving the difficulty. The patent-medicine principle is just as incorrect when applied to boiler feedwaters as it is in the healing of human ailments. Many materials used in these boiler compounds are harmful and injurious to the metal and some often guaranteed innocently by their manufacturers to be without effect on boiler metal, do in certain plants where operating pressures are high, corrode the metal and produce serious after-effects.

Deposits on the Boiler Surfaces and Concentration of Soluble Salts

Carbonate of lime when precipitated under atmospheric conditions by heat or by chemical precipitants is a white amorphous precipitate. On standing it becomes crystalline in form, much the same as the mineral calcite, and in the boiler it becomes denser and forms a sludge. Part of the precipitation, however, apparently comes down in the nature of the crystalline form of the mineral aragonite, in which form it is represented in a carbonate of lime boiler scale.

The sulphate of lime becomes a hard, solid, compact and non-porous scale and is usually mixed with variable proportions of the carbonate. Most magnesia salts are finally converted by boiler temperatures into the hydroxide, which then floats to the top together with the carbonate of lime and is carried up with the steam into the steam pipes, engines and turbines. The soluble magnesia content of water is particularly hard to remove since it reacts more slowly with the usual precipitants.

This partially explains why the *percentage* of magnesia in the treated water is a greater *percentage* of the total hardness than in the untreated.

It is useless to attempt to make any statement as to the insulating value of scale in terms of its thickness, and the percentages of fuel losses as indicated in most charts of this character are likely to be exaggerated. It can be stated, however, that hard sulphate scales offer considerably more resistance to heat transference than a carbonate formation. Since, however, the average run of scale represents a mixture of sulphates and carbonates in varying proportions, there can be no definite figure placed on its insulation value.

The soluble salts in the boilers are those which are not precipitated by boiling, and are represented by chlorides and nitrates of lime, together with the sulphates, chlorides and nitrates of magnesia and sodium. Many of these salts are far more soluble in cold water than in hot, and since they are not volatile and do not pass over with the steam, their concentration in the boilers is worthy of attention.

Treatment for Excessive Concentration

It is an easy matter to figure from the analysis of the feedwater and the number of pounds of evaporation just what concentration is reached at the end of any particular time. It is impossible to fix any definite limits as to just where the danger point lies since there are so many factors to be considered, but the consensus of scientific opinion is to the effect that with a 200-lb. working pressure there is no danger of deposition of sodium sulphate or chloride if the concentration is kept below 1000 grains per gallon.

The effective treatment for excessive concentration is blowdowns or the emptying and refilling of boiler with fresh water. Under all circumstances, however, intelligent use of blowdowns can be made to mean much in the saving of hot water, since the heat units with the present price of coal are worthy of every effort of saving.

A fairly accurate idea of the concentration may be obtained if an analysis of the raw water is at hand by knowing the evaporation per hour in gallons, the contents of the boiler, and the number of steaming hours. The author has in many instances checked up the analysis of salts in boilers with the theoretically calculated amounts and found the former figures to differ but slightly from the theoretical.

Corrosion of Boilers and Economizers

While the actions thus far considered deal with the deposition of soluble and suspended solids in the boiler, there is another action which may proceed alone or simultaneously, namely, corrosion. As noted earlier in the paper, there is usually present in water either free or half-bound carbonic acid or both, as well as soluble salts, which under the influence of boiler temperatures decompose, producing acids. Such acids, of course, attack boiler metal and corrode it, sometimes uniformly and sometimes locally in the form of pitting.

All organic matter decomposes under boiler temperatures through a series of stages, from the complex molecules until it approaches the simplest, namely, carbonic acid. The speed with which this reaction takes place and the completeness of the conversion naturally depend upon the variables of temperature, rating, boiler circulation, and other salts that are present. This carbonic or weak-acid corrosion usually takes place in economizer tubes, feed lines and economizer drums. The condensate of exhaust steam is always slightly acid on account of the free carbonic acid which is passed over from the boilers together with the oxygen and sometimes other volatile acids. Economizers and the slower-circulating elements of boilers soon become coated with a red deposit or show signs of the formation of rust cones and pitted metal. These cones consist of a black iron oxide center surrounded by a yellow hydrate in a higher state of oxidation. The red deposit is almost entirely hydrated ferric oxide. This type of pitting is very easy to recognize by its barnacle-like formation (see Fig. 2).

Corrosion once started is difficult to arrest, as the action apparently continues for a long time after the carbonic acid has been removed, and it takes considerable alkali to prevent the extension of corrosion when once it has started. The simplest form of relief is the addition of caustic soda to a point where all the free carbonic acid has been neutralized, and the excessive amounts of soda can be regulated by blowdowns.

Another form of corrosion which affects directly the tubes and drums of the boilers is caused by the accumulation of certain salts, more particularly calcium nitrate, calcium chloride, magnesium chloride and magnesium nitrate:

$$\begin{aligned} Ca(NO_3)_2 + H_2O &= CaO + 2HNO_3 \\ MgCl_2 + H_2O &= MgO + 2HCl \\ Fe + 2HCl &= FeCl_2 + H_2 \\ FeCl_2 + MgO &= MgCl_2 + FeO \end{aligned}$$

Such waters in boilers become slightly alkaline on concentration and react pink to phenolphthalein. This is very misleading to the layman, who does not realize that while the boiler may actually be alkaline, there is a corrosive condition existing. This is more true of nitrate of lime, which on concentration shows decidedly alkaline, as compared with nitrate of magnesium, the reaction of which is almost neutral.

Corrosion Due to Decomposition of Organic Compounds in High-Temperature Boiler Reactions

With high steam pressures and high superheats now in extensive use, cast-iron economizers are no longer considered safe, and when steel economizers are employed the corrosion is often accelerated. To relieve this condition there is now being marketed an air-separation process for the removal of dissolved gases, including the objectionable oxygen and carbonic acid. If the hypothesis be true that corrosion is the effect of the hydrogen ion on the iron metal and that the oxygen dissolved in the water reacts upon the nascent hydrogen liberated, then the removal of these objectionable gases should solve the difficulty. The advocates of this process recommend that it be used in preference to distillation, but in this case, of course, the hardness of the water would still have to be dealt with by the addition of chemicals. Furthermore, the author has seen waters apparently free from both free and half-bound

Fig. 2 Barnacle-like Formation Due to Corrosion Taking Place in the Tubes and Headers of a B. & W. Boiler Used as an Economizer

carbonic acid which produce CO_2 from the disintegration of organic compounds in high-temperature boiler reactions. In most cases, however, if the temperature of the feedwater is held at about 200 deg. fahr., the dissolved gases are driven off sufficiently to make it possible to treat the corrosive properties chemically.

It is apparent from what has gone before that the correct condition for water in a boiler is an alkaline reaction toward both phenolphthalein and methyl orange. The question as to the concentration of soda ash under the influence of boiler pressure and the degree of alkalinity maintained has created a field for most attractive research. As already stated, water softened by zeolites almost invariably contains free sodium carbonate; also water from all softening systems contains sodium carbonate, and by the constant evaporation of water it is an easy matter to figure theoretically and practically the number of grains per gallon present at the end of any definite period. In the fall of 1915 the author was called upon to treat water in four boilers in a textile mill near Wayne Junction. These boilers were of the return tubular type, approximately 150 hp. each, and the supply was a mixture of Schuylkill River water furnished by the city and varying amounts of well water of about 9 grains per gallon hardness. The feedwater heater

was of the closed type and the small amount of temporary hardness present was practically entirely eliminated before entering the boilers. The particular treatment called for no caustic soda but considerable amounts of soda ash and phosphates as lime precipitants. The boilers operated at about 110 lb. pressure and to the author's surprise an examination of the water at the end of two weeks' operation showed the presence of free caustic soda.

It is general knowledge that at red heat sodium carbonate in the presence of a current of superheated steam is converted into caustic, and assuming this to be 1500 deg. fahr., it is a temperature evidently greatly in excess of any temperatures in an operating boiler. Nevertheless, from work done at this and other plants, it has become evident that with the rise of temperatures as produced by increasing boiler pressures, increasing amounts of sodium carbonate are converted into caustic soda with free carbonic acid, and in the case of condensing units this would be returned again and again to the boilers.

On the assumption that carbonic acid would be found in the condensate water, an analysis would show at about 60 deg. fahr. approximately 4500 cc. of gas per gallon of condensate, whereas the author's experience in numerous samples has ranged from 50 to 95 cc. as a high figure. The thought suggests itself that perhaps the gas had been removed with the air from the air-pump discharge, but since dissolved carbonic acid is not readily liberated until its saturation point, and further, since condensate water is always saturated with oxygen, that cannot be the case.

Of the two possible combinations of carbon with oxygen, CO_2 and CO, the former combines with alkalis to form carbonates and the latter to form formates, and just as red ferric oxide can be reduced to black ferrous oxide, so carbon dioxide can be reduced to carbon monoxide and its salts from carbonates to formates. These combinations may be represented by the following equations:

$$Na_2CO_3 + H_2O = \underset{\text{(sodium formate)}}{NaCHO_2} + NaOH + O$$

$$2NaCHO_2 + H_2O = \underset{\text{(sodium acetate)}}{NaC_2H_3O_2} + NaOH + O$$

$$NaC_2H_3O_2 + NaCHO_2 = \underset{\text{(acetaldehyde)}}{C_2H_4O} + Na_2CO_3$$

In the presence of formate of soda the purple color of permanganate might be expected to be destroyed if added to a sample of boiling water, and by actual test that is exactly what happens.

Soda ash or sodium carbonate, which are not oxidizing agents under normal laboratory conditions, evidently under boiler pressures assume such a rôle and degenerate into sodium formate and free caustic soda.

It is possible to go further into the theory and show that, at about 400 deg. fahr., two molecules of sodium formate water can degenerate, with the elimination of oxygen and the production of caustic soda and sodium acetate. Further, a possible reaction is the combination of the acetate and formate with the reformation of soda carbonate, and the production of acetaldehyde. This new substance is volatile and the rest of it may polymerize into complicated organic compounds, which, acted upon by the free caustic soda, blacken scale formations.

We are all still in the field of intelligent experimentation as to just what is occurring under boiler conditions, but it may be stated with certainty that caustic soda can invariably be found, free oxygen liberated, and at least some formaldehyde produced wherever sodium carbonate exists under a steam pressure greater than 100 lb.

Effect of Caustic Soda Produced by Decomposition of Soda Ash Under Boiler Pressure

With definite evidence then in hand that caustic soda is produced through the decomposition of soda ash, we are now in a position to consider the effect of such caustic soda, and similarly, of course, the effect of caustic soda when added directly as feedwater treatment.

In 1912 a certain boiler distress occurred at the University of Illinois which was investigated by Prof. Samuel W. Parr of that university. The water in question at Urbana, Ill., was unique in character in that it was almost free from sulphates and had from 60 to 70 parts per million of free sodium carbonate. The boiler distress showed first in the form of fine cracks which developed and proceeded either from rivet holes to the surrounding plate, or from rivet hole to rivet hole, or from rivet holes to the edge of the plate where there is no tensile stress whatever. It is interesting to note that these cracks always occurred below the water line and always in conjunction with a leak or other condition, which promoted the concentration of soluble material to the saturation point. The general conclusions arrived at by Professor Parr and his associates were as follows:

1 Caustic soda of sufficient strength attacks iron with the generation of hydrogen.

2 Hydrogen in the nascent state, whether generated by alkali or acid, enters into the texture of the iron in a way to modify its physical properties.

3 The hydrogen effect, at least in its first application, is transient, and after a period of rest or freedom from the hydrogen action, the iron reverts to its normal condition.

4 Sodium carbonate is without action on iron; there is, therefore, no generation of hydrogen. The hydrolysis of sodinm carbonate is directly dependent upon the temperature maintained, the withdrawal of the vapor of CO_2, and the admission through the feedwater of carbonated water. It is evident, therefore, that the chemical activity would vary with the ratio of hydrolization or the degree of concentration of the sodium hydroxide.

5 Certain accompanying salts, as the chromates, have an inhibitive effect. Other salts, as sulphates, have at least the effect of acting as diluents. The limits of concentration for maintaining a condition which would be below the danger point have not been studied, but are the features of the case which are of the utmost importance. A continuation of experiments along the lines suggested is in progress.

To say just where the concentration of soda ash and consequently caustic soda becomes dangerous, would be impossible. There are no definite limits which can be placed since the presence of other salts, sulphates and chlorides of sodium, etc., have an inhibitive effect. Consequently larger amounts of soda ash may exist safely in a boiler, in so far as the action on iron is concerned, when the amount of sodium sulphate is larger. The question of excessive soda ash must always be considered in a conjunction with a zeolite softener when the feedwater contains high temporary hardness. It will be recalled that this temporary hardness is converted into sodium carbonate by the action of the zeolite and proceeds to concentrate in the boilers. It is indeed highly advisable that in plants where zeolites are used the concentration of water be tested at frequent intervals and the boilers drained and refilled with fresh water at such times as in the opinion of an expert this should be done. This concentration proceeds differently at different seasons of the year with the fluctuation of the raw water and the varying percentages of condensate and make-up always present in industrial plants from season to season.

In Albany, N. Y., where the author has been checking up an industrial plant on soda concentration, the analysis of the raw water varied from 4.4 to 7.2 grains of lime carbonate per gallon. This was naturally converted to the corresponding sodium carbonate by the action of the zeolites, and on the basis of about $33^1/_3$ per cent make-up these boilers tested as follows:

Boiler No.	1	2	3	4
Sodium carbonate, parts per million	574	470	483	265

Boilers Nos. 1 and 2 had been refilled with fresh water 12 days previous to these tests, and Nos. 3 and 4 six days previous. In the summer time when all this water will be make-up, the concentration will proceed almost three times as rapidly.

Effect of Cylinder Oil in the Feedwater

There is a definite type of installation in which the returns from engines discharge their drips to the boiler feedwater, and in a number of cases the oil which should be removed by means of separators or other devices has been incompletely taken care of.

On the surface it would seem that the oil entering the feedwater would only be chemically active in so far as its compounding was concerned, and since the average cylinder oil contains between 2 and 8 per cent of organic compounds, it would seem as if only this small percentage of the oil could be saponified since the remaining 90 per cent is of mineral character and in laboratory chemistry is unaffected by soda and unsaponifiable. Here again is the unaccountable to account for. In 1916–1917 the author took occasion to fill a boiler with distilled water to which sufficient caustic soda was added so that 100 cc. of the boiler water required 5 cc. N/10

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The Absorption of Gasoline From Casinghead Gas by Activated Charcoal

Particulars Regarding a Series of Tests Undertaken to Evaluate the Process When Applied to a Rich Gas, With Conclusions Drawn Therefrom as to Its Limitations

By H. R. AUERSWALD,[1] TULSA, OKLA.

THE absorption of gasoline from casinghead gas by means of activated charcoal is a comparatively recent method which has received some exploitation. It is in many ways superior to any of the methods at present used in the extraction of gasoline, although its use in connection with gases of different qualities leads to some disadvantages.

In view of the many articles that have appeared in technical publications giving publicity to the process and setting forth its various advantages, tests were conducted by the author at the experimental plant of the Gypsy Oil Company at Drumright, Okla., to investigate the process when applied to a rich casinghead gas, such as is produced in the Drumright District. The results of these tests indicate some rather important conclusions, namely:

1 Charcoal will absorb all the gasoline from casinghead gas at practically atmospheric pressure.

2 It is not possible to distill off and condense all vapors absorbed by the charcoal with superheated steam or by dry heat under the pressures and temperatures ordinarily carried in compression plants.

3 Even if all vapors could be condensed, it is impractical to use the process on casinghead gas of over 2.5 gal. per 1000 cu. ft. yield, if it is necessary to return 65 per cent of the residue gas to the leases for fuel.

4 The results obtained by testing the absorption of casinghead gas by means of activated charcoal and later distilling it in the laboratory with glycerine will give less yield than the gross or net yield obtained from the usual physical testing equipment in the field.

5 The investigation has not been carried to a point where it would be able to state whether or not the scheme would be more economical than mineral-seal-oil absorption on a low-pressure gas (about 20 lb. per gal.) of low yield. The mineral-seal-oil plant would be more economical from the view point of fuel gas consumed. However, if the charcoal does not deteriorate the cost of new absorbent would be less than in an oil-absorption plant.

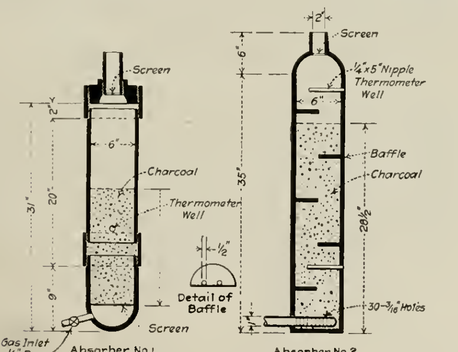


Fig. 1 Details of Absorbers Charged With Activated Charcoal

Details of Apparatus Used in Tests

In these tests two absorbers of special design which provided entrance for casinghead gas, residual gas, and superheated steam were utilized. The details of these absorbers when charged with charcoal and the general arrangement of the other equipment are shown in Figs. 1 and 2, respectively.

As shown in Fig. 2, casinghead gas can be metered to the absorber G or to the compressor C through the meter M. With this arrangement a physical test of the gas may be made by metering the gas before it enters the compressor. In this case the residual gas is allowed to escape at X, while the gasoline condensed is drawn off from the accumulators A and B at D and E. An absorption test with charcoal can be made by metering the gas, passing it thence through pipe F to the bottom of the absorber G. In this latter case the residual gas may be drawn from the top of the absorber G, thence to the compressor C, and by compressing the gas to a suitable pressure it can be determined what degree of gasoline absorption the charcoal effects.

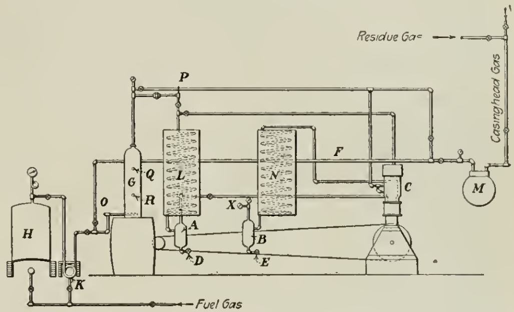


Fig. 2 General Arrangement of the Apparatus Used in Tests to Determine Gasoline in Casinghead Gas by Charcoal Absorption

After the charcoal has absorbed the gasoline, superheated steam can be admitted to the absorber G from the boiler H and the superheater K. The steam and gasoline vapors are then condensed in the condenser L, while any uncondensed gasoline vapors may be transferred to the compressor C, there compressed to any desired pressure, later cooled and condensed in the condenser N, and finally collected in the accumulator B.

Results of Tests

The results of the several tests made with this equipment utilizing the two different absorbers, and under various conditions, are shown in Table 1. From the study of these results the following interesting observations may be made:

1 Test No. 5 shows that the charcoal will absorb 22.5 per cent of its volume and 25.3 per cent of its weight in gasoline if the gas is passed through at the correct velocity. Test No. 2 showed that when the charcoal had been saturated to 15.8 per cent by volume the gasoline began to come through.

2 The best absorption seemed to be effected by a slow speed through the absorber. For the quality of the gas tested the best rate seemed to be from 9 to 12 ft. per min. through the absorber. As the charcoal was 36 per cent voids, this would be a velocity of 25 to 33 ft. per min. through the charcoal.

3 Line 10 of Table 1 shows that in each test, gasoline was condensed from the residue gas by compression. It should be realized, however, that this may have been caused by too high a velocity of the gas or by oversaturation of the charcoal. The charcoal will absorb all the gasoline from the gas if it is not oversaturated and if the gas is allowed to pass through at a slow enough velocity.

[1] District Supt., Gypsy Oil Co. Jun. Am.Soc.M.E.

Presented at a joint meeting of the Mid-Continent Section of The American Society of Mechanical Engineers, and local sections of the American Chemical Society, A.S.C.E., A.I.M.E., A.I.E.E. and A.A.E., at Tulsa, Okla., April 28-29, 1921.

4 Line 14 shows that in tests Nos. 2 and 4 the temperature of the charcoal was raised to a point which would be difficult to maintain in practice. This temperature apparently distills all of the gasoline from the charcoal so far as a flame test on the charcoal afterward will show, but the gasoline vapor formed is of such a volatile nature as to prevent condensation. In all tests except No. 2 the vapors which were uncondensed in accumulator *A* were compressed to 250 lb. gage pressure, and cooled, but they still remained uncondensed.

5 Line 16 gives in percentage the quantity of gasoline condensed by distillation of the charcoal as compared with the gross yield of the gas by physical test. Line 17 shows comparison of the yield by absorption and distillation from charcoal with that obtained when the gross product as made by physical test is weathered to 60 deg. fahr. and "net" yield is thereby obtained.

TABLE 1 RESULTS OBTAINED IN TESTS WITH TWO DIFFERENT TYPES OF ABSORBERS

1 Absorber No.	1	1	1	2	2
2 Test No.	1	2	3	4	5
3 Date	12/16/20	12/20/20	12/23/20	12/29/20	1/5/21
4 Volume of gas run through absorber, cu. ft.	40	80	112	150	180
5 Volume of charcoal in absorber, cc.	7330	7330	7330	13250	13250
6 Weight of charcoal in absorber, cc.	9.17	9.17	9.17	16.55	16.55
7 Gross gasoline contents of gas as determined by physical test, cc. per cu. ft.	17.70	17.70	11.60	20.00	16.90
8 Gasoline contents of gas gross, gal. per 1000 cu. ft.	4.675	4.675	3.070	5.320	4.47
9 Total gross gasoline in gas passed through absorbers, cc.	708	1420	1300	3018	3050
10 Gasoline condensed in residue gas by compression during test, cc.	144	40	78	337	58
11 Total gasoline absorbed in charcoal, cc.	564	1380	1222	2681	2992
12 Efficiency of charcoal as absorbent at the rate which gas was passed, per cent	79.6	97.00	94.20	89.00	98.20
13 Maximum steam temp. passed into absorber, deg. fahr.	600	820	.....	820	720
14 Maximum temp. of charcoal during distillation, deg. fahr.	350	660	400	720	570
15 Total gasoline driven off and condensed, cc.	216	455	572	1024	877
16 Efficiency of the distillation from charcoal compared with gross yield by physical test, per cent	38.3	33.0	46.7	38.0	28.3
17 Efficiency of the distillation from charcoal compared with net yield of physical test, per cent	.....	.....	75.5	54.4	47.8
18 Water condensed during test, cc.	13250	7100	12300	32100	19800
19 Ratio of water condensed to gasoline produced	61:1	15.7:1	21.5:1	32.1	22.6:1
20 Rate of passage of gas through absorber, cu. ft. per min.	5	1.45	2	2.35	1.7

The pressure on the absorber during all absorption tests while the gas was passing through was 4 oz.

In some of the tests the steam pressure on the absorber was raised to 50 or 60 lb. during the distillation.

After tests Nos. 1 and 2 the charcoal was taken out of the absorber and a sample tested with a flame to ascertain whether or not gasoline still remained in it. No evidence was found of the presence of gasoline and the charcoal was perfectly dry and dusty.

6 Line 19 shows that a large quantity of steam must be condensed to produce a small quantity of gasoline. All of the ratios in the column are perhaps high on account of the fact that in all tests steam was introduced for a long period of time to obtain a high temperature in the charcoal. From observations made on test No. 2 it seems that the steam which would have to be forced through the charcoal under ideal conditions so as to distill the gasoline would be 7 parts of water to 1 part of gasoline by volume. It would be necessary under those conditions to generate superheated steam from 7 gal. of water for each gallon of gasoline made.

To generate a pound of steam at 35 lb. boiler pressure and heat it to 600 deg. fahr. requires 1144 B.t.u. Assuming a boiler efficiency of 70 per cent and fuel gas of 1000 B.t.u. per cu. ft., it would require 95 cu. ft. of fuel gas per gallon of gasoline produced.

Because of this large consumption of residue gas it is evident that the method would be impractical on casinghead gas of this quality, especially if residue gas is to be returned to the leases. The residue gas per 1000 cu. ft. would be only about 766 cu. ft., 445 cu. ft. of which would be burned at the gasoline plant, leaving only 321 cu. ft. to be returned to the leases or 32.1 per cent of the original volume delivered. A compression plant handling the same gas efficiently would consume only 90 cu. ft. of the residue gas, leaving 676 cu. ft. for return to the residue system or 67.6 per cent of the original volume.

The consumption of fuel gas would not be such a great objection, however, if the method were used on low-pressure gas of low gasoline content. The gas consumed for fuel, however, would be more than that consumed by an absorption plant of the absorbing oil type, for in the charcoal process the latent heat of the steam is totally lost, whereas in a plant where mineral seal oil is used the latent heat is utilized in evaporating the gasoline.

TABLE 2 DISTILLATION TEST OF GASOLINE

(Product used, 70 deg. B.)

Per cent Off	Temp., deg. fahr.	Per cent Off	Temp., deg. fahr.
I.B.P.	98		
20	140	60	212
20	163	70	220
30	176	80	249
40	189	90	285
50	200	95	318 (End Point)

(Recondensed in flask, 1 per cent; loss 4 per cent; gravity of condensate, 68 deg. B.)

7 All the gasoline absorbed in the charcoal was not recovered in any of the tests, but in all tests the gasoline recovered was distilled off before the temperature in the charcoal was raised to 400 deg. fahr. Perhaps a higher temperature than this is needed to reactivate the charcoal, but it is not needed to distill off the gasoline. The exact temperature required could be determined only after a long series of tests.

TABLE 3 RESULTS OF DRY DISTILLATION TESTS

Test No.	1	2	3	4	5	6
Charcoal in flask, cc.	1000	1000	1000	1000	1000	1000
Gasoline poured on charcoal, cc.	200	200	200	200	200	200
Gravity of gasoline, deg. B.	66.5	65.5	71.4	70.4	70.5	70.3
Max. temp. to which charcoal was raised, deg. fahr.	830	816	740	770	735	730
Max. temp. of vapors, deg. fahr.	326	358	440	380	418	370
Gasoline recovered in condenser, cc.	113	180	172	200	178	168
Assumed loss, cc.	8	8	8	8	8	8
Gasoline distilled from charcoal, cc.	121	188	180	208	186	176
Percentage of original gasoline recovered	60.5	94	90	104	93	88
Percentage of accumulated condensate to original sample	60.5	77.2	81.5	87.0	88.3	88.2
Gravity of condensate from the test, deg. B.	70	68.2	69	67.5	68.4	63

Total gasoline put on charcoal during six tests...... 1200 cc.
Total gasoline recovered from six tests............ 1059 cc.
Per cent of total recovered........................ 88.2

After the distillation of the gasoline in test No. 5, residue gas was passed through the charcoal and the same cooled down. When the residue gas was passed through the absorber the temperature of the charcoal was 535 deg. fahr. and the absorber temperature just above the charcoal was 435 deg. fahr. Residue gas of 67 deg. fahr. temperature was passed through the absorber for $2^1/_3$ hours at rates varying from 2 to 3 cu. ft. per min. After 360 cu. ft. of gas had been passed through the charcoal the temperature was still 111 deg. fahr. and the absorber temperature above the charcoal was 165 deg.

TABLE 4 DISTILLATION TEST OF GASOLINE

(Glycerine poured over the charcoal)

Per cent Off	Temp., deg. fahr.	Per cent Off	Temp., deg. fahr.
I.B.P.	130		
10	170	60	206
20	188	70	238
30	190	75	280
40	196	82	294
50	200	89	350

(Gravity of condensate 69.7 deg. B.)

Inasmuch as there had been only 180 cu. ft. of green gas originally passed through the absorber, this test indicated that the absorber would have to be cooled by some other method in addition to residue gas, or the residue gas would have to be recirculated by pumps through the absorber and cooling coils two or three times in order to properly cool the charcoal.

(Continued on page 606)

Efficient Operation of Oil-Burning Steam Plants

A Discussion of the Plant Characteristic Diagram, with Particulars Regarding Its Use in the Establishment of a Standard of Performance and in Increasing Plant Efficiency

By C. H. DELANY,[1] SAN FRANCISCO, CAL.

DURING the past ten years there has been a remarkable increase in the efficiency of steam plants, both oil-burning and coal-burning. Ten years ago there were many plants operating reciprocating engines, in which the maximum economy obtained was not over 150 kw-hr. per bbl. of oil.

With the high-pressure steam-turbine plants of the present day a record of 330 kw-hr. per bbl. has been made. This increase in efficiency has been brought about by introducing more efficient machinery and increasing the range of steam pressure in the prime mover. The introduction of the steam turbine to replace the reciprocating engine effected a remarkable saving in the quantity of fuel required. Moreover the steam turbine caused a saving in operation due to the fact that its operation does not depend on the personal element in the plant.

In the old reciprocating engines there were many adjustments to be made by the engineer in charge, and the economy obtained depended very largely on the skill of the operating engineer and the care with which he made the various adjustments. With the steam turbine, however, there is nothing that the operator can do to improve the efficiency after the machine is once installed and placed in good operating condition. While this is true as regards the prime mover, it is not true in regard to many other features of the power plant. In the boiler room particularly there are many points where the operating engineer can effect a saving if he carefully studies the situation and pays attention to the small details of operation. In condensers and vacuum pumps also a great saving can be made if proper attention is paid to maintaining a high vacuum. There is still, therefore, a large field for the operating engineer in improving the economical operation of the plant, and the question of operating efficiency is consequently one worthy of very careful study.

Many tests have been published showing very high efficiency of boilers where fired with fuel oil, efficiencies as high as 80 and 82 per cent being not uncommon in test reports. It is very rare, however, that any such high efficiencies are obtained in the regular operation of power plants. In order to maintain high efficiency in regular operation of a plant, the first requisite is some means of comparing one day's operation with another. In oil-burning electric power plants it is customary to report the economical operation of the plant in terms of kilowatt-hours generated per barrel of oil. This is an excellent method of comparing one day's operation with another, provided there is steady load on the plant and conditions remain the same from day to day. With a variable load, however, such as occurs in an ordinary central-station plant, it is always found that the economy is much better at periods of heavy load, and poorer at periods of light load. Thus it is possible with a fairly heavy load on the plant to secure from 220 to 230 kw-hr. per bbl. of oil without difficulty, whereas with the same plant operating at a light load it may be difficult to secure more than 150 kw-hr. per bbl. of oil.

When the good results are obtained with the heavy load, the operating men pat themselves on the back and consider that they are doing fine, because results are better than the average. On the days of light load when the results are poor, they do not worry but say, "What's the use, you can't expect any results with such a light load." Thus in neither case is there any incentive to improve the economical operation of the station. Another reason for more or less lax methods, so far as efficiency is concerned, is the fact that efficiency must always be secondary to continuity of service. The men at the plant know that any interruption to service will be a matter of close investigation on the part of the management, and they devote all of their energies to maintaining the plant in operation and keeping the lights burning. For instance, if a fireman in endeavoring to carefully adjust the air supply in his boilers neglects to keep up the steam pressure, with the result that the turbine slows down and some of the load has to be dumped, he is sure to be called on for an explanation. If on the other hand he keeps up the steam pressure, but neglects to regulate the air in the proper proportion, there usually will be no complaint; and the boilers may be allowed to operate in this inefficient manner for a considerable length of time. The author is far from disputing the fact that continuity of service is a matter of prime importance, but he does wish to point out that efficiency is a close second. The problem before us, therefore, is to so interest the men who are operating the plants in the matter of efficiency that they will not neglect the various operating details that must have attention in order to secure good results.

In order to improve these conditions and to interest the men in the problem of efficiency, it is essential to devise some means of comparing the performance of a plant from day to day. For this purpose, the diagram here called the "plant characteristic diagram" has been plotted.

The Plant Characteristic Diagram for Comparing Performances from Day to Day

Fig. 1 shows such a diagram for one of the San Francisco stations. It consists merely in the plotting of the oil consumption against the kilowatt-hours generated. Each of the points in this diagram represents one full day's operation, and while the points as shown are more or less scattered, it is apparent that they form a well-defined line. It is thus possible to draw a straight line through the midst of these points in such a way that it will represent the average location of all the points in the diagram. There is nothing new in the use of a straight-line diagram, such as is presented. The line is similar to the Willans line for steam engines, where for throttling engines the total steam consumption plotted against the horsepower output is always found to be a straight line. A similar line for steam turbines is either straight, or very nearly so, depending on the design of the turbine. The use of the Willans line in the design of steam power plants was very ably described by R. J. S. Pigott in a paper read before the A.S.M.E. in 1916.[1] The use of the plant characteristic diagram in improving the efficiency of steam plants has been described very fully by Robert H. Parsons[2] of London; and in fact in describing this system as applying to oil-burning plants, the author is simply amplifying Mr. Parsons' paper on the subject.

Use of Diagram as a Standard for Guidance of Men in Operation of Plant

The diagonal line, having once been drawn through the points as described, may be used as a standard for the guidance of the men in future operation of the plant. Thus each day the kilowatt-hours generated and the oil burned the day before may be plotted on this diagram. If the point so plotted is found to fall below the diagonal line, it is evident that the results obtained are better than the standard. If the point falls above the line, too much oil has been used, and there is something wrong requiring a special investigation; and since the diagram takes in all loads from zero up to the full load on the plant, it is evident that it allows for the poor economy obtained at light loads. It is thus possible for the operating men to know immediately whether they are keeping up to the required standards of efficiency or running behind. They are therefore able to investigate causes of low efficiency immediately while all matters entering into the plant operation are fresh in their minds.

In adopting the standard it would be possible, instead of drawing a line through the average of the points, to draw a line through

[1] Pacific Gas & Electric Co. Mem. Am.Soc.M.E.

Paper presented at a joint meeting of the San Francisco Sections of The American Society of Mechanical Engineers and the American Institute of Electrical Engineers, March 17, 1921. Slightly abridged.

[1] Trans. Am.Soc.M.E., vol. 38, p. 687.

[2] *Electrical Review* (Chicago), Feb. 21, 1920, p. 311.

the best points, thus establishing a standard that would represent the best results obtainable from the plant. Again, it would be possible to establish a standard by drawing a theoretical line below all of the points, this line to be based on the steam consumption of the turbines and auxiliaries, as determined by tests, a boiler efficiency of, say, 80 per cent and the best possible vacuum. In other words, a line representing ideal conditions.

In adopting the average line as the standard it is felt that the men will have greater confidence in the method than if a theoretical line had been adopted. The average line is really a standard that

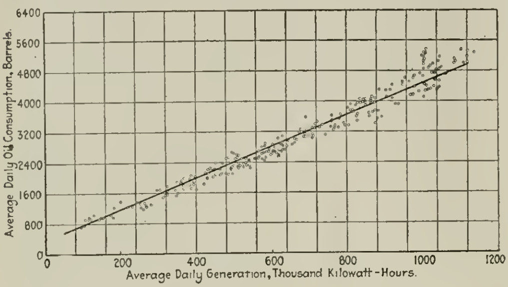


Fig. 1 Plant Characteristic Diagram for a San Francisco Station

has been established by the men themselves. It is not an arbitrary ideal impossible to attain, but as it represents the average already attained, it should be as easy to improve on the results represented by the line as to fall below them.

If the men are successful in improving on the standard each day, it is obvious that the average for a given year will represent better efficiency than the average for the previous year. With all of the points falling below the line on the diagram, another line drawn through the average of these new points would also fall below the original line.

A diagram with the same diagonal line as determined by Fig. 1, but with the points omitted, may be used at the stations each day to plot the results of the day before.

Figure 2 shows a similar diagram, but with the scale altered so as to show the kilowatt-hours generated and the oil burned during a period of 8 hours instead of 24 hours. This diagram may be used by the different shifts in the station so that each shift can check up its own performance and compare it with the performance of the other shifts. A large diagram of this form is posted on the wall of the fire room, and different colored pins to represent the different shifts are inserted each day so that the diagram shows at all times which shift is running above the line and which shift is running below it. This system has a far-reaching effect in awakening interest in the men, and leads to rivalry and competition so that they are extremely anxious to improve the efficiency, and the laxity which previously existed in regard to efficiency is disappearing. As the diagram allows for variations in load, it is possible to compare the day shift when the load is heavy with the early morning shift when there is very little load on the plant, thus making a fair comparison which was never possible with the old method of merely figuring the kilowatt-hours per barrel of oil.

Operating Efficiency and Its Determination

There is one objection to the diagram—it does not indicate the order in which the records are plotted, and therefore does not show whether the results are improving as time goes on. In order to overcome this objection, and also to enable the operation of different plants to be compared with each other, the term "operating efficiency" has been introduced. Operating efficiency as used in this connection means the percentage of standard attained for the day's run. "Operating efficiency" is entirely distinct from "boiler efficiency" or "turbine efficiency" or "thermal efficiency" or "Rankine-cycle efficiency." All of these enter into the operation of the plant in determining the standard. Operating efficiency is merely a comparison of the results actually obtained with the standard.

The method of determining operating efficiency can best be shown by an example: During one eight-hour shift there were generated 313,000 kw-hr. and 1440 bbl. of oil were burned, representing an economy of 217 kw-hr. per bbl. From the diagram it is found that for a load of 313,000 kw-hr. with standard efficiency, there would be burned only 1400 bbl. of oil, which would be equivalent to 224 kw-hr. per bbl., as against the actual result obtained of 217 kw-hr. per bbl. The operating efficiency is therefore 217 divided by 224 or 97 per cent. During another eight-hour shift, where there were only 25,000 kw-hr. generated, the oil burned was 200 bbl., equivalent to 125 kw-hr. per bbl. From the diagram it is found that for 25,000 kw-hr. with standard efficiency the oil burned would be 220 bbl., equivalent to 114 kw-hr. per bbl. The operating efficiency is therefore 125 divided by 114 or 110 per cent. It is thus seen that although in the second case there were only 125 kw-hr. per bbl. obtained, as against 217 in the first, the operating efficiency was actually higher in the second case than in the first.

It is evident from the foregoing that if an operating efficiency of 100 per cent is obtained, it means that the economy of the plant is the same as the average of last year, since last year's records were used to establish the standard. If more than 100 per cent operating efficiency is obtained, the results are better than last year, and if less than 100 per cent is obtained, they are worse. It is obvious that this method of determining operating efficiency makes allowance for inefficient machinery, and it is just as easy to obtain 100 per cent operating efficiency in a plant having old-fashioned turbines of poor design as in a plant having the most up-to-date machines, for the standard is based on the actual records of the plant in question.

Fig. 3 shows the operating efficiency of one of the plants plotted for each day during the months of January and February. In this diagram the horizontal line at 100 per cent represents the standard efficiency and the zigzag line the actual operating efficiency obtained each day. The records show a gradual improvement in the operating efficiency during the period, which is a direct result of the attention to small details brought about by this method of checking up efficiency.

In addition to the use of the diagram for setting standards and creating interest among the men, a system of weekly and monthly reports and bulletins has been adopted. The weekly report, which is made out by the efficiency man at each station, gives the operating efficiency for each day and the average for the week, and in addition a brief statement of some of the more important instrument readings such as flue-gas analysis, vacuum, feedwater temperature, and steam consumption of turbines at different loads. The monthly report which is made out at the office and sent to

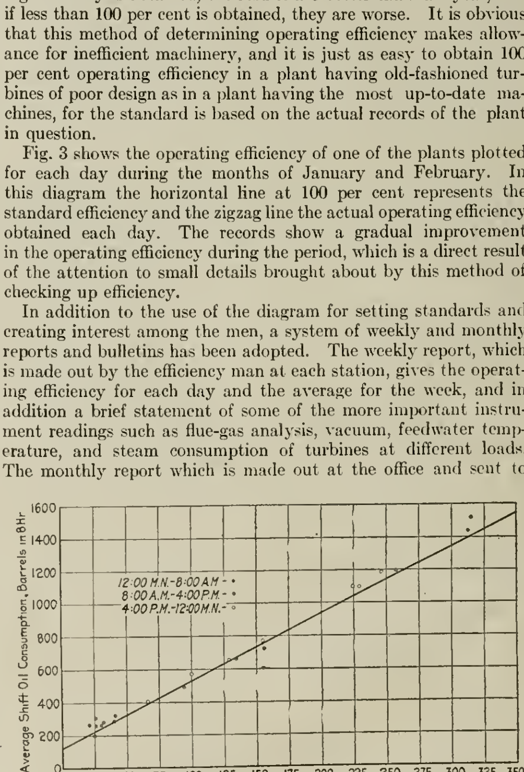


Fig. 2 Plant Characteristic Diagram with Scale Altered to Show Results Obtained on an 8-Hour Shift

each station includes a diagram of operating efficiency similar to Fig. 3 for all stations plotted on one sheet, together with a brief statement of comparative results obtained and suggestions for improved methods. A liberal use is made in the stations of flowmeters and other instruments that serve as a guide to the firemen in the proper regulation of their fires.

Since the diagonal line in the plant characteristic diagram is usually a straight line, it can of course be represented by a simple equation, namely:

$$y = a + bx$$

where y is the oil consumption in a given period in barrels or pounds, x the kilowatt-hours generated in the same period, and a and b are constants.

Evidently the constant a is equal to y when $x=0$, or in other words a represents the quantity of oil burned for zero load; that is, the amount required to keep up steam on the boilers, keep the turbine running up to speed, operate the vacuum pumps, circulating pumps and other auxiliaries, and keep the entire plant in readiness to take on load at a moment's notice. Obviously a will be larger if two turbines with their auxiliaries are kept in operation than only one, so that its value depends on the amount of load the plant is expected to take on. Where a plant is operated as a stand-by to a hydroelectric system and is kept in readiness to instantly pick up its full load in case of trouble, a will have a higher value than where it is possible to gradually shut down the turbines one after the other as the load falls. The constant b evidently represents the additional amount of oil burned in proportion to the load carried on the plant. It determines the slope of the line in the diagram, and is large for uneconomical turbines or engines and small for the most efficient types. The equation of the line in Fig. 2 in terms of barrels of oil and kilowatt-hours for an eight-hour shift is—

$$y = 120 + 0.0041\ x$$

Other Uses of the Plant Characteristic Diagram

The characteristic diagram may be used for many other purposes besides the overall efficiency of the plant. By plotting the steam generated against the oil burned in one diagram, and the steam consumption against the kilowatt-hours generated in another, it is possible to study the boiler-room and engine-room operations separately, and thus quickly locate the cause of low efficiency. By setting separate standards for the boiler-room and engine-room crews, responsibility can be more definitely fixed and the advantages of the system of operation greatly enhanced.

Since boiler efficiency usually decreases quite rapidly as the capacity increases above the boiler's rating, a single boiler will naturally have a curved characteristic. In a plant containing a large number of boilers, however, the boiler-room characteristic will be approximately straight until the load exceeds the economical capacity of all the boilers in the plant, after which it will begin to curve upward. A curved line, based on previous performance, is just as satisfactory as a straight line for setting standards and calculating operating efficiency in the manner described. Fig. 4 shows the power used by electric auxiliaries in a station, plotted against the total generation, and is of interest in showing that the points do form well-defined straight lines, and that the same methods may be used for standardizing these items as for fuel consumption and steam consumption.

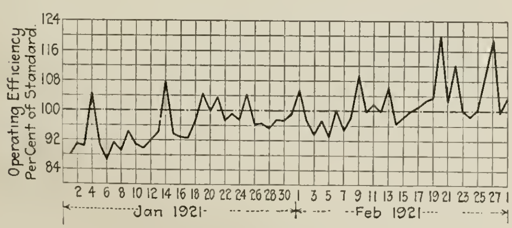


Fig. 3 Diagram of Operating Efficiency of a Plant Over a Two-Months' Period

To sum up, the essentials for securing the best efficiency in power-plant operation are:

1 A fair standard by which the daily performance can be measured and compared with previous results, at the same time giving the operating men a definite goal to work to.

2 Means of comparing results obtained by different groups of men, such as different shifts of one plant or the crews of different plants, and the posting of this comparison so that the men can see the results of their efforts

3 A system of reports that keeps up the interest of the men. combined with suggestions and advice that show where losses occur and how they may be avoided.

If the operating men are kept interested, see the results of their work, and have a definite standard to reach, they will do their best. As interest flags some sort of bonus or prize for the crew showing

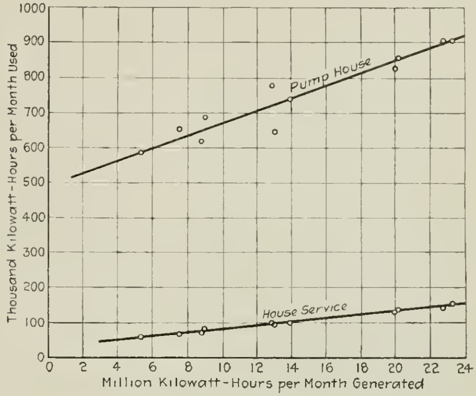


Fig. 4 Power Used by Electric Auxiliaries in a Station, Plotted Against the Total Generation

the best operating efficiency will stimulate them to greater effort, and by guiding this effort by means of thoughtful analysis of the technical features of the power plant, maximum efficiency may be obtained.

The Trent process of cleaning coal, developed on a result of certain suggestions made during the war by Walter E. Trent to the War Inventions Board, consists in agitating together powdered coal, water and oil. This produces a partly de-ashed plastic fuel, called an "amalgam," the oil selecting the coal particles and largely excluding the water and ash. The amalgam can be freed from water mechanically held by working, much as butter is.

This amalgam can be burned in several ways; for example, it may be shoveled or forced through pipes by pressure; it can also be stored under water if desired.

For pulverizing fuel, wet grinding presents many advantages over dry grinding, provided the water can be eliminated afterward.

To be able to reduce the ash in coal may make available great quantities of low-grade coals and material now considered as waste at the mines.

If an oil is used that can be distilled at a temperature below the distilling temperature of the coal, powdered fuel is reclaimed from the amalgam and the oil may be reused. If a heavy oil be used and distilled to dryness, a coke product may be recovered, although the coal may have had no coking quality. If the distillation proceed only to a heavy pitch, a mass suitable for briquetting may be made.

In distilling oil mixed with a finely powdered material the distillates are similar to those obtained by distilling under pressure so that the distillation of an amalgam of coal and oil gives quantities often more favorable than the sum of the separate distillations of the coal and the oil.

The amalgam can be used for a gas-making fuel, and gas-house-tar emulsions can be dehydrated by mixing with powdered coal, the amalgam being retorted for further gas making.

Graphite ore can be separated from its gangue, and coke can be separated from flue dust by using the Trent Process. Clean coal in anthracite sludge will make an amalgam if oil is added.

This brief sketch of possibilities revealed by small-scale laboratory work shows that the field for investigation and development is large. The general results show that real benefits are physically possible by treating coal in this manner.—From an article by O. P. Hood, Chief Mechanical Engineer, U. S. Bureau of Mines, in *Power*, Aug. 2, 1921, p. 196.

DIE SINKING AND METAL PATTERNMAKING BY AUTOMATIC MACHINE

(Continued from page 588)

unusual layout which could not have been accomplished in the old way.

There is another very important point which must appeal powerfully to the thoughtful engineer: A mechanical method which makes of die reproduction merely a routine manufacturing proposition insures constant use and employment of correct dies; the necessity for keeping or the temptation to keep in use dies that have sunk, checked, or spread, is removed. The resultant decrease of rejections and scrap, with a consequent saving of labor and material, is quite evident. What this means to the growth of an industry may be left to the imagination.

Fig. 14 shows a roll-cutting machine. This is a three-dimension automatic machine which cuts a pattern intaglio or relief on the periphery or the inside of cylindrical surfaces. It is useful on embossing and forging rolls for rubber, metal, lace paper, male and female, and particularly for cutting molds for glass.

The propeller-carving machine shown in Fig. 15 is obviously not a die-cutting machine, but is of interest because it shows a very useful application of the principle of the duplicator. This is a very productive machine and capable of cutting accurate and true propellers of any desired shape of pitch. It has records to its credit of 50 large propellers in 8 1/2 hours out of the fullg-lued blank, cutting down to size, ready for sanding.

Fig. 16 shows another interesting applic tion of the reducing machine, designed to overcome the difficulty of getting a smooth and uniform bucket on the wheels of the steam turbines used in connection with torpedoes. The principle is the same as that previously described in connection with the reducing machine for cutting ellipses, with the addition of a special automatic indexing mechanism which carries the turbine wheel and a templet or model the exact shape of the outer contour of the bucket, but four times its size. Spiral end mills and a roller tracer are used.

It has been many times reiterated that without the munitions produced by the American industries, including the machinery, tools, and the great quantities of articles that were so essential, the late war could not have been successfully carried on.

In this connection it may be said that automatic die-sinking machines not only produced many thousands of dies in this country but were also used in the British, French and Italian armories and artillery plants. They supplied dies for howitzers and field guns, for turbines and other parts of torpedoes, for Liberty motor parts, saddlery, shells, surgical instruments, bayonets, trench tools, hand grenades, Emergency Fleet and other marine forgings, aircraft telephone reels, navy chains, submarine parts, horseshoes and tractors.

The question naturally presents itself, how could all these thousands and thousands of dies have been produced had man power been the sole source of supply?

UTILIZATION OF LOW-GRADE COTTON

(Continued from page 596)

body, wiry, of good staple and possesses excellent spinning qualities, permitting the use of less twist and the securing of a higher production. The cleaning machine produces the most remarkable results in cleaning all these types of cotton and makes it possible for a mill to use such cotton in producing many kinds of goods.

On a unit of twenty machines in commercial cotton cleaning where the cotton is rebaled, the cost is less than 1 cent per lb., taking everything into consideration except the shrinkage in stock. This unit of machinery will clean about two bales per hour. In 1920 the profit was from 5 to 7½ cents per lb., and at present the author believes it to be from \$20 to \$25 per bale.

In a manufacturing plant cotton could be taken to the cleaning outfit, opened, cleaned and blown into the picking department. In order to mix this stock properly a mechanical mixer should be used. To reclaim card strips or comber noil the cleaning machine should be installed in the picker room. As the strips are taken from the card, they can be run through the machine and mixed with the cotton in such a percentage as is necessary in number up to and including 40s and then forgotten.

Our machine builders now make equipment to manufacture any kind of product required. What is known as the "coiler" system is used on hard yarns and is perfected to spin good yarn from very low stock. The greatest difficulty has been overcome by being able to clean this stock properly and to mix it in absolutely uniform batches. Most of this low-grade product, especially in Europe, was manufactured on what is known as "woolen machinery." The Europeans were successful because of their low-priced labor and the great care taken with cleaning and mixing. We have learned this and with our improved machinery are in a position to take any raw product and utilize it as efficiently as they.

WATER TREATMENT FOR BOILERS

(Continued from page 600)

normal sulphuric to neutralize it. The cylinder oil analyzed as follows:

Flash point	520 deg. fahr.
Fire test	590 deg. fahr.
Gravity at 60 deg. fahr	25.7 deg. B.
Viscosity at 210 deg. fahr. (Saybolt)	120 sec.
Fat (as tallow)	5.2 per cent
Free acid (as oleic acid)	0.12 per cent

One quart of this oil was injected into the boiler, which was operated at 125 lb. pressure. At the end of three days the water was just faintly alkaline to phenolphthalein, although there was theoretically nothing in that water which should have absorbed the alkali.

THE ABSORPTION OF GASOLINE FROM CASINGHEAD GAS

(Continued from page 602)

After three tests in which steam had been used for distillation, it was demonstrated that all the gasoline could not be distilled and condensed by this method. It was then decided to investigate distillation by dry heat.

The apparatus used in this test was a standard 1000-cc. distillation flask and copper condenser. The distillations were conducted as follows: 1000 cc. of charcoal was placed in the flask and 200 cc. of low-gravity gasoline poured over it. The gasoline used was a drip product of 70 deg. B., with an initial boiling point of 98 deg. fahr. The distillation test of Table 2 shows that it was a very stable product which could be distilled and condensed at atmospheric pressure without excessive loss.

Table 3 shows the results obtained when dry distillations were made by saturating 1000 cc. of the charcoal with 200 cc. of the gasoline under consideration.

The same charcoal was utilized in all tests, but after each distillation the charcoal was cooled down to room temperature before another charge of gasoline was tested.

From Table 3 it is to be noted that in the distillation of gasoline from charcoal by dry heat a greater loss is encountered than when the gasoline is distilled alone. The contact of the gasoline with the charcoal seems to render a certain part of the vapor more volatile. Thus, the use of charcoal for testing casinghead gas, if distilled dry, would give an incorrect yield when compared to the gross or net yeild obtained by the use of a compression physical testing equipment.

A test was conducted to determine whether or not all of the gasoline contained in a certain sample of charcoal could be distilled off and condensed if glycerine is poured over the charcoal containing the gasoline.

A 500-cc. distillat on flask was set up and 250 cc. of charcoal placed in it. 100 cc. of gasoline of low gravity was then poured over the charcoal, after which 150 cc. of glycerine was added. Gasoline of 71 deg. B. was used which had a 4 per cent loss in its own fractional distillation.

Inasmuch as the boiling point of the glycerine with charcoal is 350 deg. fahr. the test was stopped at that point.

Results of this test indicate, as shown in Table 4, that even in the presence of glycerine it is not possible to distill off and condense the original quantity of gasoline in the charcoal without an unusually high distillation loss. In this particular case the results obtained show an unaccounted-for loss to the extent of 7 per cent.

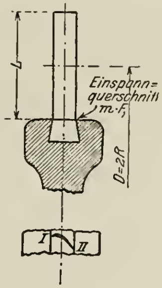
SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Steam Turbines for Maximum Loads

By A. LOSCHGE

THE author believes that the development period of the steam turbine, which has been extremely rapid and at times precipitate, is about over. Out of a plethora of inventions only a few types of construction have survived and these have been adopted by practically all turbine builders and are very nearly the same everywhere, notwithstanding material differences in design and construction of metals. These types represent mainly combined turbines with high- and low-pressure stages and for a number of years turbine designers have endeavored to improve and simplify these combined turbines, their efforts being mainly directed toward increase of speed and reduction in the number of stages. As the result of this, it has become possible to employ a speed of 3000 r.p.m., which is the highest that can be used to drive a 50-cycle alternator, and has been applied to increasingly large units of output. How well turbine designers have succeeded in this direction is shown by the fact that the maximum output, that is, the output which can be secured from a turbine unit at the maximum speed of 3000 r.p.m., has increased from 6000 hp. in 1912 to 8000 in 1914, and to about 25,000 in 1921. It is clear that this tendency has very great economic importance and that from now on all turbine builders will have to construct maximum-output turbines.



FIGS. 1 AND 2 TURBINE BLADES
(*Einspannquerschnitt* = Cross-Section at Fastening.)

From this the author proceeds to a discussion of the magnitudes which determine the value of maximum output of a turbine, the technical difficulties which have to be overcome in order to make a higher output possible, and finally the ways and means adopted by various concerns to overcome these difficulties. Because of lack of space only certain parts of the articles can be here abstracted.

Importance of Blade Length in the Last Turbine Stage. The magnitude of maximum output of a turbine is in the first place determined by the length of the blades in the last turbine stage and there are certain conditions which determine the maximum possible length of the longest blade at each circumferential speed u. It was found at the start that the ratio—

$$\frac{\text{average diameter of wheel } D}{\text{blade length } L}$$

should not be less than 5 in the utmost case, since otherwise the blade passage becomes too wide on the outside and too narrow on the inside, which causes a very uneconomic utilization of the steam. From this limiting value $D/L = 5$ it appears that for constructive reasons for a given speed of rotation n the values for L for any circumferential speed u should not exceed those given in the following table:

u (meters per second)	100	125	150	175	200	225	250
D (meters)	0.637	0.796	0.956	1 114	1.274	1 433	1.592
$L_{\max I}$ (at $D/L_{\max I} = 5$) meters	0.127	0.159	0.191	0.223	0.255	0.287	0.318

The blade length $L_{\max I}$ is computed from the equation

$$L_{\max I} = {}^1/_5\, D = {}^1/_5 u/(\pi n/60) = {}^1/_5 u/(\omega/2) \qquad \text{[1]}$$

Stresses in the Blades. A second consideration which tends to limit the maximum length of a blade has to do with the requirement that the blade should have a sufficient factor of safety with respect to its mechanical strength.

Turbine blades are stressed in two different ways, namely: in tension by the centrifugal force of the mass of the blade, and in bending as a result of the pressure which the steam jet exerts on the blade and—in superpressure turbines—also by the difference between the specific steam pressure on the entrance and exit sides of the blades. The tensile stress is determined in a simple manner.

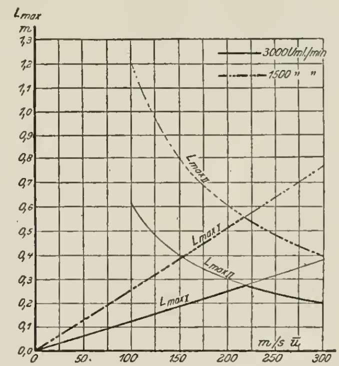


FIG. 3 DEPENDENCE OF MAXIMUM BLADE LENGTH ON THE PERIPHERAL SPEED
(*Uml./min.* = r p.m.; *m/s* = meters per sec.)

If F is the cross-section of a blade in sq. cm., which may be assumed to be the same throughout the blade, and if L is the length of the blade, R the average diameter of the wheel in meters, σ_z the tensile stress in kg. per sq. cm. in the cross-section of the blade at the fastening—which should have an area of mF sq. cm., where m is equal or less than unity (Figs. 1 and 2)—then the centrifugal force is—

$$C = \frac{FL\,\gamma u^2}{1000\,gR} = m\,F\,\sigma_z$$

From this may be computed the specific stress

$$\sigma_z = \frac{\gamma\, Lu}{1000\, mgR} \quad \frac{2\,\gamma\pi}{60\times 1000\, mg}\, nLu = \frac{1}{C}\, n\, L\, u$$

and also the maximum length of blade $L_{\max II}$ that will withstand a given centrifugal stress, assuming certain values for m, u and σ_z:

$$L_{\max II} = \frac{C\sigma_z}{\gamma\, n\, u} \qquad \text{[2[}$$

As regards the bending stresses on a turbine blade, data are available from Stodola's book on steam turbines, (4th German edition, pp. 236 ff.). In many cases these bending stresses may neglected.

If only centrifugal stresses be taken into consideration and if n and σ_z be taken as constant, then Equation [3] will obtain:

$$L_{\max II} = \frac{e'}{u} \quad \ldots\ldots\ldots\ldots [3]$$

This and Fig. 3 show that the connection between $L_{\max II}$ on one hand and u on the other hand is expressed by an equilateral hyperbola, while the connection between $L_{\max II}$ and u at a constant speed of rotation in revolutions is expressed by a straight line. Fig. 3 clearly shows that $L_{\max I}$ and $L_{\max II}$ represent the greatest permissible leng h of blade for small and larger values of u respectively, and that the greatest length of blade that can be used for a given number of revolutions n likewise increases at first with the value of u and then from a certain value of u on begins to decrease. It should be clearly borne in mind, however, that the value of $L_{\max II}$ has been in the first place determined only with respect to stresses produced by centrifugal force and that the calculation given above is based on certain assumptions which affect the value of $L_{\max II}$ very materially. Among such assumptions is that of equal cross-section F throughout the entire length of the blade. In many cases, especially where the blades are long and subjected to high stresses, the cross-section is reduced toward the head of the blade, the blade being made thinner at the end or narrower in the axial direction. With such a type of blade $L_{\max II}$ can be, of course, greater than it could have been with a blade with equal cross-section throughout.

Finally the numerical value of $L_{\max II}$ depends materially on the value of m. $m = 1$ requires that all weakening of the cross-section should be avoided at the places when the blade is held in the hub, which is easily done in the case of machined plates. On the other hand, in the case of rolled plates the plate is undercut in the insert. For this case $m < 1$ and $L_{\max II}$ has to be made of course smaller than for machined and unweakened blades.

The following table contains values for $L_{\max II}$ derived from Equation [2] with $m = 1, n = 3000, \sigma_z = 1500$ kg. per sq. cm. and $C = 93.9$, and gives the values of $L_{\max II}$ for different values of u:

u (meters per second).....	100	125	150	175	200	225	250
$L_{\max II}$ (meters).........	0.602	0.481	0.401	0.344	0.301	*0.268*	*0.241*

A comparison of this and the previous table shows that under the above assumptions $L_{\max II}$ passes into $L_{\max I}$ at about u = 200 meters per second. The actual maximum blade length for each peripheral speed is indicated in both tables by italics. If one takes into consideration the bending forces in addition to the centrifugal stresses it is found that the passage from $L_{\max I}$ to $L_{\max II}$ takes place likewise under 200 meters per second.

In Fig. 3, in addition to the curves for n = 3000 r.p.m. are also given the curves for n = 1500 r.p.m. From this and Equations [1] and [2] it would appear that for the same values of u the maximum length of the blades increases with the decrease in n. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 28, July 9, 1921, pp. 739–744, 10 figs., *t*.—Only the first part of the article has been abstracted. Further abstracts will appear in a early issue.)

Short Abstracts of the Month

AIR MACHINERY

Drier Air For Blast Furnaces

Air Conditions in Blast-Furnace Plants, with Special Reference to Moisture Content in Air, J. Bronn. The author made an extensive investigation of moisture content in air at various places around a blast-furnace plant, using a special recording apparatus called a "thermohydrograph," made by R. Fuess, of Steglitz, Germany. This apparatus records both the temperature of the air and the moisture percentage, from which it becomes possible to determine by proper tables the weight of water in a cubic unit of air.

These investigations have shown that the moisture content in air at an altitude of 30 meters (98 ft.) above ground level is about 20 per cent lower than at the ground level, both measurements being made in the neighborhood of a blast furnace. This led to an inquiry as to whether such a difference is universal or due to specific conditions surrounding a blast furnace, and surprisingly enough the author discovered that no reliable information was available as to moisture content at even low altitudes above the ground. A further investigation has indicated, however, that a difference of moisture content as high as that observed in the present instance was by no means universal. and was probably due chiefly to the fact that air even at an elevation of 100 ft. above the ground in the neighborhood of a blast-furnace plant is very much colder than at the lowermost level, and the author ascribes this to the tremendous amounts of heat delivered to the air from blast-furnace or rolling-mill plants.

In fact, he states that, roughly, each square meter (10.7 sq. ft.) of the area of a blast-furnace plant is heated daily by 3 kg. (6.6 lb.) of coke or coal, in addition to which there is a very large amount of water discharged every minute in the various cooling and washing devices. This leads the author to the conclusion that in order to obtain as dry air as possible for the blast furnaces it is of advantage to take this air from as high an elevation as possible.

In order to meet these conditions when in 1912 the blowing-engine house at the Rombach mills was being reconstructed, it was decided to place the suction orifices of all the eight gas-driven blowing engines into a common suction tower 42 meters (138 ft.) high. The new blower unit was not completed until 1915 and then war conditions made measurements difficult, particularly as neither an air hygrometer nor a registering moisture indicator could be used in connection with the suction tower, because of the very great vibration of the air flow, and all measurements had to be made by weight analysis which is a very time-consuming process. Nevertheless, fifty-three measurements were carried out, with the result that it was found that air taken through the top of the tower contained on an average 12 per cent less moisture than air at the ground level.

In this connection it is of interest to note that it was found that when the wind came from the east and particularly from the north-east, there was a rapid increase in the moisture content in air coming through the suction tower. This is explained by the fact that at the distance of some 50 meters (164 ft.) from the tower was located a tall stack discharging the exhaust of all the engines driving the blowers, and it was evidently the vapor from this exhaust that tended to increase the moisture content in the air.

The latter part of the paper presents a calculation indicating the importance from the point of view of economy of reducing as far as possible the moisture content in the air. This computation does not materially differ from several similar computations that have been published in this country. (*Stahl und Eisen*, vol. 41, no. 24, June 16, 1921, pp. 813–820, 7 figs. *e*)

BLAST FURNACES (See Air Machinery)

ENGINEERING MATERIALS (See also Metallurgy)

Alloys of Tellurium with Some White Metals, J. H. Ransom and C. O. Thiem. The experiments carried out covered alloys of tellurium with 50-50 tin-lead solder, and with lead, tin, zinc, aluminum and zinc-base die-casting metal.

Tellurium was added to the molten metals in comparatively small percentages. When it was added to the solder it burst into a glow and then seemed to form hard lumps which only slowly and in part disappeared. No samples of these lumps have been secured for analysis.

As regards the results obtained, it was found that in some cases the addition of tellurium reduced the amount of copper in the solder. No appreciable difference was found as being due to the addition of tellurium to lead and tin, but in the case of aluminum the tensile strength increased from 13,940 to 14,810 lb. and the elongation from 18.5 per cent to 28.5 per cent. In the case of zinc, no difference in elongation was found, but the tensile strength increased from 4955 lb. to 5510 lb. per sq. in. On the whole, it would appear that where metal dissolves tellurium the hardness and tensile strength are increased to an appreciable extent. In all cases investigated it is probable that tellurides of the metals are formed and that these are little soluble in the molten mass. (*Chemical and Metallurgical Engineering*, vol. 25, no. 3, July 20, 1921, pp. 102–103, 1 fig., *e*)

Cast Iron in the Construction of Internal-Combustion Engines, P. W. P. It is claimed that when cast-iron bars are subjected to prolonged heat treatment at temperatures between 575 and 600 deg. cent. a partial decomposition of the pearlitic carbide takes place and that the extent of decomposition of carbide is greater in the comparatively silicon-rich alloys. This decomposition is almost complete when the silicon content exceeds 2 per cent.

The author therefore expresses the opinion that no subsequent treatment, no matter how thorough, will entirely overcome distortion due to repeated application of heat and that little advantage, if any, is to be gained from the standpoint of release of internal stresses set up by the primary crystallization produced during the cooling or freezing of the iron. He believes that it is necessary to select a material having a much lower silicon content than that contained in commercial gray cast iron, and he suggests that 1 per cent be considered the maximum for material to be used for cylinders and pistons of internal-combustion engines. (*Engineering and Industrial Management*, vol. 5, (new series), no. 26, June 30, 1921, pp. 736, *p*)

Effect of Crusher Screenings in Concrete. Data of tests carried out in Canada which are claimed to show an increase in strength of concrete through use in the aggregate of crusher screenings in quantities up to 20 per cent.

Tests carried out have shown among other things that when 5 per cent of the weight of the crushed-stone proportion was added in the form of screenings, which is less than 3 per cent of the total mixture, the strength was increased from 2223 to 2729 lb. per sq. in., or 22 per cent. This is, however, not an entirely new fact.

Tests were also made to determine the effect of screenings from the upper rock as compared with those from the lower rock. It was found that mortars made with crushed sand are considerably stronger than those made with river sand. (*Cement and Engineering News*, vol. 33, no. 7, July 1921, pp. 19–21, 1 fig., *ce*)

Latent Heats of Fusion of Nickel and Monel Metal. Walter P. White. Description of apparatus and methods used for determination of the specific heats of solid or liquid metals. The results found indicate that formerly published figures are in error by about 30 per cent.

The general method employed was that of heating the specimens of metal and then dropping them into a water calorimeter. The metal specimens were handled in closed and nearly exhausted silica glass tubes which protected them from oxidation and supported them while melted. Before exhausting, the tubes were filled with nitrogen to protect the metal during the inclosing process. The total heat of melted nickel is found by pouring the metal directly from crucibles into the calorimeter, using the first appearance of solidification to indicate the temperature—which was therefore the melting point (some practice was required in catching the right moment for pouring).

The latent heat of nickel was found to be 73 calories per gram, 17 calories greater than the determination of Wust (1918). The latent heat of monel metal, 68 calories, is in excellent agreement with that of nickel. (*Chemical and Metallurgical Engineering*, vol. 25, no. 1, July 6, 1921, pp. 17–21, 2 figs., *e*)

FUELS AND FIRING (See Power-Plant Engineering)

HOISTING MACHINERY

The Graphical Dynamics of a Winding Engine, Charles D. Mottram. Description of the apportionment of the external losses in a large steam winding engine at a British colliery. These losses are determined at instants throughout a complete wind in horsepower and curves are plotted on time abscissae.

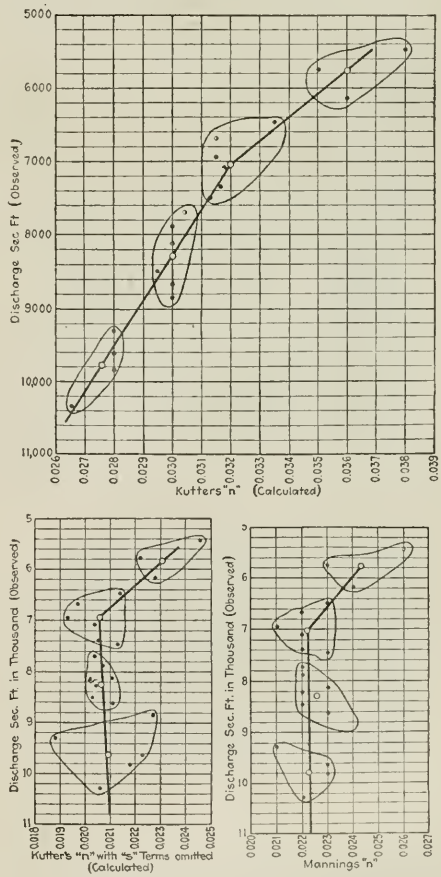
The velocity and acceleration throughout the wind were determined both on the full and on the empty side, this being done from a record automatically drawn by the engine. The record is a diagram showing ordinates proportional to the winding-drum speed in revolutions. On the recorder used in this instance the chart is carried on a cylindrical clock-driven drum varying less than a minute in 24 hours and thus giving an abscissa directly proportional to the time.

The interesting data presented in the paper are not suitable for abstracting. (*The Colliery Guardian and Journal of the Coal and Iron Trades*, vol. 121, no. 3155, June 27, 1921, pp. 1733–1734, 8 figs., *p*)

HYDRAULICS

Manning and Kutter Formulas. In a résumé of four years' intermittent gagings of the flow through the main channel of the Sanitary District of Chicago, contributed to the *Journal of the Western Society of Engineers*, for Sept. 5, 1920, Murray Blanchard, formerly with the Sanitary District, now hydraulic engineer, Illinois State Division of Waterways, Chicago, who made the study, concludes that Kutter's formula to obtain the value of c in the Chézy formula $V = c\sqrt{(Rs)}$ will not apply. The value of n, computed and tabulated from measured discharges ranging from 5,000 to 11,000 sec-ft., is not a constant but increases in value with the decrease in discharge, as shown in Fig. 1.

Similar computation for n with Manning's formula, which for c in the Chézy formula gives $c = 1.486 R^{1/6} n$, shows that n comes out a fairly constant value of 0.220 for all except the low discharge, as shown by Fig. 2.



Figs. 1, 2 and 3 Comparison of Values of n Calculated from Observed Discharges in Main Channel of Sanitary District of Chicago

H. W. King, professor of hydraulic engineering, University of Michigan, in commenting on Mr. Blanchard's equation, states that eliminating the s, or slope terms, will give far more consistent results. Fig. 3, based on the Sanitary District records, gives for n a value somewhat less than 0.021.

Professor King states further that for some time he has been of the opinion that Kutter's formula will give just as satisfactory results without the *s* terms. It is his opinion that the Kutter formula has been used satisfactorily for many years because, in most cases, channels are constructed with slopes so great that the value of *c* is not generally affected by the inclusion of the slope terms. (*Engineering News-Record*, vol. 87, no. 3, July 21, 1921, pp. 96, 3 figs., *ct*)

INTERNAL-COMBUSTION ENGINES (See Engineering Materials; Lubrication)

LUBRICATION

The Carbonization of Lubricating Oils in Internal-Combustion Engines, Frederic H. Garner. The paper discusses the factors which cause decomposition of the oil in the engine, decomposition being considered the fundamental cause of carbonization. According to the opinion of the author, decomposition of oil in an engine can occur in two ways, namely:

First, rapid carbonization due to exposure of the oil (in the form of a fine spray or mist) to the explosion flame causing incomplete combustion of the oil; the result of such carbonization being the production of carbon and asphaltic material.

Second, gradual carbonization of the thin oil film on the piston and cylinder heads at temperatures of 200 to 400 deg. cent., giving first asphaltic material which is changed to carbon by the prolonged action of these temperatures.

The paper describes experiments to determine the evaporation losses and degree of carbonization for various oils and the estimation of the asphalt resin content of lubricating oils.

Among other things it was found that the evaporation losses of lubricating oils of similar boiling-point range were approximately the same whether the oils were derived from Texas or Pennsylvania crude.

It was also found that for similar oils there is a general relationship and that the higher the flash point of the oil, the lower is the amount of asphaltenes formed in a given time at a given temperature. Moreover, the rate of asphaltene formation appears to follow a mathematical law and decreases almost uniformly with rise in flash point and fire point of the oil. Direct carbonization increases much more rapidly than the evaporation loss, both as regards increase of time at a particular temperature and increase of temperature after heating for the same length of time. (*Journal of the Institution of Petroleum Technologists*, vol. 7, no. 26, April 1921, pp. 98–126, with discussion pp. 126–138 and bibliography 139–148, *eA*)

MACHINE PARTS (See Machine Shop)

MACHINE SHOP

Lantern Projector Apparatus for Inspection of Machine Work

Cold Swaging. Second of two articles describing the methods employed in making swaging dies, the first of which was abstracted n Mechanical Engineering, August 1921, p. 546.

An interesting feature is the use of a lantern projector apparatus for the inspection of swaging dies. The machine has a magnification of 50 diameters, which facilitates inspection of the condition of the dies either from a projectograph of the matrix of the die or of a piece of swaged work.

The projectographs reproduced in Figs. 4 and 5 emphasize the value of such an inspection means for detecting imperfections in the die surfaces. Fig. 4 shows a needle of 0.07 in. diameter after being swaged in a pair of dies, and enables the irregularities in the blade, produced either by wear or by improper machining, to be easily detected. Mention has been made in a previous paragraph of the quality of product which may be realized in the manufacture of threaded rods by swaging. The projectograph of swaged threads shown in Fig. 5 is self-explanatory. The thread form, it will be seen, is exceptionally good, although it is not in respect to thread form that the swaging process is most efficient, but rather in the lead.

On precision work such as the sizing of wire or for work encountered in needle manufacture, the existence of worn surfaces must be detected before it has advanced far enough to produce unsatisfactory work. The detection of this wear probably cannot be accomplished with such a degree of positiveness as by the use of the projectograph apparatus. (*Machinery*, vol. 27, no. 11, July 1921, pp. 1018–21, 8 figs., *d*)

Position of Lathe with Respect to Light. The general tendency is to place a lathe, when possible, in front of or near to a window, or under a top light, but only seldom is an effort made to secure any result beyond that of obtaining as ample light as possible.

An engineer who has done a considerable amount of research work in turning is credited with the statement that when a lathe has been moved from a position in front of a window facing to the west to one facing to the north, a much better view of the operations has been obtained.

Artists have for a long time endeavored to have their studio windows face north; weaving sheds and other workshops have also been planned to obtain north lighting. (*Model Engineer and Electrician*, vol. 45, no. 1054, July 7, 1921, pp. 1 and 2, *p*)

Fig. 4 Projectograph of a Needle of 0.07 In. Diameter

Fig. 5 Swaged Thread Projectographed to Show the Contour

Non-Metallic Gears

Design and Manufacture of Non-Metallic Gears, Fred R. Daniels. Description of the methods and processes employed in the manufacture of rawhide and micarta gears.

The raw material from which rawhide gears are made is the green packer hides cured and treated by processes that leaves mainly a fibrous structure. These processes reduce each hide to a thickness of approximately $^1/_{16}$ in., the hide being then blanked into circular disks or into rings or segments according to the requirements of the gear manufacturers. These blanked-out hides are then dipped into a vat of special glue and assembled between steel end blocks until a thickness of from 8 to 10 in. has been reached. Hydraulic pressure is next applied to squeeze out the surplus glue, after which the blank is kept compressed until dry, which may require several days.

Gears made from various fabric-base materials are said to resemble closely each other in physical characteristics. The fabric is first impregnated with compositions (condensation products of phenol and formaldehyde), after which a number of the blanks are bonded together under great pressure and application of heat. The rings or segments are cut from the impregnated fabric and placed in a suitable mold before the pressure and heat are applied.

Rings or segments are used in designs where a spider or bushing is the main support. Such constructions are employed where a stress on the key is likely to be greater than the material itself would be able to withstand if the gear were made of one solid blank. Micarta is frequently mounted on a hub center in such a manner that no additional mechanical retaining means are required.

Rawhide gears should not be subjected to a temperature in excess of 225 deg. fahr., neither must they become wet. Care must be therefore taken to provide suitable storage space for rawhide gears and when not in use the rawhide should be coated with shellac and kept in a cool, dry place. The life of the gear in service is greatly prolonged by the use of a lubricant consisting of a thin mixture of lard oil and graphite. Mineral oils should never be used as a lubricant for rawhide.

On the other hand, rawhide is as strong as cast iron at high speeds and gears are often used with peripheral speeds of from 1700 to 2000 ft. per min. or more. Rawhide can successfully compete with bronze from the viewpoint of ultimate cost, owing to its comparative length of service, but is somewhat higher as regards first costs.

A safe working load for rawhide pinions is 150 lb. per inch width of face for gears of 1-in. circular pitch. The working load for other pitches should be in proportion but should never exceed 250 lb. per inch of face width, and an allowance of from 20 to 25 per cent should be made for such conditions as overload, etc. The above figures apply only to pinions constructed without flanges and may be increased from 10 to 25 per cent for pinions with flanges.

Fabric-base materials are not affected by water or oil, not susceptible to the action of acids or alkaline solutions, and not attacked by rodents. They will not shrink at temperatures under 200 deg. fahr.

The specific gravity of these fabric-base materials is 1.4, the weight 0.05 lb. per cu. in., and the Brinell hardness from 30 to 40. The raw material has a tensile strength, parallel to the laminations, of 10,000 lb. per sq. in.; a compressive strength of from 35,000 to 47,000 lb. per sq. in. perpendicular to the laminations, and from 17,000 to 24,500 lb. per sq. in. parallel to the laminations; and a transverse strength, both parallel and perpendicular, of 17,000 lb. per sq. in. In figuring the strength of gear teeth by the Lewis formula, however, a safe working load greater than 5000 lb. per sq. in. should not be used.

The diametral pitch of gear teeth recommended for service is as follows: For smaller loads up to and including $1/2$ hp., 10 pitch; for 1 hp., 8 pitch; 2 hp., 5 pitch; 10 hp., 4 pitch; 15 hp., 2 pitch; 25 hp., $2\,1/2$ pitch; 50 hp., 2 pitch; 75 hp., $1\,3/4$ pitch; and 100 hp., $1\,1/2$ pitch. When heavier service than 100 hp. is encountered, the design of the gears should receive special consideration. The maximum recommended pitch-line speed is 2500 ft. per min. The greatest length of service for gearing is obtained when there is a good rolling contact; consequently the most desirable condition in non-metallic gear design is where there is a comparatively large number of teeth. Gears having less than fifteen teeth do not furnish good rolling contact, and they wear faster and vibrate more than when a finer tooth is used. It may even be good engineering to redesign the entire gear train in order to use gears of smaller pitch.

The article gives extensive information on the design and machine methods of these gears and also illustrates several of the designs of the gears. (*Machinery*, vol. 27, no. 11, July 1921, pp. 1005–1011, 12 figs., *d*)

Milling Slender Castings. Description of the fixtures and processes used by the Remington Typewriter Co. Of particular interest is the discussion of the effect of rate of feed or distortion of work.

It was found that the rate of feed used for milling has a decided influence on the distortion of such slender parts as the bed and carriage rails of the typewriter. When a fine feed is used there is considerable distortion, but when the feed is coarse the distortion is not great enough to cause trouble.

The explanation given for this fact is as follows: Milling often leaves on the surfaces uniformly spaced revolution marks caused by some irregularity of the cutter such as the presence of a tooth which differs slightly from the others. As this irregular tooth comes around, it strikes the work with greater force than the others. This irregularity while slight, may have, nevertheless, a pronounced effect on the work when the feed is fine because the "peening" action, due to the irregularity of the cutter, is greater or occurs often in a given length with the fine feed than with the coarse feed; consequently there is greater distortion with the fine feed. (*Machinery* (London), vol. 18, no. 456, June 23, 1921, pp. 356–358, 4 figs., *dp*)

MACHINE TOOLS

Inclined Wheel Grinders

Phantom Wheel Grinders, Ellsworth Sheldon. Description of a new type of grinder of American manufacture.

The device was invented primarily for grinding extremely thin pieces of hardened steel. The pieces are not absolutely flat when they come from the hardening process to the grinding operation and will not lie still under the wheel unless packed. Packing each piece to grind first one side and then the other alternately would render the cost prohibitive, even if it were possible mechanically. A magnetic chuck could not be used because some of the

Fig. 6 Parts of the Phantom Grinding Wheel

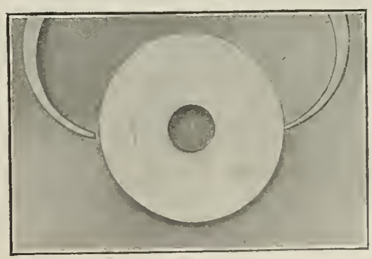


Fig. 7 Ellipticity of the Phantom Grinding Wheel

pieces were so thin that even the pull exerted by it would distort them. To handle these wheels a special bearing was provided, but its character was such that there was no very efficient way of conducting the heat away from the piece being ground. Furthermore, a solid wheel wide enough to cover the surface of the work would quickly sweep the pieces off the chuck or would overheat them, and a very narrow wheel that would enable the operator to avoid both these troubles would take a long time to traverse over the width of the piece, besides being likely to induce distortion because of the slow progression of the hot spot across the work.

It was to avoid these troubles that the "phantom" wheel was developed.

The parts of the phantom wheel are shown in Fig. 6. A standard grinding wheel 7 in. in diameter and of about $^1/_2$ in. width of face was first mounted in the usual manner and dressed to the shape shown in the figure, leaving a very narrow face. A sleeve was then fitted with a pair of collars, one face of each collar being machined to form an angle of about 15 deg. with its axis.

These collars are keyed to the sleeve. The lead bushing of the grinding wheel is then dug out to allow the wheel to tilt to an angle corresponding to that of the collars, a ring nut holding the whole combination together.

When the whole combination is first mounted on the grinding machine the periphery of the wheel does not run true. There are two high and two low spots. In other words, the wheel, though round of itself, will appear to be elliptical. To correct this condition the periphery must be redressed and thereafter the ring nut that binds the parts together must not be slackened; for the wheel that now presents a truly circular periphery to the work is in fact elliptic, as may be seen in Fig. 7, and as is shown by the calipers; the actual difference between the larger and smaller diameter with a wheel initially 7 in. in diameter amounts to about $^3/_{32}$ in.

The grinding action of the wheel is in effect the same as that of a solid wheel of the width equal to the scope of gyration, but the action may be represented as a series of contacts progressing back and forth across the work in a direction at right angles to its lineal advance.

When in motion the solid lines of the wheel disappear and, though the wheel is grinding with the apparent continuity of a solid wheel of 1 in. face and throwing sparks clear across the work, the work is at no time concealed from the operator's view.

Furthermore, because of the narrow surface in contact with the work at any time, comparatively little heat is generated and it becomes possible to cover the entire surface of the work without side traverse and with little danger of drawing the temper.

The original article shows a rather unusual method of dressing the wheel in which the diamond is placed at an angle of 45 deg. (*American Machinist*, vol. 55, no. 2, July 14, 1921, pp. 44–45, 5 figs., *d*)

METALLURGY

High-Temperature-Resisting Alloys for Carbonizing, A. Bensel. In two of the processes of case carbonizing, namely, pack carbonizing and liquid-bath carbonizing, the parts are packed in containers and it is claimed that cast-iron and steel containers are badly distorted in a relatively short time, with the result that it is impossible to load a furnace evenly. It is also stated that cast-iron and steel containers are subject to the formation of scale. While this scale clings to the box it makes the heat penetration poor, and when it drops off the walls become thinner and more heat is supplied to the work than should be.

The material for containers should be such that it will not easily carbonize, is not brittle and is capable of being machined. It should have a high tensile strength and retain much of that strength at the usual operating temperatures.

The alloy developed for this purpose is said to have the following characteristics:

Percentage composition: Nickel, 60; chromium, 12; iron, 26; carbon, silicon, manganese, etc., 2.
Melting point, 2660 deg. fahr.
Safe working temperature, 2000 deg. fahr.
Specific gravity, 8.15; Weight per cubic inch, 0.29 lb.
Specific heat, 0.111 at 100 deg. cent.
Brinell hardness number, 179
Scleroscope hardness, 27 to 30
Coefficient of linear expansion over temperature range from 0 to 100 deg. cent., 0.0000121
Thermal conductivity is 0.0341 cal. per cm. per sec., or a ratio of 1 to 4.888 with soft iron; or expressed in percentage, 20.5 per cent of the thermal conductivity of soft iron

The following tests were made on a 1-in. diameter specimen:

Tensile tests at 70 deg. fahr.:
Elastic limit, 40,000 lb. per sq. in.
Ultimate tensile strength, 54,000 lb. per sq. in.
Elongation, 1.00 per cent
Reduction of area, 2.50 per cent

Tensile tests at 1500 deg. fahr.:
Elastic limit, 20,100 lb. per sq. in.
Ultimate tensile strength, 24,500 lb. per sq. in.
Elongation, 4.00 per cent
Reduction of area, 4.30 per cent

The use of such an alloy made it possible to design a round container with a machined taper-fit cover which goes snugly into the container and closes it as a ground-glass-stoppered bottle. (*Transactions of the American Society for Steel Treating*, vol. 1, no. 10, July 1921, pp. 598-601, *dp*)

PIPE LINES

Economics of Lagging Oil Pipe Lines

Pipe-Line Transportation of Hot Oil. Leonard L. Barrett Discussion of effect of applying insulating coverings to hot-oil pipe lines such as are found in the California, Texas, and Mexican fields, with special reference to the economic results to be obtained by such practice.

The rate of heat loss from a hot-oil pipe line has a governing effect upon the location of stations. As the temperature of the oil drops, due to loss of heat by radiation, the viscosity of the oil increases rapidly and a point is reached where it becomes necessary to install a pumping station and heaters to force the oil along. The low specific heat of crude oil (approximately 0.5) accounts in a measure for the rapidity with which the oil drops in temperature during its passage through the pipe lines, because for a given loss of heat the temperature of the oil will drop twice as fast as would that of water.

The chief advantage of a suitable insulating covering on the pipe line is found in the heat saving effected, as it permits to space farther apart the pumping and heating stations which form the principal element of cost in pipe-line construction. It is stated in this connection that the loss of heat to the air from a pipe covered with a 1-in. thickness of 85 per cent magnesia is 0.45 B.t.u. per sq. ft. of pipe surface per hour per degree temperature difference, while the bare-pipe loss in air is between four and five times as much and the ditched-pipe loss may even exceed that of pipe in air if the ground is wet.

An extensive calculation of the flow of viscous fluids, of spacing of pumping stations and temperature of oil during flow is presented. This is accompanied by temperature-distance curves, viscosity-distance curves, density-distance curves and calculation of thermal efficiencies obtained in practice.

As regards the coefficient of radiation, it is stated that the values given in the article for above-ground insulated lines are very reliable, likewise the values for above-ground uninsulated lines, though the latter have been determined only for still-air conditions and would have to be increased for air in motion. The value of the coefficient for ditched insulated and uninsulated lines cannot be considered as fully reliable.

The discussion of the economic aspects of the question brings the author to the conclusion that insulation of pipe lines would bring the following net savings, (based on present cost): A capital saving of $72,000 per 100 miles, an annual saving of $36,700 per 100 miles and a saving of 3.85 cents per 1000 barrel-mile cost. To this should be added the advantage gained through the protection of the pipe from electrolysis and the steadiness in operating conditions which is gained by eliminating all the trouble due to moist ground during rainy weather. (*Chemical and Metallurgical Engineering*, vol. 24, no. 26, June 29, 1921, pp. 1148–1152, 3 figs., *cp*)

POWER-PLANT ENGINEERING

Economic Features of Pulverized-Coal Firing

Pulverized-Coal Versus Stoker Firing, F. P. Coffin. Comparative data on the value of the two under different operating conditions. The author arrives at the conclusion that where great flexibility of operation is required, pulverized coal may prove preferable.

The development of the underfeed stoker has made the adoption of pulverized fuel more difficult, though improved machinery for its preparation may help in this respect. It is also claimed

that large plants can be equipped for the preparation and burning of pulverized fuel at less cost than for burning coal on stokers.

The most important advantage of pulverized-fuel firing is its ability to handle a wider range of coals than can be burned on stokers and the same furnace is available for burning all grades of coal in pulverized form. Another important advantage is the facility and economy with which fires may be banked and the ease with which they may be restarted when steam is wanted suddenly. This makes pulverized fuel especially desirable where the steam plant is used as a reserve unit either in connection with water power or to carry peak loads.

From a discussion of several large central stations the author finds that the coal consumed in banking fires and bringing them back into steaming conditions was in one instance 3.76 per cent of the annual consumption. In another system with 15 stations feeding into it, 1.5 per cent of the annual consumption, and in a third instance the coal used for maintaining banked fires ran from 5.5 to 6.5 per cent of the total coal used.

In the first of these systems the underfeed stokers could be economically banked, the consumption then being only 35 lb. per hour for each 5000-sq. ft. boiler, but 1500 lb. was required to bring the fire back into condition for operation. When a fire was allowed to go out, 1000 lb. of coal was left on the grate and credited to the plant, while 6000 lb. was required to light a boiler and bring it to steaming condition, ready to put on the line.

When coal is burned on stokers in stations that are used for stand-by service for a considerable part of the year, the consumption in banking fires is an appreciable item of expense. The amount of coal burned during banking periods varies with the service conditions. Banked fires are carried as "hot bank" or cold bank." "Hot bank" or "live bank" consists in carrying full steam pressure and having the fire in condition to get the boiler to the normal rating in from five to seven minutes. A "cold bank" or "dead bank" consists in burning only enough fuel to keep up a low steam pressure. On modern underfeed stokers the average hourly coal consumption during banking is about 0.05 lb. per sq. ft. of heating surface on live bank and 0.02 lb. on dead bank or 7.5 to 10 and 2.5 to 3.5 per cent, respectively, of the fuel at full load.

Where pulverized fuel is used, steam has been held over night with only a small drop in pressure and in the morning about four minutes' firing sufficed to bring the pressure up to normal.

This suggested that the equivalent of dead-banking conditions may be effected by burning fuel only under a single boiler in a battery and by maintaining a steam pressure in the remaining boilers by circulating either steam or hot water through them from the live boiler. This will keep the boilers hot and permit raising the pressure rapidly without undue overstrain.

A further advantage claimed for pulverized fuel is that it is more responsive to delicate control of combustion conditions than solid fuel. On a good station-load factor the investment required for a pulverized-coal installation is comparable with that required for a stoker installation, but as the load factor becomes poorer the pulverized-coal installation will cost less in proportion, provided the fuel requirements are sufficient to enable the preparation plant to operate at a good load factor. (*Power*, vol. 54, no. 2, July 12, 1921, pp. 52–54, 2 figs., *cp*)

POWER PLANTS (See also Pipe Lines)

Cleaning Surface-Condenser Tubes, D. W. R. Morgan. After discussing the economic importance of keeping the condensers clean, the author proceeds to a description of eight methods of cleaning, some of which appear to be very expensive and others lacking in efficiency. The following, however, are recommended for use under certain conditions. The use of adjustable rubber plugs is said to be well adapted to cleaning the tubes when the deposit is of a slimy nature. These plugs are inserted into the tubes and are driven through by compressed air or water pressure. Cleaners of the scraper type are applied in a manner similar to the adjustable rubber plugs. This method of cleaning applies particularly to cases where there is a brittle or hard deposit on the tubes. The sketch in Fig. 8 illustrates the arrangement required for either the adjustable rubber plug or the cleaner of the scraper type, in cases where the condenser head has been removed. The brackets which support the scaffold plank are bolted to the flange of the condenser and may be set at any elevation. The seat and foot rest are made in one piece and can be moved along the plank to the most convenient position. A $^3/_4$-in. quick-opening gate valve is supported from the foot rest and is controlled by the operator's foot. Large condensers are cleaned without taking the heads off; this eliminates the seat and foot support, and the $^3/_4$-in. valve is then located adjacent to the nozzle and is operated by hand.

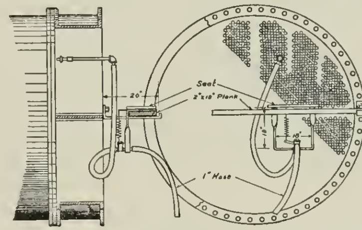


Fig. 8 Arrangement of Equipment for Cleaning Condenser by Rubber Plugs or Scrapers (Head Removed)

The author does not believe in the efficiency of providing valve in the intake and discharge line of the condenser in order to reverse the flow of the water.

The ejector method applying low-pressure water and air at 80 lb. pressure to the tubes is illustrated in Fig. 9. The equipment consists of a $^3/_4$-in. tee into which the $^1/_4$-in. air nozzle A is inserted, thus forming an ejector. Nozzle N is flattened out so as to impart a spiral flow to the water. The air connection is made tc point A

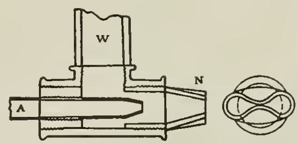


Fig. 9 Ejector for Applying Low-Pressure Water to Condenser Tubes by Compressed Air

and the water connection is made at W, using water at atmospheric pressure. It requires about five seconds to clean each tube properly with this method. (*The Electric Journal*, vol. 18, no. 7, July 1921, pp. 313–315, 6 figs. *d*)

Removing Scale from Surface-Condenser Tubes with Hydrochloric Acid, Norman G. Hardy. Date obtained from the practice of the Arizona Copper Co., at Clifton, Ariz., where hydrochloric acid has been used to clean condensers for the last two years. It is not claimed that this method is entirely satisfactory or that it is suitable under all conditions, but it has given very good success at the plant.

The general arrangement of apparatus is shown diagrammatically in Fig. 10. The condensers in this outfit have a tube area of 7600 sq. ft. in 2500 Muntz metal tubes $^3/_4$ in. in diameter by 15 ft. 1 in. long. The condensers have two passes with a vertical diaphragm between the water inlet and outlet compartments.

Before using the acid, both heads are removed from the water boxes, the tubes are washed out with a hoset he scale is cleaned from the water boxes, theheads, and, so far as,practicable, from the tubes sheets also; after drying thoroughly, water boxes, heads and tube sheets are painted with two coats of roofing cement, to eliminate all chances of corrosion of the permanent parts of the condenser.

At first an acid-proof paint was tried, with the idea of maintaining a coating that would only have to be replaced occasionally, but it was found that the coating would not remain serviceable from one cleaning to the next. After trying several asphaltic paints, it

was decided that roofing cement, such as is ordinarily supplied for cementing the seams of prepared roofing, was best because it is sufficiently acid-resistant, can be easily applied, and dries quickly.

Cover plates with gaskets are next fastened over water inlet and outlet with capscrews tapped into the water box. The heads are then replaced and the apparatus connected up as indicated in the figure.

Vent pipes about 12 ft. long are placed at the top of each water compartment. The water boxes are tapped for $1^1/_2$-in. pipe and have a short nipple and reducer to connect to the 3-in. vent pipe. These vent pipes are very necessary, and it has been found that gas will blow water over if a height of less than 12 ft. is used. To circulate the solution, a 2-in. brass centrifugal pump with direct-connected motor drive is used.

The acid used is commercial hydrochloric, averaging about 24 per cent HCl. It is estimated that the water boxes and tubes will hold 7800 lb. of water, and 1000 lb. of acid is used for cleaning, making the solution about 3 per cent HCl. A stream from a $^3/_4$-in.

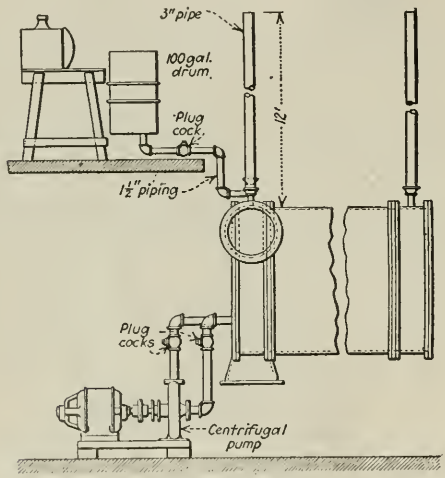


Fig. 10 Arrangement of Apparatus for Cleaning Condenser with Hydrochloric Acid

hose is used for supplying water and the time required to discharge a measured quantity to the mixing tank is noted. From this the length of time necessary to empty one carboy of acid, with water flowing into the tank continuously, is calculated. Having the outlet from the mixing tank open, the water from the hose and the acid from the carboy are delivered into the mixing tank at a predetermined rate, whence they flow into the condenser continuously until it is filled. This is a rather crude method of proportioning the mixture, but it has been satisfactory in practice.

As soon as the level of the solution in the condenser rises above the pump suction, the pump is started. It is kept running for four to five hours, by which time the acid is entirely neutralized. The solution is usually not drained from the condenser until the following day.

The amount of scale actually dissolved is relatively small, being equivalent to a thickness of about 0.001 in. for the condenser and mixture described. But the great benefit of acid treatment is that it softens and loosens scale, so that it can easily be removed by washing and brushing. For this reason, if the condenser is very dirty, it will probably be more economical to treat it several times with a weak solution, washing out the loosened material between treatments, than to use a stronger solution.

The principal objections to the use of acid for cleaning are high cost and the possibility of injury to tubes and packing. The first of these is undoubtedly justified and eliminates this method in any case where the tubes are in good condition and the scale is not too hard to permit mechanical cleaning.

With regard to the second objection, it can be positively stated that the experience of the Arizona Power Co., Ltd. for two years past does not indicate any serious deterioration of tubes as a result of the use of acid for cleaning. (*Power*, vol. 54, no. 1, July 5, 1921, pp. 22–24, 1 fig., *b*)

SPECIAL PROCESSES (See Machine Shop)

Charcoal-Iron Boiler Tubes

The Manufacture of Charcoal-Iron Boiler Tubes. Description of the processes employed by the Parkesburg Iron Co., Parkesburg, Pa. The processes are of interest, partly because of the considerable use of this kind of tubes and also because of the fact that the manufacture has been to an unusually slight degree affected by the general processes of mechanization of modern industry.

The first stage in manufacture is selection of scrap to go into the melt. Metal containing copper, tin, nickel, chromium or more than one-half of one per cent silicon is considered to be unfit for use, as these elements tend to make he finished product dry or brittle and unweldable.

The charges, in not more than 300-lb. lots, are placed in small forge fires in furnaces which to all intents and purposes have not changed in design in the last thousand years. In a rectangular hearth about 16 in. deep by 2 ft. square with a cast-iron box about 3 ft. high and open in the front, the charges are slowly melted in incandescent charcoal, the required oxygen being furnished by a blast of air entering the charcoal bed at an angle at about half its depth. Under the action of the blast the light scrap begins to melt and during the heating the impurities such as carbon, manganese, silicon and sulphur are slowly oxidized, a relatively large proportion of iron also undergoing the same process. The oxides unite to form a high basic slag with a comparatively low melting point and therefore quite fluid.

Gradually the mass becomes a conglomeration of microscopic grains of pure plastic iron, each covered or glazed with a film of slag.

The incandescent lump is then removed to a steam hammer where it is forged or "shingled" to a bloom about 30 in. by 5 in. by 6 in. Before it is placed under the hammer the lump resembles a sponge with the holes filled with molten slag, and the whole covered with a husk of iron oxide and partly consumed charcoal. Under the hammer most of the slag between the grains of the iron is forced out. From the hammers the hot blooms are passed to a reheating furnace and then rolled into bars. In this process the balance of the slag is almost entirely worked out.

After cooling, the bars are sheared into the required length, reheated and rerolled in a two-high plate mill. The rolling is done transversely, that is, the length of the pile is parallel with the axis of the rolls. The pile is run through the mill until the length of the resulting slab is equal to the desired width of the finished plate. The slab is then turned through 90 deg. and rolled for length and thickness to give the iron cross fiber or additional strength across the grain. The metal is always rolled in the same direction, and the few impurities left are worked to one end of the plate, which is cropped off and a much better surface is obtained.

The plates are next trimmed into strips of the proper width to make the tubes ("skelp").

The rest of the operations do not materially differ from the manufacture of welded tubing of other kinds. (*The Boiler Maker*, vol. 21, no. 7, July 1921, pp. 187–190 and 212, 9 figs., *d*).

STEAM ENGINEERING (See Power Plants)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Engineering Research at Michigan

THE report of Prof. A. E. White, Director of the Department of Engineering Research at the University of Michigan, made to the third meeting of the Executive Committee of the Advisory Board, outlines the plans of the department. The report shows the great value of the industrial products of Michigan and comments on the work done at the Mellon Institute, the M.I.T. and the University of Illinois, and from this points out the opportunity for development of the department of research at the University. The department has an Advisory Board of one hundred men made up of the leading business men of the state and divided into groups according to the industries to which they belong. These subdivisions will be called Committees, and the chairman of each Committee will be empowered to enlarge the Committee when necessary. These sub-committees will confer with the Director of the Department of Engineering Research on problems and policies and on the methods of solving various research problems. The University has placed all of its facilities at the service of the Department of Engineering Research.

The method of financing various research investigations has not been decided on. Six plans are suggested:

1 All cost of investigation cared for by interested parties
2 Investigations financed from income from the state
3 Investigations financed from funds of an association formed for this purpose
4 Joint financing: industries provide funds, state provides building
5 Joint financing: industries provide building, state provides endowment
6 Industries provide buildings and endowments.

Locomotive Testing

The Locomotive Testing Laboratory of the University of Illinois is one of the largest laboratories for this purpose and in some respects the best-equipped locomotive laboratory in existence. The expense of operating it, however, is great, and for that reason little work is being done. It is hoped that steps may be taken by certain railway interests to use the laboratory for the purpose of research regarding the action of locomotives. It is believed that the authorities of the University of Illinois are willing to donate the use of the laboratory provided interested parties would finance the maintenance of the Research Staff and the purchase of coal and necessary supplies. This cost would amount to $60,000 per year, exclusive of any rental which might be charged the company furnishing the locomotive for test. The use of this laboratory for an investigation of locomotive problems would probably lead to extensive savings in the use of coal and other supplies. Address Dean C. R. Richards, University of Illinois, Urbana, Ill.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

Apparatus and Instruments A7–21. Hygrometer. Technical Note 148 of the Forest Products Laboratory is on the Care and Use of Hygrometer in Kiln Drying. The note states that each thermometer of the hygrometer should be compared with the standard thermometer before using and a record noted. The hygrometer reservoir should be filled with pure water only. It is important that the silk or muslin covering of the wet bulb be kept in good condition at all times. A small amount of solid material is always left in the meshes after evaporation and this impedes distribution of moisture. The hygrometer should be placed at the exact points at which information is desired. Do not place it near door, wall or radiator. Such positions are not representative. In reading wet bulb sufficient air circulation should be present to give maximum evaporative rate from covering. U. S. Forest Products Laboratory, Madison, Wis. Address Director.

Automotive Vehicles and Equipment A7–21. Brake Linings. An investigation on commercial brake linings is being made at the Bureau of Standards and the results of these tests will be published later. One of the preliminary results shows that the coefficient of friction between the brake band and drum may fall to one-third of its normal value when the brakes first become hot. On cooling the normal value is restored. Used linings do not show this effect to such a great extent. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Economics A1–21. Telephone Service. Circular 112 of the Bureau of Standards on Telephone Service has just been published and may be obtained at 65 cents per copy from the Superintendent of Documents. This circular describes the service which the telephone company sells, enumerating the elements of the service and how the grade of service is dependent on each. It describes the various instruments used and calls attention to what determines the grade of service furnished by various companies. It describes the regulatory commissions controlling telephone service and discusses the matter of plant extensions, abandonment of service, physical connections, accounting, valuation, rates, contracts, collections and discriminations, etc., etc. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Electrical Communication A1–21. Telephone Service. See *Economics A1–21.*

Fuels, Gas, Tar and Coke A12–21. Sulphur in Coal. The Analysis of the Sulphur Forms in Coal is the subject of Technical Paper 254 by Alfred R. Powell for the Bureau of Mines. The purpose of the paper was to test the method of Powell and Parr for the analysis of sulphur forms in coal, to determine its application and to indicate, if necessary, certain refinements in the process. The Powell and Parr method is described and the investigation proves it to give correct and accurate results and that dilute nitric acid will extract small amounts of organic sulphur from certain coals. This is in the unstable phenol-soluble form. In order to avoid this error it is recommended that pyritic sulphur be calculated from the pyritic iron value. The results show that acid extractions can be materially shortened by a shaking machine and that dilute nitric acid not only extracts the pyrites quantitatively but also the same iron and sulphur taken into solution by dilute hydrochloric acid. Hence dilute nitric acid extraction need not be extracted first with hydrochloric acid. The experiments showed that semi-bituminous coals and harder bituminous coals must be digested a long time with concentrated nitric acid before the organic matter will become completely soluble in ammonia. The research proved that the Eschka method is preferable to the sodium peroxide method for the analysis of sulphur in coal and the coal residue, unless the sodium peroxide used has a low and constant sulphur content. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Heat A11–21. Constants of Transmission for Pipe Covering at High Temperature Differences. One of the thesis subjects at the Rensselaer Polytechnic Institute during the spring of 1921 was the investigation of pipe covering of the Philip Carey Company of Cincinnati. Three types were tested: Carey Carocel, consisting of numerous laminations corrugated longitudinally with about ten layers per inch; Carey Multiply, a laminated covering made up of numerous rough-surfaced asbestos sheets of about 32 layers per inch, and Carey 85 per cent Magnesia. These coverings were tested in single, double and triple thicknesses—approximately 1 in., 2 in. and 3 in. The constant k of transmission was computed from the formula—

$$\text{Heat} = k2\pi L(t_1 - t_2)/\log_e(r_2/r_1)$$

in which L = length in feet, $(t_1 - t_2)$ = temperature difference in deg. fahr., and r_2 and r_1 are respectively the radii to the outside and inside of covering.

The results of the tests are shown in Figs. 1 and 2. Fig. 1 indicates that in general the coefficient of heat transfer increases with the temperature difference in 1-in. covering, and as the thickness of the covering increases the coefficient remains more nearly constant. The variations of the coefficient with thickness of covering at temperature differences of 200 deg. and of 600 deg. are indicated in Fig. 2. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Heat A12–21. Heat Transfer to Oil. The Coefficient of Heat Transfer from Steam to Oil through Steel Pipe has been the subject of a thesis at the Rensselaer Polytechnic Institute. The results of this thesis

are shown in the curves of Fig. 3. The oils used were as follows:

450 Red—Kendall Refining Company.
- Specific gravity........ 31 deg. B.
- Viscosity.............. 181 Saybolt at 100 deg. fahr.
- Flash point............ 356 deg. fahr.
- Burning point......... 451 deg. fahr.

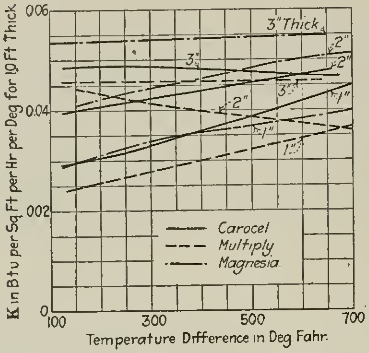


Fig. 1 Variation of Coefficient of Heat Transfer with Temperature Difference

600 Cylinder—Kendall Refining Company
- Specific gravity........ 25.5 deg. B.
- Viscosity.............. 95 Saybolt at 212 deg. fahr.
- Flash point............ 428 deg. fahr.
- Burning point......... 550 deg. fahr.

Kerosene—Commercial Kerosene of the Standard Oil Company

28–30 Petroleum Fuel Oil—Standard Oil Company
- Specific gravity........ 30.8 deg. B.
- Viscosity.............. 51 Saybolt at 100 deg. fahr.
- Flash point............ 205 deg. fahr.
- Burning point......... 300 deg. fahr.

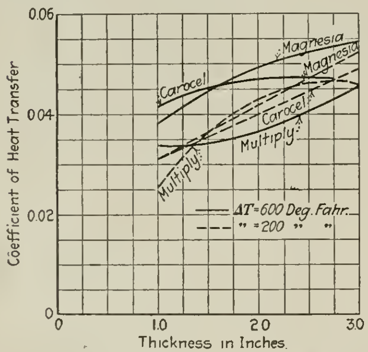


Fig. 2 Variation of Coefficient of Heat Transfer with Thickness of Covering at Temperature Differences of 200 and 600 Deg. Fahr.

Crude Oil—Standard Oil Company
- Specific gravity........ 33.4 deg. B.
- Viscosity.............. 53 Saybolt at 100 deg. fahr.
- Flash point............ 110 deg. fahr.
- Burning point......... 136 deg. fahr.

The 14–16 fuel oil was not tested for physical properties. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Illumination A1–21. Prof. E. H. Waldo has investigated the distribution of incandescent street-lighting units and has found that the statements issued by the various companies producing the units are substantially correct. Address Dean C. R. Richards, Engineering Experiment Station University of Illinois, Urbana, Ill.

Internal-Combustion Motors A3–21. Water Injection with Kerosene as Fuel. One of the undergraduate theses at the Rensselaer Polytechnic Institute during the spring of 1921 has been the investigation of effect of injecting water with kerosene in an internal-combustion engine. The engine used was a 7-in. by 12-in. Fairbanks-Morse type horizontal gas engine fitted for various types of fuel. Water was allowed to enter with the kerosene and both the water and kerosene were preheated to 150 deg. fahr. by passing them through an iron tube heated by a bunsen burner. In all cases the amount of water injected was computed as that above the moisture in the air at 5.8 grains per cu. ft. The effect of the water injection is to reduce the initial explosion pressure and at full load the injection of water seems to decrease the fuel consumption. The decrease of explosion pressure increases the smoothness of operation of the engine and this seems to increase mechanical efficiency of the engine by giving greater pressures at more advantageous crank angles. At great quantities of water injection the mechanical efficiency decreases, and this is believed to be due to the tendency of the water to destroy the cylinder lubrication. Water injection seems to result in a cooler operation of the engine, as shown by the decrease in the amount of heat absorbed by the cooling water and the lower temperature of the exhaust gases. Fig. 4 shows the pounds of fuel per brake horsepower-hour at different ratios of kerosene to water, the curves indicating that 8 lb. of kerosene to 1 lb. of water gives the best result. Fig. 5 shows the effect of various amounts of water injected at different horsepowers. Fig. 6 shows the effect of water injection on the initial explosion pressure and Fig. 7 the effect of water injection on the mechanical efficiency. Rensselaer Polytechnic Institute, Troy, N. Y. Address Arthur M. Greene, Jr.

Metallurgy and Metallography A12–21. Centrifugally Cast Steel. Technologic Paper No. 192 of the Bureau of Standards dealing with centrifugally cast steel has just been issued. It may be obtained from the Superintendent of Documents, Washington, D. C. at 10 cents a copy. The experiments reported show that metal so cast shows physical soundness and freedom from chemical segregation. For certain shapes forging and boring operations may be eliminated. It is shown that subsequent heat treatment of such castings improves them and makes them comparable with forgings. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A13–21. Corrosion of Soft Metals. The results of the investigation of corrosion will soon be published. The investigation has determined the extent of intercrystalline embrittlement of soft metals—zinc, aluminum and tin—as a result of prolonged corrosion. Lead has been previously studied. Although the effect of stress in accelerating this action in lead will be studied, the publication of the results is expected at an early date. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mining, General A4–21. Gas Masks. Gas Masks for Gases Met in Fighting Fires is the subject of Technical Paper 248 issued by the Bureau of Mines. It is prepared by A. C. Fieldner, S. H. Katz and S. P. Kinney. It also contains a chapter on the Effects of Gases and the Treatment of Gas Poisoning by Y. Henderson. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Mining, General A5–21. Safety Lamps. The Relative Safety of Brass, Copper and Steel Gauze in Safety Lamps is the subject of Technical Paper 228 of the Bureau of Mines by L. C. Ilsley and A. B. Hooker. The pamphlet describes the method of mixing the gas and air, the construction of the flame-testing galley, the method of mixing and the condition of the gauze at different times. The investigation includes:

1 Study of European reports on similar research
2 A selection of critical tests for a publication on safety
3 Obtaining enough material to duplicate such tests
4 The performance of check tests
5 A report and analysis of results.

The investigation checked the results obtained by Belgian investigators. For conditions of high temperatures steel proved superior to brass or copper, while at low temperatures the different materials were about equal. Brass proved more satisfactory than copper. The least safe lamp of all tested was the single-gauze unbonneted lamp of the Davy type. The double-gauze unbonneted lamp is safer than a single-gauze lamp. The bonneted lamps were better than unbonneted lamps, the bonnet being more effective than an additional gauze. The safest lamp was the double-gauze bonneted lamp. The results indicate

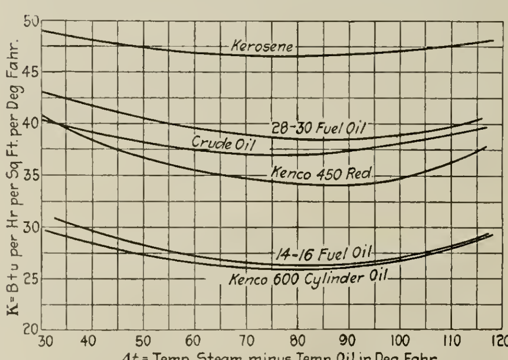


Fig. 3 Coefficient of Heat Transfer from Steam to Oil through Steel Pipe

that the present specification of Schedule No. 7 is not detailed enough. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Petroleum, Asphalt and Wood Products A5–21. Bulletin 194 of the Bureau of Mines is devoted to some principles covering the production of oil wells. It is prepared by Carl H. Beal and J. O. Lewis. The bulletin describes the factors controlling the production such as the oil content of the ground, the ultimate production, the factors governing the decline of oil wells, the declining production of an oil property, the consideration of flush and settled production, and the life of oil wells. In addition the bulletin gives the publications on petroleum technology issued by the Bureau of Mines. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Petroleum, Asphalt and Wood Products A6–21. UNDERGROUND CONDITIONS IN OIL FIELDS. Bulletin 195 on the Underground Conditions in Oil Fields by A. W. Ambrose is a publication of 238 pages. Its purpose is to point out the general method of procedure in studying underground conditions and to place before the petroleum industry the results of proper coöperation between the technical man and practical man. The bulletin would also serve as a guide to the engineer in solving oil-field problems and indicate to him studies that should be made in oil-field development. The bulletin is illustrated with charts, diagrams and halftones. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Wood Products A5–21. WOOD RESEARCH. The Forest Products Laboratory has recently issued Technical Note 150 on the Effect of Direction of Fibers on the Strength of Fiber Boxes. Technical Note 151 on the Cause and Prevention of Blue Stains in Wood and Technical Note 152 on the Antiseptic Treatment of Wood Pulp to Prevent Mold and Decay. U. S. Forest Products Laboratory, Madison, Wis. Address Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Explosives and Explosions B1–21. GASEOUS MIXTURES. See *Internal-Combustion Motors B8–21.*

Frame Structures B1–21. INDETERMINATE STRUCTURES. A classification is being made of the source material on the subject of analysis of stresses in statically indeterminate structures which were published in Bulletin No. 108 of the Engineering Experiment Station, University of Illinois. The purpose of the research is to put the material in form for use by practical engineers. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Fuels, Gas, Tar and Coke B2–21. BREAKAGE OF COAL. Prof. H. H. Stoek and Messrs. L. R. Nylius and H. H. Huang are determining the breakage of different coals when dropped from different heights. Circular 6 of the Engineering Experiment Station discusses the apparatus used.

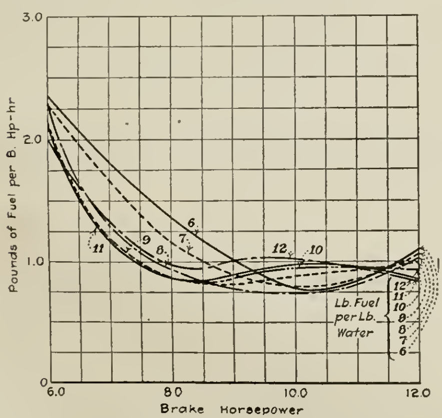


FIG. 4 FUEL REQUIRED PER BRAKE HORSEPOWER-HOUR AT VARIOUS RATIOS OF KEROSENE TO INJECTION WATER

See page 125. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Internal-Combustion Motors B7–21. IGNITION. A study of the electrical ignition systems for gasoline engines is being made under the direction of Prof. E. P. Payne by Mr. Y. Naito and others for the purpose of determining the relative amounts of energy delivered by sparks from various systems. The heat energy is being determined by a special calorimeter and the electrical phenomena are being determined by means of oscillograph records. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

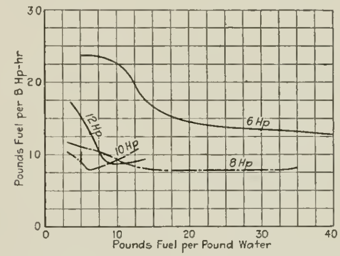


FIG. 5 RELATION BETWEEN FUEL CONSUMPTION PER B.HP-HR. AND RATIO OF FUEL TO INJECTION WATER

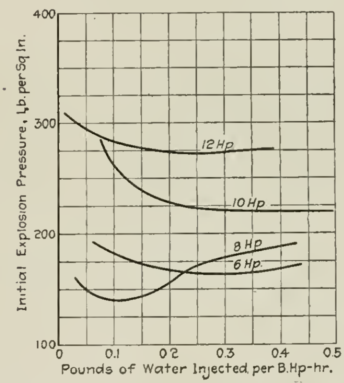


FIG. 6 VARIATION OF INITIAL EXPLOSION PRESSURE WITH AMOUNT OF WATER INJECTED

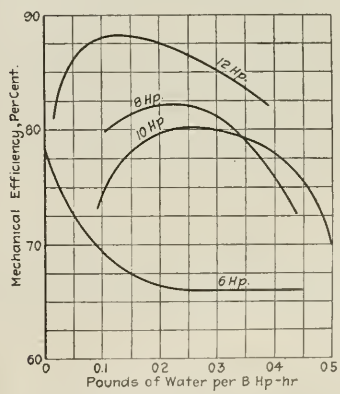


FIG. 7 VARIATION OF MECHANICAL EFFICIENCY WITH AMOUNT OF WATER INJECTED

Internal-Combustion Motors B8–21. EXPLOSION OF GASEOUS MIXTURES. Prof. A. P. Kratz and Mr. C. Z. Rosecrans are investigating the effect of shape of cylinder head, position of ignition plug and the effect of agitation of the gases upon the maximum pressure produced by explosion and on the time of explosion of gaseous mixtures. The pressure is measured by a specially designed diaphragm indicator making use of a spot of light, and time is determined by comparison with a photographic record made by a mirror on a tuning fork. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Internal-Combustion Motors B9–21. Internal Phenomena. An analysis of the thermal and chemical phenomena occurring in the cylinder of an internal-combustion engine is being made by Prof. G. A. Goodenough and Messrs. C. T. Felback and C. Z. Rosecrans. This work is almost complete. Address C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Machine Design B4–21. Riveted Joints. Prof. W. M. Wilson is investigating riveted joints subject to reverse stresses for the purpose of determining suitable working stresses for rivets and such joints and to determine the relative merits of different methods of driving rivets. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Machine Tools B3–21. Gear Measurements. Representatives of the Bureau of Standards have visited a number of gear manufacturers to obtain information as to the requirements of testing and measuring gears, cutters and hobs. A machine is now being designed to measure the important elements of gears and gear-cutting tools. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mechanics B1–21. Pressure Through Granular Materials. Mr. L. M. Enger is determining the bearing pressure which granular materials will sustain under various conditions of size, angularity and restraint. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B2–21. Rapid Loading. The strength and ductility of steel under rapid loading is being investigated by Prof. H. F. Moore. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B3–21. Boiler Heads. The stresses produced in forming boiler heads are being examined by Prof. H. F. Moore in studying the effect of the rapid application of a load produced by the fall of a heavy weight. Address C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Metallurgy and Metallography B10–21. Tempering of Hardened Steels. The Bureau of Standards is continuing the work on this subject in the Metallurgical Division. The investigation deals with micro changes which occur during tempering. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Railway Rolling Stock and Accessories B2–21. Timber for Freight-Car Construction. For the antiseptic treatment of timber used in freight-car construction, see *Wood Products B2–21.*

Steam Power B1–21. Air-Steam Mixtures. Dean C. R. Richards and Mr. L. A. Wilson are investigating the thermal efficiencies of a small Corliss engine using various mixtures of compressed air and steam, the quantity of air being determined by a venturi meter and the amount of steam being determined by condensation. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Ventilation B1–21. Friction and Power Loss. Prof. A. C. Willard and others are preparing to investigate the friction and power requirements for supplying and exhausting air from the projected vehicular tunnels under the Hudson River. The air ducts in this case will be made of concrete with concrete elbows. The air discharge will be uniform from the side of the experimental duct. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Wood Products B2–21. Freight-Car Floor Timbers. The antiseptic treatment of timber used in freight-car construction is the subject of a research to determine the best commercial method therefor. Open-tank and brush methods of treatment on air-dried timber have been tested after cutting to dimensions. Tongue-and-groove joints, lap joints and common joints have been used with each type of treatment. Floors are assembled and placed in a position exposed to the weather. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring to conduct special investigations may know where such work may be done.

Aircraft D1–21. Large Wind Tunnel. See *Apparatus and Instruments D1–21.*

Apparatus and Instruments D1–21. Large Wind Tunnel. The Aerodynamics Section of the Bureau of Standards is constructing a new tunnel 10 ft. in diameter. This will give exceptional facilities to all types of research work involving the study of the behavior of objects in a wind stream. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

University of Arizona D1–21. The Mechanical Laboratory is provided with the following equipment:

- 75-hp. internally fired boiler and accessories
- A small vertical boiler
- Three high-speed engines, gasoline engine and automobile motor
- Pelton wheel
- Turbo-blower
- A single-stage and double-stage centrifugal pump
- Duplex direct-acting steam pumps and instruments for testing and calibration.

The power plant of the University is also used for a mechanical laboratory. Address Professor A. J. Wiechardt, University of Arizona, Tucson, Ariz.

University of California D1–21. The following equipment at the University of California is modern, dating from 1916. The equipment is noted under various Experiment Stations at which certain experiments are performed:

General:

Experiment Stations 100 to 109. Comprising calibration apparatus for thermometers, pyrometers, gages; lubricators; indicator and manograph study; valve, valve-gear and governor study from one simple and one Stephenson link compound engine; measurements of gases; measurements of vapors; orifices; measurement of power by prony brake, belt dynamometer, water brake, Sprague dynamometer, etc.

Fuels and Oils:

Experiment Stations 200 to 205. Comprising gas photometry; fuel calorimetry on the Parr, Junker and Hempel apparatus; fuel analysis; gas analysis; testing of lubricating oils.

Air:

Experiment Stations 300 to 305. Comprising Ingersoll-Rand compressor tests with variable-speed motor drive and belt dynamometer; Rider-Ericsson hot-air engine tests.

Internal-Combustion Engines:

Experiment Stations 400 to 406. Comprising tests on Continental motor, Ferro gas engine, Willys-Knight sleeve-valve engine, semi-Diesel engine, Westinghouse gas engine, Standard gas engine, Sprague dynamometer, etc.

Automotive Equipment:

Experiment Stations 500 to 514. Comprising work on Ford chassis; Willys-Knight sectional model; "Cut-away" chassis showing every moving part of a standard slide-gear car; magnetic gear shift; caterpillar tractor; Weidley engine; Buick engine; battery ignition systems; magnetos; rectifiers; Sprague dynamometer tests of generators and of starters; carburetors; also in the official headlight testing laboratory of the State of California which is located in the building.

Steam:

Experiment Stations 600 to 610. Comprising steam calorimetry; study of steam auxiliaries such as traps, separators, valves, boiler-feed apparatus and boiler-feed-heating equipment; tests of steam pumps; injectors; tests on Ideal marine compound engines; complete tests of a Curtis turbo-generator; complete boiler test; complete power-plant test; study of section models of a Curtis 30-hp. turbine, of a Curtis 500-kw. turbine and of a 3000-kw. Westinghouse Parsons turbine.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession and especially the members of the A.S.M.E. of bibliographies which have been prepared. These bibliographies have been prepared at the request of members, and where the bibliography is not extensive, this is done at the expense of the Society. For bibliographies of a general nature the Society is prepared to make extensive bibliographies at the expense of the Society on the approval of the Research Committee. After these bibliographies are prepared they are loaned to the person requesting them for a period of one month. Additional copies are prepared which are available for periods of two weeks to members of the A.S.M.E. or to others recommended by members of the A.S.M.E. These bibliographies are on file in the offices of the Society and are to be loaned on request. The bibliographies are prepared by the staff of the Library of the United Engineering Society which is probably the largest engineering library in this country.

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 351 to 356 inclusive, as formulated at the meeting of May 12, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 351

Inquiry: Is it necessary, under Par. 2 of the Boiler Code, that welded or seamless circular furnaces or flues in boilers up to 18 in. in diameter as specified in Par. 241, must conform to the requirements for firebox plate material when exposed to the products of combustion?

Reply: It is not necessary that welded or seamless circular furnaces or flues up to 18 in. in diameter meet the specifications for boiler plate material. It is the opinion of the Committee that such boiler parts should be constructed from material fulfilling the requirements for lap-welded and seamless boiler tubes given in Par. 165 of the Boiler Code.

CASE NO. 352

Inquiry: Is it not permissible to construct boilers of the locomotive, economic or other portable types as coming under the classification of traction or portable boilers, as regards the attachment of lugs or brackets for which Par. 325 of the Boiler Code permits the use of studs with pipe threads? It is found impossible to properly rivet the lugs on certain designs of locomotive-type boilers where the lugs are to be located near the bottom of the waterleg of the firebox.

Reply: It is the opinion of the Committee that where the boilers of the portable type are to be fitted with lugs or brackets, the practice specified in the last sentence of Par. 325, of using studs, is permissible.

CASE NO. 353

Inquiry: Is it permissible, under the requirements of Par. 218 of the Boiler Code, to use stay tubes in place of through stays for supporting the surfaces around the manhole in the heads of h.r.t. boilers?

Reply: Stay tubes are not permissible for supporting the surfaces around the manhole in the heads of h.r.t. boilers.

CASE NO. 354

Inquiry: What are the requirements of the Heating Boiler Section of the Code, relative to the staying of flat surfaces of steel heating boilers designed to operate at a pressure not to exceed 15 lb. per sq. in.?

Reply: Par. 372 of the Code specifies a shop test of 60 lb. per sq. in. hydrostatic pressure shall be applied to steel or cast-iron boilers used exclusively for low-pressure steam heating. It is the opinion of the committee that in staybolting a boiler of this sort, the stresses in the material should not exceed those allowable in power boiler practice which would necessitate computing the staybolts and their spacing for a working pressure of at least 40 lb. per sq. in., or two-thirds of the test pressure.

CASE NO. 355

(In the hands of the Committee)

CASE NO. 356

Inquiry: Is a boiler constructed as shown in the prints and described, safer under the Boiler Code Rules than other forms of similar boilers?

Reply: The Boiler Code Committee does not express opinions upon the relative merits of different designs of boilers. This is in accordance with the Constitution of the Society, C56 of which reads as follows:

> C56 The Society shall not endorse any commercial enterprise. It shall not allow its imprint or name to be used in any commercial work or business.

An interpretation of the Boiler Code is a proper action of the Boiler Code Committee and will always be given upon request.

"The A.S.M.E. Code Boilers"

The A.S.M.E. Boiler Code Committee has been apprised of the fact that several boiler manufacturers are following the practice of referring to boilers built to conform to the requirements of the A.S.M.E. Boiler Code as "A.S.M.E. Boilers." In fact, advertisements in the trade papers have actually appeared in which Code boilers are referred to in that form.

Inasmuch as this practice is erroneous and incorrect, the Boiler Code Committee suggests that manufacturers state that their boilers are built in accordance with the Boiler Code of The American Society of Mechanical Engineers, or should the manufacturers or any one else desire to refer to such boilers in a briefer way, that they designate them as "A.S.M.E. Code Boilers."

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Appraisal Methods

TO THE EDITOR:

Appraisal and the determination of annual depreciation, which is an inseparable part of it, has until recently been almost wholly in the hands of accountants, but the recent problems involving capitalization which have been made an important issue on account of the income and excess-profits tax, have brought the engineer into the problem, so that at the present time we have two general methods of procedure in appraisals, i.e., the accounting method and the engineering method. The faults and weaknesses of the first are simple and easily exposed, but the weakness and liability to error of the engineering method, involving as it does the personal factor, are likely to be hidden in a mass of varying opinions.

The accountants' method consists in assuming a more or less correct total life of the property, and marking off an annual depreciation on a straight-line, logarithmic or some other purely mathematical basis. In prewar days this method, with a large factor of safety in the annual rate, was safe if not sound. It resulted in the extinction of values—on the books—which existed as a matter of fact.

The engineering method in its simplest form implies that the engineer can by his personal inspection determine the physical deterioration, the liability to obsolescence and inadequacy, and any other of the factors in the depreciation of the property under consideration. If he can do this he can justify his method. In so far as he relies on or colors his judgment with ideas of average length of life, he has departed from strict engineering methods. It will be seen, therefore, that while the accounting method depends but little on mental equipment of the appraiser, the engineering method relies on it almost entirely. If we not unreasonably assume any advantages for the latter method, it follows that they exist in fact only when applied by the right sort of man.

As a matter of fact and of practice the best results in appraisal are not secured by purely engineering methods as defined above, and one reason why the engineer is likely to make a better appraiser is that he is in a much better position to adopt any profitable accounting methods than the accountant is to adopt engineering methods. For example, there are at least three different values that usually appear in a valuation report: First, cost or investment values; second, replacement values; and third, the depreciated values derived from the first two. It is safe to say that if the first two values can be found by accounting methods they will be more accurate than if figured by the engineer. For the cost value there is nothing that can exceed the invoice cost for accuracy and authority, plus, of course, transportation and erection cost. If the invoice is not available, it can often be valued by office records of the cost of similar commodities at a time as near as possible to the date of purchase of the original item. This figure may need to be corrected for any known change in prices between the two dates. If neither of these methods is possible, the question reverts to one of an engineering estimate of the cost of building and selling such a machine, which is very unsatisfactory. The cost to produce depends on the quantity produced and various other factors which are not likely to be known. Furthermore the selling price of an article is controlled by other factors than shop cost. It will be seen, therefore, that here is a case that should be handled by engineering methods only as a last resort.

The replacement or basis for insurable value is the next item. This is also valuable information for those companies whose system of accounting includes a reserve for depreciation, or sinking fund for replacements. This value represents what a similar article would cost new at the time of appraisal, but it usually happens that in ten years or more such articles have been improved upon. The same company may make them, but with such improvements as make them more expensive. The question now arises, should the replacement value be the estimated cost of a similar article as if it were a commercial product, or the actual cost of the nearest similar article now made to do the same work? In practice this is largely an academic question, or at least one to be settled as a matter of expediency, but it may be said that whatever light is shed on the problem will be furnished by the engineer. He is the one who must pass on the suitability of available equipment, or furnish an estimate of the present theoretical replacement cost of a duplicate article.

It is only when such commodities are in the nature of standard equipment that the foregoing methods are applicable. That is, the value of a lathe, either cost or replacement, may be so determined if it is of standard construction, but if it be a special-purpose machine built to order, or, as is commonly found in machine shops, special jigs and tools, these are to be handled only by the engineer, and he will find few problems of valuation that are more difficult to handle.

Depreciation from these values to determine the present remaining value, or the theoretical replacement value allowing for wear, etc., is the most difficult part of appraisal and is distinctly an engineer's problem, whatever other sciences, trades or professions he may draw on for assistance.

Depreciation is either a process that can be detected by the senses, or it is something that experience has shown exists, even if we can detect no sign of its progress. The odor of a hot bearing, the sound of worn gearing or their inspection by sight, touch, or measurement, are practical demonstrations of depreciation. Any or all of these may not establish its exact extent or percentage, but they at least are palpable evidence of it. There is also the depreciation due to chemical or molecular change such as crystallization of an axle, or the burning out of an incandescent-light bulb. Any examination not involving the destruction of the article itself would show no indication of impending failure, even though it were to fail within the next hour. The depreciation of a lead pencil can be established definitely. It is a definite length when new. It is discarded at another reasonable definite length. It can be measured at any time, and the percentage of remaining available service established, which it will be noted is something altogether different from predicting how much longer the owner will use it. The one is a statement of present facts, the other is an attempt to use this information in an attempt to read the future, something that is often necessary, but always dangerous. On the other hand, it is in general a waste of time to attempt by inspection to establish definitely the present condition of an electric motor. It may run without mishap for years, or it may burn out within the next five minutes. No inspection that it is practical to make for valuation purposes could predict either case, nor could the most careful laboratory tests determine when it would next be subjected to an overload beyond its capacity.

The causes of depreciation such as wear, obsolescence, inadequacy, etc., have been enumerated too often to require it here, but in addition to these there are various intangible factors that often overbalance all others. For example, if a shop superintendent believes that a certain machine is obsolete, so far as his shop is concerned, it *is* obsolete, notwithstanding the fact that another man might think otherwise; and the fact that it is obsolete is due to the decision of the man who ordered it scrapped, rather than to anything inherent in the machine. With tangible causes of depreciation the difficulty is not in recognizing them but in measuring their effect in dollars. Wear is easily detected, or measured if need be, but how will you translate thousandths of an inch of wear into dollars of depreciation? With standard types of familiar machines, such as engines, pumps, lathes, motors, etc., the degree of obsolescence or inadequacy may be easy to determine, but in the case of special machinery such as automatic bottle-blowing machinery, looms for wire fencing, or automatic machinery for watch parts, the results of inspection may not be very fruitful. Mechanical engineering is divided and subdivided so often, with a different kind of fruit at the end of each branch, that no one man can be expected to be an authority on all of them. With these problems it is a question of knowing where to find the right information, and being able to get it.

There is one fundamental difference between engineering and accounting appraisals that has been previously hinted at. An engineer standing in front of a machine says, in effect, "This machine, now, today, has 75 per cent of its original value left. I do not care how old it is, or whether the repairs will be kept up in the future. It is in good running condition now, the superintendent is satisfied that even if it is not the very best design for his purpose, it is well up in the list, and without attempting to predict anything that may happen to it in the future, I make my report all in the present tense." If called on to justify his figures, he can point to the satisfactory operation of the machine both as to quality and quantity, and the superintendent can qualify as an expert on that type of machinery. The accountant's report is: "This machine is 10 years old, general practice and various authorities give 20 as the average life of machinery. The remaining life and value is therefore 50 per cent of the original cost. I am not in a position to consider whether or not unusual and extraordinary repairs have been made, or what the plans of the operating force may be with regard to it. I work on the law of averages. If I am not strictly accurate in this particular instance, the accuracy of the total results is not necessarily impaired." The original source of his justification will be found somewhere in a book.

If a considerable volume of statistics were available on the actual active life of different kinds of machinery, extending over a period of at least 30 years, it would be possible to secure a true average life, either of any one kind of machinery, or of machinery as a whole. But no such records exist. Even this is not enough. What is desired in appraisal is a valuation of the particular property under consideration, with consideration for its individual characteristics, and not a cross-section of the average experience of machinery users. The more specialized the nature or conduct of

following report made by an engineer on the valuation of the machinery in such a plant is offered as an example:

July 14, 1920.

It will be noted that numerous machinery items have been depreciated comparatively little, considering their nominal age. The reason for this is as follows:

In Departments A and B the machinery is all of a highly special nature, a major percentage having been either made or materially improved in your own shops and no equally productive machines can be purchased elsewhere. Concrete evidence of these repairs and improvements will be found in the 452, patterns—made for improvements alone—now segregated in Building No. 14.

In general, the manufacturer is able to purchase his machines in the open market, and for this reason does not find it necessary or even advisable to make extensive repairs, but in this instance this does not hold. In case of fire or other total loss, a large part of this special machinery would necessarily be built in their own shops, and the remaining part would require extensive changes to give them a productive value equal to the present equipment.

As a result of these conditions, it has been the persistent policy of the company to give unusual care and attention to repairs. The plant is closed for one week each year, and advantage is taken of this to make repairs that would otherwise be neglected.

In Department C the splitting and shaving machines are simple in construction and have easily renewable parts, consequently the maintenance expense is comparatively small. On the other hand, the cost for repairs in the Weaving Department is a heavy item. Notwithstanding this, however, these machines have been maintained in good condition. For example, —three looms which originally cost less than \$700 each were repaired and improved in 1908 at a cost of \$1830 each (See Journal No. 2, p. 54).

The fact that no better machines are known to exist indicates that there is no depreciation for obsolescence. The fact that repairs are of an unusually extensive nature, indicates that depreciation for wear is correspondingly unusual. The result of these two factors is that the depreciation of these machines is unusually small.

This report indicates the necessity for a thorough investigation of both mechanical and industrial conditions in the plant under consideration, and for this sort of work there is no one better fitted than the engineer. The broader his industrial experience, the better he is fitted for the task. Engineering *methods* are not enough, engineering personnel in the field staff is vitally necessary. Satisfactory results from any method or process presuppose the use of the indicated materials.

Columbus, Ohio. L. L. Thwing.

Concerning Honorary Membership

To the Editor:

Members of about twenty years' standing who remember the old brownstone club house in which the mechanicians of twenty years ago used to gather, will find the new order and new ideals as set forth by our engineering prophets Mr. Cooke, Mr. Hoover, et al., most inspiring.

But as the boys say, the young "grad." this June will be asking, "How do you get that way?"

May it not be summed up in words of one syllable for them once for all by one who has been a "prof.:"—To be a good engineer, "an exceptional man," be something else, or something else also.

Be a portrait painter like Robert Fulton, a polar bear hunter and north pole hunter like dear old Melville, engineer of the universe like dear old Uncle John Brashear, or an engineer of humanity and capitalist like dear old Doctor Andrew Carnegie, and become an Honorary Member like these.

The universe being a mechanical phenomenon, it don't make any difference what you do well—you are a successful mechanical engineer, even if you don't know it till you are elected, like Mr. Charles M. Schwab, Honorary Member.

This is as it should be, and agrees with the conclusions of laborious investigations of the Society for the Promotion of Engineering Education, which I understand were:

1 That engineering education didn't need any promotion, it was just a natural phenomenon going on of itself;

2 That the less technical details a man learned or the more he forgot, the sooner he came into harmony with this natural phenomenon and became a good engineer and material for honorary membership.

When this inspiring process is carried to its logical conclusion as outlined by Mr. H. G. Wells and other engineers, we shall all be Honorary Members and the Society, having outlived its usefulway."

Arcadia, Los Angeles, Cal. David H. Ray, Sc.D., Mem. Am.Soc.M.E.

The Question of Entropy

To the Editor:

In the June issue of Mechanical Engineering I find an article by Prof. G. A. Goodenough relative to a criticism made of American steam tables in a review of Professor Callender's tables contained in London *Engineering*. The particular statement objected to is— "the elaborate tables compiled in America.....fail to satisfy the test...that the work done in a given cycle should be the same whether measured on the temperature-entropy chart or on the indicator diagram."

In respect to this matter, I beg the privilege of submitting that the criticism made is apparently, but only apparently, sound. I have spent the last six years in a complete restudy of heat and allied subjects, developing new vapor equations, etc., which, while attacking the problem from an entirely new viewpoint, show that the truth lies almost exactly between the values given in Goodenough's steam tables and those given in the Marks and Davis tables, while the work of Keyes and Bromlee on ammonia at the Massachusetts Institute of Technology is, for accuracy, probably the most remarkable piece of experimental work ever accomplished anywhere in the world.

That there is an inconsistency between the temperature-entropy and pressure-volume diagrams is due to an entirely different matter that happens to be to the credit and not to the discredit of these tables for the reason that entropy is *a complete error*. To substantiate this statement I submit (*a*) a mathematical proof, (*b*) a physical proof, and (*c*) its probable original derivation, as follows:

(*a*) Assume that entropy is true to begin with. By definition—

$$dN = \frac{dH}{E}$$

where N is the entropy, H the heat energy, and E the absolute temperature. Since entropy is a function of H and E, we may write—

$$N = f(H,E)$$

Differentiating this equation gives—

$$dN = \left(\frac{dN}{dH}\right)_E dH + \left(\frac{dN}{dE}\right)_H dE$$

the parts in the parentheses being the usual partial differentials. We can therefore equate the two values of dN, getting—

$$\frac{dH}{E} = \left(\frac{dN}{dH}\right)_H dH + \left(\frac{dN}{dE}\right)_H dE$$

This equation is satisfied only when—

$$\left(\frac{dN}{dE}\right)_H = 0$$

and therefore E = a constant. That is, entropy is an error except when the temperature is constant.

(*b*) Assume again that entropy is true. We have then that

$$H = \int EdN$$

Let us now have reference to the temperature-entropy diagram shown in Fig. 1. Suppose a substance is originally under the conditions indicated by the point 1 and that its thermal conditions are changed until they are as indicated by the point 2. According to the equation $DH = EdN$ the heat added will equal the area under the path by which the thermal conditions are changed from the conditions 1 to the conditions 2. If, for example, the path of change is $1A2$, the heat added, according to this equation, will be the area under the curve $1A2$. If it is changed by the path $1B2$, the heat added will equal the area under the curve $1B2$; and similarly for the curve $1C2$, or any other conceivable curve. According to the equation $dH = EdN$ the heat content of a substance for any given conditions (E,N) is infinitely many-valued. As a matter of fact, the heat content of a substance depends only upon its final conditions and not at all upon the path by which these final conditions were arrived at. A pound of dry saturated steam

has a certain heat content when at, say, a pressure of 100 lb., irrespective of how this steam was produced, whether by heating up a liquid, or cooling down from the superheated state, or any other way. The conclusion is therefore enforced that the equation $dH = EdN$ is not true.

(c) The calculus teaches that the area A under a given curve $y = f(x)$ is—

$$dA = ydx$$

We thus have two simultaneous equations, namely,

$$y = f(x) \text{ and } y = dA/dx$$

Letting

$$y = E, \ A = H, \text{ and } x = N$$

then

$$E = dH/dN$$

or

$$dN = \frac{dH}{E} \quad [1]$$

and

$$E = f(N) \quad [2]$$

Equation [1] is meaningless without Equation [2], for what can be the area under a curve when there is no curve?

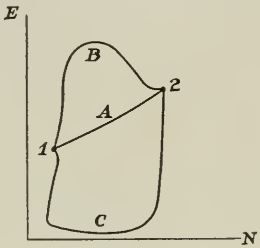


Fig. 1

I think that heat engineering will be greatly benefited by getting away from this age-old error. I know that it has proved so in my case.

O. B. Goldman.

Portland, Ore.

U. S. Patent Office Relief

To the Editor:

I note your article in the July number of Mechanical Engineering on U. S. Patent Office Relief, and wish to say that too much publicity cannot be given to Patent Office conditions.

In my opinion the Patent Office stands at the very foundation of industrial welfare and progress. Great industries are founded on patent rights; they either could not have been founded at all or would have been greatly delayed if the inducement of a limited period of enjoyment of the fruits of the invention had not been given. Mechanics and students of the sciences are constantly striving to accomplish great inventions, and in many cases their sole incentive is a patent whereby their fortunes may be assured. I doubt if there is a single engineer of any standing who has neither secured nor applied for a patent.

Consequently the administration of the Patent Office is of great moment to both engineers and manufacturers, whose success often depends on valid patent rights. It is desirable that applications receive prompt action, but above all things such action should be the result of a careful search by competent examiners.

At the present time neither of these requisites can be fulfilled by the Patent Office, because there is a shortage of examiners and this shortage exists principally among the older, more skillful examiners, who are daily being lured away from the Office by higher salaries. At the present time I have applications pending in mechanical engineering classes that were filed nine months ago, and on which I have received no act on. About one-third of the applications filed are not acted on for six months or more.

Surely this situation would be remedied if brought forcibly to the attention of the representatives in Congress.

Engineers, inventors, manufacturers: write your representative to vote for the Lampert Bill.

St. Louis. Mo. H. A. Baimes.

The Banki Hydraulic Turbine

To the Editor:

The May issue of Mechanical Engineering on page 345 gives particulars regarding a "new" hydraulic turbine, the invention of Professor Banki of Budapest. This development has been given considerable publicity, but engineers and manufacturers of hydraulic turbines have been practically unanimous in agreeing that the design does not incorporate those features of efficiency, reliability and reduction of first cost which are the fundamental requirements in modern turbines.

The turbine in question is very close in its major characteristics to the Girard type of turbine in use twenty or thirty years ago, but since discarded. This type of turbine has not been built in any appreciable quantity for the last fifteen years and is not in any way a factor in modern development because it possesses numerous operating disadvantages in connection with pitting of the blades and nozzles, low efficiency, and uneconomical arrangement. These comments apply to the Girard type of turbine arranged with a single application of the jet. All of the disadvantages would be greatly increased in the attempt to pass the jet through the wheel a second time. As a matter of fact, it is not conceivable that a jet, having passed a set of buckets, should remain in a state capable of developing additional power at desirable efficiency.

The inventor of the turbine under consideration fixes the diameter of the wheel at $D = 72.86\sqrt{(H)}/n$. In terms of peripheral coefficient this formula means that the rim runs at a speed equal to $0.48 \sqrt{(2gH)}$. This peripheral coefficient of 0.48 is the same as is used on standard impulse wheels, so from that standpoint there is practically no advantage in the type proposed. While it is possible to use a smaller diameter and consequently higher r.p.m. and maintain this same coefficient, the most extreme proposition that could be secured is far below that easily obtained with the Francis type of runner, which has a peripheral coefficient of 0.6 to 0.7 for the heads to which the proposed wheel is apparently adapted. Furthermore the Francis turbine can be reduced in diameter to a much greater extent than can the proposed Banki wheel in the effort to secure higher speeds. There might be an advantage in the Banki wheel in connection with the width of opening between buckets, this being an advantage as regards clogging on smaller-sized wheels, but the other mechanical disadvantages of the Banki arrangement, particularly in connection with arrangement of nozzle, far outweigh this single point.

In addition to amplifying the features which caused the Girard turbine to be a commercial failure, this type of wheel possesses the inherent disadvantage of an impulse wheel, that is, it must be set above tail-water level so that with the medium-head field, which alone is open to this type of development, there is a prohibitive percentage of loss due to its application.

From a theoretical hydraulic standpoint there is considerable justification for some of the contentions made. From a standpoint of practical hydraulic engineering there is no advantage. Mechanically the wheel can hardly be arranged to permit of the use of a needle type of nozzle, which alone has stood the test of time in the development of the impulse type of turbine.

F. Nagler.

Milwaukee, Wis.

Engineering Schools

To the Editor:

On page 420 of the June issue of Mechanical Engineering, Dean Bishop is quoted as saying "There is no first-class engineering school to be found in America." Taken by itself as printed and with no explanation of the word "first-class" it is a surprisingly frank statement, but I fear it may tend to compromise our engineering education in the eyes of some who may think it is really true. In the words of Dr. Adams, who supported the charge, it "neglects most of the variables." Probably the speaker desired simply to "start something" in the same way as did Edison with his questions for the college men.

Your report of discussion includes the following comments by Dr. Comfort A. Adams:

In support of the last and rather startling statements made by Dean Bishop the chairman said that he would guarantee to take the graduates in electrical engineering from any institution in this country and prove in a

five-minute oral examination of each one, in 98 or 99 per cent of the cases, that the men do not understand in any thorough fashion the fundamentals of the subject; that in most cases they do not even know the meaning of the words they use; that they are carried through analyses of comparatively complicated problems, but in a machine-like superficial way, neglecting most of the variables, so that they get into the habit of a kind of loose thinking which so affects all their work that they cannot be counted on for any sound results.

Does not Dr. Adams miss the point? The highest aim of the teacher is to direct the student to think for himself, rather than to carry him through "comparatively complicated problems in a machine-like, superficial way." The good teacher has that higher aim constantly in mind. Measure up your graduate by that as well as by the test mentioned by Dr. Adams and see if 98 or 99 per cent of the graduates will fall down. If over 90 per cent do fall, then you may more safely conclude there is no first-class engineering school in the country; but don't place the charge solely upon the depth of abstract knowledge which a man ten years out of college in responsible work would also fall down on if put to the same test.

True, we need more than ever a larger number of first-class engineering schools, but more than that we need a greater stress laid on the fundamentals in all the engineering schools of the country. Measure the standard on the basis of ability to think clearly rather than solely on the ground of a multitude of accumulated facts. We need to cultivate the engineering type of mind, and that calls for elements of character as well as elements of knowledge.

State College, Pa. ARTHUR J. WOOD.

Progress Report on Symbols in Heat Engineering

Preliminary Report of The American Society of Mechanical Engineers' Standing Committee on Technical Nomenclature

SINCE July 1917 The American Society of Mechanical Engineers has had a committee coöperating with a similar committee of the Society for the Promotion of Engineering Education for the purpose of systematizing and standardizing technical nomenclature. Recently this committee was made a standing committee of the Society and for the past year or more it has devoted its attention to the subject of heat engineering.

The report which appears below is of a preliminary nature and is printed here to elicit general discussion by those interested in this phase of the subject.

The Chairman of the Committee is Mr. W. D. Ennis, and he may be addressed in care of The American Society of Mechanical Engineers, 29 West 39th Street, New York City.

THE PRELIMINARY REPORT

1 The concepts or quantities relating to a liquid, its saturated or its superheated vapor for which symbols are most commonly used are:

Heat content
Temperature
Pressure
Volume
Entropy.

In addition, the following quantities are commonly symbolized:

Specific heat of superheated vapor at constant pressure
Mechanical equivalent of heat (778)
Dryness (saturated vapor)
Latent heat of vaporization (rarely that of fusion)
Entropy of vaporization
Internal and external portions of the latent heat of vaporization
Ratio of specific heats of gases
Specific heats at constant pressure and at constant volume (gases).

Less commonly used symbols are those for—

Reciprocal of the mechanical equivalent of heat density
Absolute temperature.

2 As the result of a few preliminary letters and some oral discussion, the following principles seem to command rather general (though not universal) assent:

(*a*) Greek letters should be avoided.
(*b*) Dimensional symbolism should not be attempted.

3 The standardization most needed is that which relates to symbols for properties of liquids and their vapors—particularly water. There are three physical conditions to be distinguished: liquid, saturated vapor (wet or dry), and superheated vapor. It is natural to use small and capital letters for two of these conditions: as h, H; t, T; v, V; n, N; for liquid and saturated vapor. The third condition must then be designated (unless by a different letter) by either a prime or a subscript.

Primes are not likely to be confused with exponents, because the latter are rarely used in heat engineering. The chief objection to them is one of typography—they are apt to break off or slip out.

Subscripts are objectionable because they are also needed to refer to stated points. Thus if N_1 denotes entropy of superheated steam, we might have to write $(N_1)_a$ and $(N_1)_b$. Both are awkward forms and do not sound when enunciated verbally.

4 Absolute temperature could be designated by $t + 460$, $T + 460$, etc., and no special symbol is imperatively necessary, although many writers use t for fahrenheit and T for absolute.

5 Present usage seems to indicate maximum popularity for the following:

Cp, J, p, t, h, L or r, H, v
(with primes or subscripts)

For other quantities there is no uniformity of symbolism.

By using the following, there would be no departure from generally accepted usage:

Heat content	h, H, H'	
Temperature	$(t = T)$ T'	
Pressure	p	
Volume	v, V, V'	
Entropy	n, N, N'	(It is true that n is often used as the polytropic exponent)
Mechanical equivalent of heat	J	
Its reciprocal	A	
Dryness	x or q	(preferably the latter)
Latent heat of vaporization	$L = H - h$	
Entropy of vaporization	$N - n$	(no single symbol.) See Note.
Internal latent heat	r	(implies the use of L for total latent heat)
Ratio of specific heats	y	(suggests a former Greek symbol)
Specific heat at constant pressure	C_p	
Specific heat at constant volume	C_v	

NOTE:—There is perhaps a real need for a single symbol. The entropy of a wet vapor would be—

$$n + q\,(N - n) = qN + n\,(1 - q)$$

If for $(N - n)$ we had a single symbol, l (though this might be useful for latent heat of fusion) there would result the simpler form—

$$n + ql$$

Tests carried out on paint-spraying machines have shown, according to the *Architect*, that spraying requires approximately 10 per cent more paint than brushing when the surface being treated is an iron roof, while brushing requires approximately 200 per cent more labor than spraying. On exterior brick walls spraying requires 7 per cent more paint than brushing, while brushing requires 109 per cent more labor than spraying. On interior ceilings and walls of plaster spraying requires 40 per cent more paint than brushing but gives a better hiding in one coat. On similar work brushing requires 160 per cent more labor than spraying, and gives a poorer hiding in one coat. Although it has not been possible as yet to arrive at a definite conclusion confirming the relative durability of spraying as compared with hand painting, it is claimed that the investigations so far made tend to support the belief that the spraying work will last longer.—*The Engineer* (London), July 25, 1921.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

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C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

What the Virginia Capes Aircraft Bombing Tests Show

THE conflict between the air bombing squadron and the ex-German battleship *Ostfriesland* off the Virginia Capes was an epoch-making incident in the ever-present conflict between the old and well-established and the new and untried. The new device proved successful and indicated a future.

Elmer A. Sperry

When the United States entered the world war in 1917 it did not possess a single military flying machine, and of the two score training planes then owned by the Army and Navy there were barely a baker's dozen capable of an hour's flight. Not quite four years have elapsed between the foundation of American military aeronautics and the sending out of the unprotected David of the air with a few bombs to do battle with the Goliath of the sea protected with armament representing forty years of sustained development costing billions of dollars. The battleship went to the bottom of the ocean in less than twenty-five minutes. Still the aircraft engineers responsible for this remarkable performance thoroughly realize the crudeness of the airplane, especially as regards the sighting, aiming and bomb-dropping devices.

The battleship can be made larger and faster, but this will not make it less vulnerable to aerial attack. The airplane, however, is only at the threshold of its development. The question seems to be one of time when the battleship will be driven from the sea.

American engineers have particular reasons to glory in the success of our flyers. The planes used were chiefly of American design, driven by a typical American motor. The bold conception of the test was on a par with the big things done every day by our engineers, and the daring of the men who flew for over a hundred miles out to sea in planes which had no facilities for landing on the water is something of which the nation may well feel proud.

Great honor must be given to the persistent and marvelous organization of the Air Service, which carried this difficult task to such successful completion. This is due in large measure to the enthusiasm and leadership of General Mitchell and his extremely able corps of assistants. Colonel Bane, chief of the Engineering Division of the Air Service, is another who should receive no small amount of praise and congratulations.

From my experience in connection with the production of the first depth bomb for the Navy, I am convinced that it is the only device capable of reaching the vulnerable parts of a battleship. The enormous sledge-hammer blow that is delivered to the ship's structure by a depth bomb at a distance is something prodigious. The compressibility of water being only 1/150 at the pressure of one ton per square inch, it acts to all intents and purposes as a perfect solid in transmitting the enormous concussion. Mass action is the secret of the success of the depth bomb, as is shown in the following formula:

$$P = \frac{0.68\,WK}{D^{1.39}}$$

where P is the effective pressure in tons per square inch against the target from the depth bomb; D the distance from the center of the charge to the face of the target, in feet; K the coefficient, which for the TNT equals 3.17; and W the weight of the charge in pounds.

In early bombing days, from the heights to which anti-aircraft guns drove the aircraft it was lucky if the bomb was able to hit the township containing the target. The precision obtained since that time in the various elements of the bombing equipment is due in no small measure to the astute, practical mathematician, the man who is 100 per cent mathematician and also 100 per cent engineer, in being able to point out a practical and physical, as well as simple, solution of otherwise very perplexing and abstruse formulas. This, together with the new method of stabilizing, finding and being able to hold the exact vertical reference line, and precision flight due to great care on the part of the pilot, are all important elements, but in the last analysis the level head and horse sense of the "man behind the gun" constitute no small part of the answer.

So aircraft, which is the natural American heritage, is coming not only into its own, but assuming nothing short of sovereign leadership in direct offensive action, and it has remained for America again to lead the way.

There are many defensive actions in which aeronautics will from now on take prominent leadership, and all are based on the most highly organized engineering analysis and skill. I therefore recommend that our Aeronautic Division make a close study of these intensely interesting activities so as to be in readiness to extend first aid in this all-important development.

Elmer A. Sperry.

The Value of the Waste Report

THE report o fthe Committee of The Federated American Engineering Societies on the Elimination of Waste in Industry, an abstract of which we publish elsewhere in this issue, has recently been released.

Some criticism of it has appeared, based evidently upon too brief and incomplete extracts from it. In the main, however, comment upon the report has been intelligent and appreciative, and we believe will be more so as the complete report is studied and understood.

The carefully prepared "Questionnaire" used by the field workers for the committee has been declared by some of the shrewdest and most progressive manufacturers to be in itself a valuable thing that ought to be meditated upon by every one in any way responsible for the conduct of industrial operations.

The report shows that the opportunity of management for improving industrial affairs is much larger than that of "labor," and upon this point the report sustains the opinion of practically all trained observers who have studied the matter, including many industrial managers and proprietors of manufacturing establishments themselves.

The real value of the Waste Report will be determined by its success as a stimulant to future waste-eliminating activity.

In the industry of this country there are a great many variables, the evaluation of which, to permit comparison between plants or

divisions in the same industry or between the various industries, cannot but lead to greater or less differences of opinion about the findings of any group of men. The report, however, definitely points out wastes and recommends steps for their elimination. This last is the work of years, calling for the concentrated, coöperative effort of every individual and organization interested in industrial administration and development. This effort should not be dissipated in combating statements in the report that happen not to please. Wastes must be eliminated, not argued away, if the industries of America are to stand the test of the future. As the product of capable, conscientious men, realizing the tremendous importance of the subject, this report deserves more than criticism of details, especially since its great mission is that of a call to service in waste elimination.

Admittedly preliminary in character, the Waste Report sheds enough light on the situation to show the way of future waste-elimination procedure.

The American Society of Mechanical Engineers is taking the lead, and the 1921 Annual Meeting will be devoted to the subject of Elimination of Waste in Industry. Although the program has been prepared without definite relation to the Waste Report, the various Professional Divisions will present definite technical contributions to waste elimination in their various fields. The following subjects indicate the character of the meeting: Power-Plant Heat Balance as a Factor in Economic Operations; Avoidable Losses in Locomotives; Waste in Small Machine Shops; Hidden Wastes in Textile Mills; Importance of Research in Waste Elimination; and Development in Boiler and Furnace Design as a Factor in Reducing Fuel Waste. The presentation and discussion of these papers on that occasion will constitute a strong attack against waste.

This meeting will be but a step forward, however, and great strides are necessary. The report should be studied carefully by every industrial and business leader so that the results of this intensive study may be put to work at once in every industrial establishment where there is the desire to advance the economy and industrial technique of the country. Furthermore, general familiarity with the Waste Report should stimulate thought and action toward the development of an aggressive program for waste elimination.

The DeLamater Ericsson Tablet Committee

March 9, 1922, will be the sixtieth anniversary of the battle of the *Monitor* and *Merrimac* at Hampton Roads, Va., which demonstrated the merits of the turreted battleship. That has been the date selected by the DeLamater Ericsson Tablet Committee to memorialize the services of Mr. Cornelius H. DeLamater and Capt. John Ericsson, who for 50 years, 1839–1889, were pioneers in developing the naval, marine and industrial interests of this country, and who at the time of the civil war, without thought of personal reward, turned their mental and financial resources to account and applied their knowledge and experience to accomplish what the Government had failed to do.

The Government has appropriated $35,000, and private individuals have subscribed a larger sum for a memorial to Captain Ericsson in Washington adjacent to the Lincoln Memorial, and $5000 is being raised by private subscription among engineering and marine interests to erect bronze tablets on four sites of buildings in New York City with which the lives and work of the two men were identified.

These are (1) The Phoenix Foundry, 260 West Street, between Laight and Vestry Streets, where the first iron boats in this country were built and the screw propeller was first introduced on river and ocean steamers. Some of the equipment of the *Princeton*, the first battleship with machinery and boilers below the water line safe from cannon shot, was constructed there, revolutionizing the navies of the world. The 3-in. pipe for the Croton Aqueduct and hot-air engines to pump the Croton water to the upper floors of houses were conceived and built there, as well as much other notable work. (2) The DeLamater Iron Works, foot of West 13th Street, where many industries now internationally established obtained their first development. There the first self-propelled torpedo, the first torpedo boat, the first submarine boat, and the engines for the original *Monitor*, were built, and the *Dictator* was built complete. (3) The Continental Iron Works, Greenpoint, Brooklyn, L. I., where the hull of the original *Monitor* was built and the *Puritan* and other monitors were built complete; and (4) No. 36 Beach Street, where Captain Ericsson lived and worked and died. By the *Monitor*, the navies of the world were revolutionized a second time.

The movement to erect these tablets started at the DeLamater Ericsson Commemoration meeting held December 3, 1919, in the auditorium of the Engineering Societies Building, 29 West 39th Street, in which the following twelve engineering and civic organizations participated: The American Scandinavian Alliance of Greater New York; American Scandinavian Foundation; American Scenic and Historic Preservation Society; The American Society of Mechanical Engineers; American Society of Naval Architects and Marine Engineers; American Society of Refrigerating Engineers; American Society of Swedish Engineers; Associated Veterans of the DeLamater Iron Works; Engineers' Club of New York; General Society of Mechanics and Tradesmen; John Ericsson Memorial Committee; New York Historical Society; and The Union League Club.

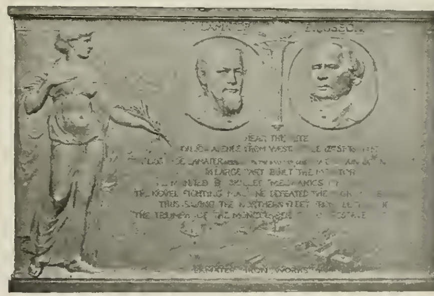


Table to Mark Site of DeLamater Iron Works

Since then the following additional societies have joined the movement; Amaranthus Lodge, I.O.O.F.; Bredablick Lodge, F. & A.M.; Captain John Ericsson Memorial Society of Swedish Engineers; Engineers' Club of Trenton, N. J.; Past District Grand Masters Association; and the United Swedish Societies of New York. A number of prominent marine interests and private individuals have subscribed to the Tablet Fund.

Mr. Isidore Konti is the sculptor, the Municipal Art Commission has accepted the design and the American Scenic and Historic Preservation Society will serve as guardian of the tablets.

The Committee proposes to unveil the tablets in the afternoon of March 9 and in the evening to hold a public dinner meeting at one of the large hotels, at which representatives of the Swedish and United States federal, state and municipal governments, as well as of prominent marine and industrial interests, will be present and speak. The children attending the various public schools located near the localities of the tablet sites will participate in the ceremonies.

The Committee would like to hear from other technical societies, civic organizations, marine and industrial interests and individuals who desire to show their patriotism and appreciation of the services to the country of Mr. DeLamater and Captain Ericsson by participating in this movement. Any money left after the tablets are erected will be devoted to the establishment of a depository for relics and memorabilia of Captain Ericsson, of which there are already considerable in hand. Correspondence should be addressed to The DeLamater Ericsson Tablet Committee, Engineering Societies Building, 29 West 39th St., New York, N. Y. This Committee consists of H. F. J. Porter, *Chairman*, Oakley R. De Lamater, Frederick A. Halsey, Axel S. Hedman, Ernst Ohnell, Henry R. Towne, and Charles Vezin.

Death of Dr. George F. Blessing

George F. Blessing

Dr. George Frederick Blessing, professor of engineering at Swarthmore College, passed away at his summer home at Bay View, Mich., June 24, after a brief illness. He was born in Carrollton, Ky., in 1875, and was a graduate of Kentucky University and also of Hanover College, Ind., from which he received the degree of Ph.D. in 1908. After graduation, Professor Blessing spent several years in practical work, becoming professor of mechanical engineering at the University of Nevada in 1899, where he stayed till 1905, spending his summers in practical work with various concerns on the Pacific Coast. In 1905 he became connected with the General Electric Company at their Lynn works as a designer in the steam-turbine department, and in 1906 he became assistant professor of machine design at Cornell University. In 1908 he accepted the position at Swarthmore which he held at his death.

Professor Blessing was essentially a great teacher. Gifted with a brilliant mind, he also possessed the interest in his fellow-beings so essential to the successful teacher. At the time of his death he was employing a leave of absence from university work in making an investigation of industrial conditions for Mr. John D. Rockefeller, Jr., in the mines and mills of the Colorado Fuel and Iron Company in Colorado, and in endeavoring to develop new ideas in this work. The result of this work and similar previous experiences was to have been published in book form and it is hoped that the large amount of material gathered can be edited and published in the near future, as such a volume would undoubtely prove of great value to students of industrial conditions. Overexertion incident to this work brought on a physical breakdown from which he failed to rally, and his illness was of short duration.

Professor Blessing was the author of books on machine drawing and descriptive geometry and of various contributions to the technical press. He was a member of The American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education, the Efficiency Society, the Engineers' Club of Philadelphia, and the honorary scientific societies of Sigma Xi and Tau Beta Pi.

In his death the Society and the teaching profession lose an able engineer, a fine teacher, and a man of sterling qualities and of lovable character. His untimely end will be deeply regretted by a host of friends and former students throughout the entire country. Few men possess the attractive personal qualities that endeared him to a very large circle of acquaintances.

Conference to Stabilize Road Building

Herbert Hoover, Secretary of Commerce, called a conference of engineers and state highway officials on July 18 in Washington. The purpose of the conference was to obtain engineering suggestions and criticisms on the advisability of awarding highway contracts in the fall for the next season's work. This would stimulate the buying of materials and equipment early enough to give a stable period for the manufacture and shipment of such materials and would also enable the contractor to plan in the winter for his work in the coming year and to devote all of his time and efforts to the construction of roads in the favorable part of the summer. The following men attended the conference: Col. W. D. Uhler, chief engineer, State Highway Department, Pennsylvania, representing Civil Engineers; Mr. Coleman, chief engineer, Highway Department, State of Virginia, representing Association of State Highway Officials; Mr. Upham, chief engineer, State Highway Department, North Carolina, representing, the State Highway Officials; Gen. R. C. Marshall, Jr., general manager, Association of General Contractors; Prof. W. K. Hatt, representing National Research Council; Thomas MacDonald, chief, Bureau of Public Roads, Department of Agriculture; L. W. Wallace, executive secretary, American Engineering Council; and R. M. Gates, representing The American Society of Mechanical Engineers.

The conference prepared and presented a report in which were pointed out the engineering advantages of fall awarding of highway contracts, namely, a much longer construction season and a consequent better service in the handling of highway construction materials; less fluctuation in construction and a greater possibility of completion of highway programs. This system would permit interseasonal work with resulting increase in the continuous employment of labor, more uniform production in basic industries, and more efficient road-building organizations.

The conference did not substantiate the assumption that the cost of road-making materials is generally high in the fall. From the report of the conference Secretary Hoover prepared a memorandum for the governor of each of the states, which he forwarded to them with the earnest request that the matter be given careful consideration in view of the need for economical construction and the stabilization of employment and manufacture of material and equipment.

Highway Research on a National Basis

The Advisory Board on Highway Research which was established by the Division of Engineering of the National Research Council, with the coöperation of Engineering Foundation at a conference held in New York last November, has recently engaged William Kendrick Hatt, professor of civil engineering and director of the materials testing laboratory, Purdue University, to direct its work in national highway research.

The purposes of the Advisory Board are:

a To assist existing organizations in outlining a comprehensive national program of highway research and coördinating their activities thereunder

b To organize committees for specific problems

c To act in a general advisory capacity

d To serve as a clearing house for highway research information.

The Advisory Board is composed of fifteen organizations of national importance interested in the design, construction, economics, maintenance and financing of highways, in materials and equipment therefor, and in vehicles used on highways; governmental departments and bureaus of similar interests, and higher educational institutions. In addition to the member organizations, which include The American Society of Mechanical Engineers, thirteen state highway departments and more than forty universities have definitely signified their interest in the work of the Advisory Board and their willingness to coöperate.

Anson Marston, dean of engineering, Iowa State College, and a member of the Iowa State Highway Commission, is chairman of the Board, and Alfred D. Flinn, secretary of Engineering Foundation and vice-chairman of the Division of Engineering of the National Research Council, is vice-chairman.

Three technical committees have been at work for a number of months. These are the committees on Economic Theory of Highway Improvement; on Character and Use of Road Materials; and on Structural Design of Roads. Committees on Vehicle Design as Related to a Road; on Economics and Cost of Transport; on Financing Highway Improvements, on Traffic Studies, and on Organization of Construction Plants are under consideration.

Professor Hatt, in consultation with the Advisory Board, will prepare a comprehensive plan of the field of highway research, including economics, design, construction and administration, and will arrange a program of committee work for those fields that need to be occupied immediately.

N.E.L.A. Issues Reprints of Prime Movers Committee Report

The Prime Movers Committee of the National Electric Light Association presented a comprehensive report at the recent Chicago Meeting of the Association. The functions of the Committee are the investigation and reporting of developments in design, installation, and operation of prime movers and equipment for the production of power from fuel for the generation of electricity.

This report, a book of 350 pages, contains considerable information about the various types of new equipment which have been developed and placed in use. The statements of users and manufacturers are given concerning each class of equipment. A bibliography is also provided for those who wish to get more complete information. The demand proved to be so great that the N.E.L.A. has authorized the reprinting of the report. Copies are on sale at the Association headquarters, 29 West 39th St., New York, N. Y.

September Board Meeting to be Held at Washington

THE next meeting of the Executive Board of the American Engineering Council will be held at the Cosmos Club in Washington on September 30. This will be the first meeting of the Board in Washington since its initial meeting held there November 20, 1920. It is probable that the Board will decide at this meeting whether it will hold future meetings regularly at the Washington headquarters or will pursue the plan of meeting at various engineering centers throughout the country as it has been doing during the past year.

The most important business coming before the September meeting will be the election of a president to succeed Herbert Hoover, who resigned after he became Secretary of Commerce. Nominations to fill this vacancy were ordered at the last meeting of the Executive Board, held at St. Louis on June 3. Other items which have been before the Board will come up for further consideration, special attention being given to the plans for the Engineering Assembly, the extension of the Employment Service, and the question of licensing and registration of engineers.

Employment Service Conducts Special Work

In regard to Employment Service extension the Finance Committee has made arrangements to increase the budget of the Employment Service so that special emergency work can be done for the large number of engineers now out of employment. Prominent engineers, manufacturers and bankers throughout the country will be canvassed by letter for the purpose of compiling information on vacant positions. Special committees of engineers will call on prospective employers as much as possible throughout the states.

In New York City a volunteer committee of twelve has been engaged in this work since late in May. In spite of the fact that the vacation period and changed addresses and business connections have materially delayed the work, a report of this committee submitted on August 15 shows that over 1600 calls have been made 1000 interviews granted, 36 positions found, and 59 prospective positions listed. Practically all of the technical journals, allied journals and periodicals read by engineers and captains of industry have been called upon and a number of editorials have already been published. Slightly over 300 new calls and some return calls remain to be made in New York City proper. A classification of members by companies in the commuting area of the city (outside of Manhattan) is well under way and recommendations may be made on the organizing of one or more committees to cover that area.

The special Employment Committee of the Council is working in conjunction with the Employment Management Committee in developing further plans for the Service.

Engineering Assembly Planned for January

The Engineering Assembly Committee has been appointed as follows:

A. P. Davis, Washington, D. C., *Chairman*
Philip N. Moore, St. Louis, Mo.
L. P. Alford, New York, N. Y.
John C. Hoyt, Washington, D. C.
F. A. Vaughn, Milwaukee, Wis.

This committee will work out detailed plans for an assembly to be held in conjunction with the annual meeting of the American Engineering Council, the assembly having been authorized by the special vote of the Executive Board at its Philadelphia meeting in April. Present plans are to make this assembly a three-day session during the latter part of January 1922. One day will probably be devoted to special meetings of the Executive Boards of member organizations and committees of the Council, one to sessions of the Council, and one to the discussion of some special topic such as elimination of waste, licensing of engineers, the National Department of Public Works, or some other subject of equal importance to the engineering profession.

Committee Work of Council Varied and Important

The Committee on Procedure and the Committee on Public Affairs have been of great assistance in carrying on the work of the Council. Under their direction the Council has been active in advancing the plans for a National Department of Public Works, improving the status of public health engineers, obtaining equitable engineering research legislation, coöperating with the American Engineering Standards Committee, working for the appointment of engineers to engineering positions in the Federal Government, supporting the topographic mapping program and much-needed patent legislation, etc.

The most important committee work of the Council during recent months has been the study of Elimination of Waste in Industry. An abstract of the report of this committee will be found elsewhere in this issue. Copies of the complete report will be available shortly and may be secured from L. W. Wallace, Secretary of the Federated American Engineering Societies, 719 Fifteenth St., N. W., Washington, D. C.

Engineering and Industrial Standardization

Results of the Last Three Years' Work of the Joint Committee on Steel Roller Chains Shown by Report on Standards Developed

FROM time to time since its organization in July 1917, the Joint Committee of the Society of Automotive Engineers and The American Society of Mechanical Engineers has made progress reports. Now, however, we are able to publish the standards which it has developed for (1) Roller Transmission Chain Dimensions, Heavy, Medium and Light Series; (2) Roller Transmission Chain Sprockets; (3) Tooth Forms for Roller-Chain Sprockets and corresponding cutter design; and (4) Uniform System for Numbering Chains.[1]

As its work has progressed, the Joint Committee has kept constantly in touch with the work of the Association of British Driving Chain Manufacturers with a view to the final adoption of standards which would receive international approval. Consequently certain concessions have been made on both sides and the standard dimensions given below are the same, with a very few exceptions, as those adopted by the A.B.D.C.M.

Roller Transmission Chains—Heavy Series

The "chain widths" given in Column 5 of Table 1 are for the wide-chain series. The numbers express the exact distance between the inside plates and are as near to the norm of $W = {}^5/_8 P$ as seems advisable in consideration of present practice and the desire to express dimensions in terms of binary fractions. These are known as "wide" chains.

The Committee also recognizes as standard a narrow class of chains for which $W = 0.41\ P$, but recommends only the wide series for general practice. These narrow chains can be made in all three series, heavy, medium and light.

Roller Transmission Chains—Medium Series

The standard medium-weight series of roller transmission chains is developed by adopting for each pitch the standard rollers, bush-

[1] Standards (1) and (2) were presented to the A.S.M.E. at the Spring Meeting held in May, 1921, in Chicago and were adopted. Standards (3) and (4) will be presented to this Society for adoption in December, 1921. The S.A.E. has already adopted the entire set.

ings, and pins of the next shorter pitch and assembling them with side plates equal in thickness to those of the next shorter pitch of the heavy series.

Roller Transmission Chains—Light Series

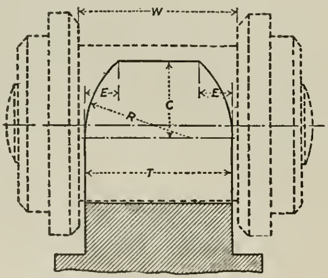
The standard light-weight series of roller transmission chains is developed by adopting for each pitch the standard rollers, bushings, and pins of the second shorter pitch and assembling them with side plates equal in thickness to those of the second shorter pitch of the heavy series.

TABLE 1 DIMENSIONS OF ROLLER TRANSMISSION CHAIN, HEAVY SERIES, IN INCHES

Pitch	Roller Diameter	Pin Diameter	Thickness of Inside Plates	Chain Width, Min. (W[1])	Measuring Load, Lb.	Approx. Test Load, Lb.
3/8	0.250	0.125	0.050	0.250	14	464
1/2	0.3125	0.156	0.060	0.3125	25	825
5/8	0.400	0.200	0.080	0.375	39	1280
3/4	0.469	0.234	0.094	0.500	56	1850
1	0.625	0.3125	0.125	0.625	100	3300
1 1/4	0.750	0.375	0.156	0.750	156	6150
1 1/2	0.875	0.4375	0.1875	1.000	225	7430
1 3/4	1.000	0.500	0.220	1.125	325	10700
2	1.125	0.5625	0.250	1.250	400	13200
2 1/2	1.550	0.781	0.3125	1.5625	625	20600
3	1.900	0.9375	0.375	1.875	900	29700
4	2.500	1.250	0.500	2.500	1600	52800
5	3.000	1.500	0.625	3.000	2500	82500
Formulas	Approx. 5/8 P	Approx. ½ roller diam.	⅛ P	Approx. 0.625 P	100 P^2	Approx. 3300 P^2 or 1/3 breaking strength

[1]See *W* in illustration of Table 2

TABLE 2 DIMENSIONS OF ROLLER TRANSMISSION CHAIN SPROCKETS



R (Min) = 0.43 P. W = Chain width.

Pitch (P)	Sprocket Width (T)	C	E	Sprocket Bottom Diam. Minus Tolerance	Nominal Clearance (W—T)
3/8	0.227 ±0.004	0.113	3/64	0.004	0.023
1/2	0.284 ±0.005	0.150	1/16	0.006	0.028
5/8	0.343 ±0.006	0.1875	5/64	0.007	0.032
3/4	0.459 ±0.007	0.225	3/32	0.009	0.041
1	0 575 ±0.008	0.300	1/8	0.012	0.050
1 1/4	0 692 ±0 010	0.375	5/32	0.015	0.058
1 1/2	0.924 ±0.012	0.450	3/16	0.018	0.076
1 3/4	1.040 ±0.013	0.525	7/32	0.021	0.085
2	1 156 ±0.015	0.600	1/4	0.024	0.094
2 1/2	1 447 ±0.018	0.750	5/16	0.030	0.115
3	1 738 ±0.021	0.900	3/8	0.036	0.137
4	2.319 ±0.027	1.200	1/2	0.048	0.181
5	2 784 ±0.032	1.500	5/8	0.060	0.216
Formulas	T = 0.93W − 0.006 Tolerances = ±(0.01W + 0.002)	0.3P	P/8	0.012P	0.07W + 0.006

All dimensions in inches.

By thus setting the five principal dimensions of the chain for each of the thirteen pitches in each of the three series, the Committee has done all that is necessary to insure the interchangeability of spare links between chains of various makes and also the interchangeability between chains and sprockets.

Tolerance for Chain Length. New chains under standard measuring load may be one sixty-fourth inch per foot over length, but must not be under length.

Roller Transmission Chain Sprockets

Table 2 and its accompanying figure give in convenient form the standard dimensions of chain sprockets as far as width, clearance and transverse sections are concerned.

Roller Transmission Chain Sprocket-Tooth Form and Sprocket-Tooth Cutters

Historical Note. The first tooth forms for roller-chain sprockets were designed upon the theory that the tooth action was similar to that of gear teeth, the chain being regarded as analogous to a rack. It was, however, soon found that when chains had been in use a short time the wear at the joints caused an elongation of the pitch of the chain, thus destroying perfect registration with the sprocket teeth which resulted in rough action and rapid wear. The sprocket teeth were then redesigned to provide for the chain elongation by making the tooth gap somewhat greater than the diameter of the chain roller, but with little or no modification in the contour of the tooth, which was so shaped that the chain roller bore almost squarely against the sprocket tooth, throwing practically the whole load on a single tooth.

Meanwhile, the use of roller chains became more extensive and the demands made on them more exacting. This condition naturally led, both in this country and abroad, to a more careful study of the action between chains and sprocket teeth than had heretofore been given to the subject, and it soon became apparent that by giving some obliquity to the face of the sprocket tooth, quite different and decidedly better results could be obtained. The action of the forces called into play can be readily analyzed by the graphic method of laying out a parallelogram of forces which will show in true proportion the initial tension on the chain, the resultant thrust on the sprocket tooth (determined by the degree of obliquity selected) and a balancing force passed on to the ensuing links of the chain where this action is repeated in a lessening amount.

By this method the load on a chain may be distributed over several teeth of the sprocket and at the same time, by extending the oblique portion of the sprocket tooth a suitable distance, make it possible for a chain of elongated pitch to slide outward on this oblique face until it finds a pitch circle on the sprocket coinciding with the lengthened pitch of the chain. These general findings were freely exchanged among the chain manufacturers and one of the English companies published a brochure on the subject. During the war more pressing matters prevented an interchange of opinion on this subject, but never the less most of the sprocket manufacturers evolved tooth forms along these lines.

It is now proposed to effect an agreement upon one standard form that shall supersede the various individual designs, and the formula now presented by the Joint Committee for adoption is a composite of the best features of the various tooth shapes that have been tried out and pronounced satisfactory.

Sprocket Tooth Form (See Fig. 1)

P = pitch of chain
D = nominal roller diameter
N = number of teeth in sprocket
D' = diameter of seating curve = 1.005 D + 0.003 in.

$$A = 31° + \frac{90°}{N}$$

$$ws = 0.8\,D$$

$$B = 13° - \frac{18°}{N}$$

xz = a circular arc whose center is at w
zy = a straight line perpendicular to wz

$$xy = 1.3\,D \times \sin\left(25° - \frac{90°}{N}\right)$$

ek = a line perpendicular to st

H = height of tooth crest above the chord $se = 0.35\ P$

qy = a line parallel to wz with q so located that the circular arc through y will pass through k, thus forming a pointed tooth.

Outside Diameter of Sprocket = Pitch Diameter +

$$P\left(0.7 - \tan\frac{90°}{N}\right) = \text{(approx.)}\ P.D. + P\left(0.7 - \frac{1.592}{N}\right)$$

$$E = O.\ D. \times \sin\frac{180°}{N}$$

Sprocket-Tooth Cutters (See Fig. 2)

Cutters shall be designed for 6, 7-8, 9-11, 12-17, 18-34, 35 teeth and over.

The number of teeth on which each cutter shall be based is, $M = \frac{2\ N\ n}{N+n}$, where N and n are the maximum and minimum number of teeth to be cut by any given cutter. A sprocket having N teeth will thus have a pressure angle which departs the same amount from the desired pressure angle as one having n teeth.

The values of M for the various cutters are respectively, 6, 7.47, 9.90, 14.07, 23.54 and 65.42 teeth.

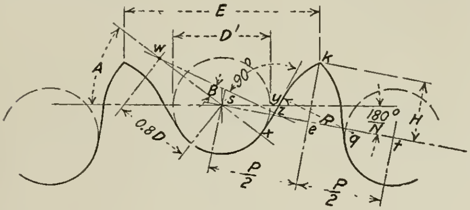


Fig. 1

Cutter numbers shall be respectively, 6, 7½, 10, 14, 24 and 65.

$D' = 1.005\ D + 0.003$ in.

$A = 31° + \frac{90°}{M}$

$ws = 0.8\ D$

$B = 13° - \frac{18°}{M}$

xz = a circular arc with w as the center

zy = a straight line perpendicular to wz

$xy = 1.3\ D \sin\left(25° - \frac{90°}{N}\right)$

$se = \frac{1}{2} P$

$ek = H = 0.35\ P$

yq = a line parallel to wz

q = a point so located that the arc yk, struck from q as a center, will pass through k

The radius R may be determined graphically.

Where the same roller diameter is used on chains of two different pitches (as $^5/_8$-in. roller, 1-in. pitch; and $^5/_8$-in. roller, $1^1/_4$-in. pitch), cutters Nos. 6 and 7½ shall be designed for the longer pitch, and may be used for cutting sprockets of the shorter pitch. Cutters Nos. 10, 14, 24 and 65 shall be designed for the shorter pitch and may be used to cut sprockets of the longer pitch.

W = width of cutter $= 1.02 \times O.\ D. \times \sin\frac{180°}{n}$, to the next higher 32nd inch; where $O.\ D.$ equals the outside diameter of the sprocket with the larger pitch and the lowest number of teeth to be cut with the cutter.

Note: The specifications to the cutter maker may be simplified if w and z are located as follows:

$$a = 0.8 \times D \times \sin\left(31° + \frac{90°}{M}\right)$$

$$b = 0.8 \times D \times \cos\left(31° + \frac{90°}{M}\right)$$

$$xz = 2.6 \times D \times \sin\left(6.5° - \frac{9°}{M}\right)$$

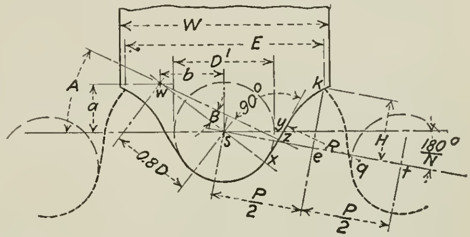


Fig. 2

This proposed standard tooth form and the cutters which produce it have slight modifications from those in general use, but the principles involved have all been thoroughly tried out and the compromises that have been made to produce a standard are in no case large enough to influence the result. Sprocket teeth cut to this form have been in very general use for a number of years.

Standard chains made to fit the old form of sprocket teeth will fit the new form as well, but they will run better on the new sprockets.

Standard Uniform System for Numbering Chains

In this system of numbering, each chain number consists of three parts, the first indicated by the first one or two digits; the second by the last digit, and the third part by the letter which follows the figures. The rule for fixing the number of any standard chain is as follows:

a The left-hand figures shall denote the number of one-eighth ($^1/_8$) inches in the pitch

b The final figure shall denote the series to which the chain belongs. "0" stands for the heavy series, "1" for the medium series, and "2" for the light series

c The letters "W" and "N" following the figures shall denote whether the chain is wide or narrow.

Thus, if the pitch is $^3/_8$ in. and the chain is a wide one of the heavy series, its number is 30W. Again, if its pitch is $1^3/_4$ in. and it is a narrow chain of the medium series, the standard number is 141N.

To provide for rollerless bushing chains the committee proposes the use of the digits 5, 6 and 7 in place of 0, 1 and 2.

LIBRARY NOTES AND BOOK REVIEWS

The Aircraft Handbook. By Fred H. and Henry F. Colvin. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 5 x 8 in., 415 pp., illus., $4.

This work was first published in 1918 under the title, The Aircraft Mechanics' Handbook and was intended to meet the wartime need for a book for airplane mechanics. It has now been thoroughly revised, and increased in scope to meet the needs occasioned by the development of commercial aviation. The book is intended to give a good general knowledge of the principles involved in the design of airplanes and their motors, without describing details, and to show how both planes and motors are assembled, cared for and repaired.

Automaten. By Ph. Kelle. Julius Springer, Berlin, 1921. Cloth, 6 x 9 in., 426 pp., illus., 144 marks.

This work treats of automatic and semi-automatic lathes, screw-machines and similar machine tools. The book first explains the various systems of automatic machinery, and follows this by a detailed discussion of such special parts as driving mechanisms, work holders, feeding devices, gearing and turret heads. Machines

and appliances for special classes of work are also described. The volume is thoroughly illustrated with drawings and photographs of modern German tools.

Automobiltechnisches Handbuch. By Richard Bussien. Tenth edition. M. Krayn, Berlin, 1921. Cloth, 5 x 7 in., 1194 pp., illus., $2.

This pocket-book of automotive engineering is intended primarily for designers and builders, for whom it provides the formulas, technical data, standards and other information usually needed, in convenient form. The first division of the book is given over to general subjects, such as the properties of materials, engine fuels, lubricants, standards, gearing and chain drives. The second division takes up in detail the calculations of mechanical traction, the organs of power transmission, motors, speedometers, electric lighting and starting apparatus, accounting, motor boats, motor plows, fire engines, etc. This edition has been carefully revised.

The Case-Hardening of Steel. By Harry Brearley. Second edition. Longmans, Green & Co., New York, 1921. Cloth 6 x 9 in., 207 pp., illus., $6.

This work, which first appeared in 1914, has been out of print for some years. It is intended for those actively engaged in the commercial manufacture of case-hardened objects, and for this reason is arranged to appeal to the workshop experiences and observation of craftsmen.

Die Drahtseilbahnen. By P. Stephan. Third edition. Julius Springer, Berlin, 1921. Cloth, 6 x 9 in., 459 pp., illus., 150 marks.

This work is presented as a complete treatise on wire ropeways. The first chapter is devoted to a historical account of their development. This is followed by a description of the various details, such as cables, towers, cars and buckets, landing stations and protective devices. Chapter III gives examples of the use of ropeways for transportation in mountainous lands, for river crossings and as conveyors in various industries; while Chapter IV presents the various types. Chapter VI discusses the economic aspects of the subject and legislation. The closing chapter considers erection and operation.

The Efficiency of Pumps and Ejectors. By E. C. Bowden-Smith. D. Van Nostrand and Co., New York, 1920. Cloth, 6 x 9 in., 205 pp., plates, diagrams, $5.

This book discusses their efficiency with regard to a single problem the raising of crude sewage, the author's object being to enumerate and discuss those points which tend to economy, and to suggest methods of increasing efficiency. The problem is treated from three points of view, mechanical efficiency, commercial efficiency and sanitary efficiency.

Engineering Instruments and Meters. By Edgar A. Griffiths. D. Van Nostrand Co., New York, 1921. Cloth, 7 x 10 in., 360 pp., illus., diagrams, $7.50.

The writer has attempted to give a brief review of the appliances which have been devised for the measurement of some of the fundamental quantities of mechanical science, such as length, screw threads, area, volume, velocity, force, mass, work and temperature. The book should enable the reader to appreciate the advantageous and drawbacks of the various types of instruments for making any particular measurement, and to choose the instrument best suited to his requirements. References to literature on the subject accompany each chapter.

Engineering of Power Plants. By Robert H. Fernald and George A. Orrok. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 x 9 in., 595 pp., illus., tables, $5.

This is an epitome of the subject arranged for classroom use, in which an especial effort has been made to awaken a realization of the fact that engineering, although based on exact sciences, is not itself an exact science, but requires the application of judgment, and to give the student some idea of the commercial side of engineering. The present edition includes corrections, slight modifications and reasonable additions.

The Engineers and the Price System. By Thorstein Veblen. B. W. Huebsch, Inc., New York, 1921. Cloth, 5 x 8 in., 169 pp., $1.50.

Contents: On the Nature and Uses of Sabotage; The Industrial System and the Captains of Industry; The Captains of Finance and the Engineers; On the Danger of a Revolutionary Overturn; On the Circumstances which Make for a Change; A Memorandum on a Practical Soviet of Technicians.

This series of papers is reprinted from the *Dial*, where they appeared during 1919. They discuss certain difficulties involved in the American industrial situation, and present the author's views concerning the way in which they will be solved.

Foundrywork. By Ben Shaw and James Edgar. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Pitman's technical primer series.) Boards, 4 x 6 in., 115 pp., illus., $1.

This book is intended to supply engineers responsible for the designing machines that involve castings with some knowledge of the fundamental principles applied to their production in the foundry, in order that the difficulties involved in the casting of intricate forms may be understood by the designer and avoided in the design when possible.

Gasoline and Other Motor Fuels. By Carleton Ellis and Joseph V. Meigs. D. Van Nostrand Co., New York, 1921. Cloth 6 x 9 in., 709 pp., diagrams, $10.

The authors of this work have endeavored to prepare a substantially complete survey of the field, which would include a description of practically every process of making gasoline and of most other motor fuels of prominence or promise. The chief fuels considered are gasoline, benzene, alcohol and shale and asphalt oils. Much attention has been given to patent literature.

Handbuch des Wasserbaues. By Hubert Engels. Second edition. Wilhelm Engelmann, Leipzig, 1921. 2 vol., 7 x 11 in., diagrams.

The first edition of Engels' Handbuch des Wasserbaues, published in 1914, was intended to meet the lack of a modern work covering the entire field of hydraulic engineering in a uniform manner. The second edition has been revised and enlarged.

The work is divided into ten sections treating of the occurrence and movement of water, hydrology, river works, weirs, dams and water-power plants, protection of land, agricultural hydraulic works, navigation, ship locks, river canalization and ship canals, and harbors. Each of these is an extensive summary of modern theory and practice, accompanied by a list of "sources."

The High Cost of Strikes. By Marshall Olds. G. P. Putnam's Sons, New York, 1921. Cloth, 6 x 8 in., 286 pp., $2.50.

In this book the author has attempted to analyze the costs to the public and to labor itself of the strike epidemic which followed the war and to show, as concretely as possible, the results, to labor and the whole country, of the theories of the professional labor leader as they become apparent in this large-scale demonstration. He endeavors to make clear the wasteful absurdity of strikes as a means of controlling the division of the proceeds of production, and suggests other measurements for adjusting labor questions.

Industrial Organization and Management. By Hugo Diemer. La Salle Extension University, Chicago, 1921. Cloth, 6×8 it., 291 pp., illus., $3.

Contents: The Principles of Business Organization; Types of Organization; Locating an Industry; Manufacturing Plants and Equipment; Buying; Receiving, Storing, and Recording Materials; Planning; The Determination of Costs; Methods of Collecting Material and Labor Costs; The Distribution of the Expense Burden; Standardization; Scientific Management; Time and Motion Studies; Wage Systems; Welfare and Betterment Work; Employment Problems; Reports to Executives.

The contents illustrate the general purpose and scope of this book. The volume is intended for beginners and sets forth the elements of the subject clearly and concisely.

The Manufacture of Pulp and Paper. Volume 2. By J. J. Clark and T. L. Crossley. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 x 9 in., 182 pp., illus., $5.

This is the second volume of the series of textbooks prepared under the direction of the educational committees of the pulp and paper associations of the United States and Canada, as a course of study bringing together the fundamental facts of mathematics and elementary science and the principles and practice of paper and pulp making. The present book is devoted to mechanics, hydraulics, elementary electricity and chemistry. It is adapted for home study as well as for classroom instruction.

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Building Construction. Prevention of Accidents in the Erection of Steelwork. Contract Rec., vol. 35, no. 25, June 22, 1921, pp. 605–608. Instructions issued by construction firm to its foremen engaged in placing of structural steel. Rules governing handling of erection equipment and tools.

AERODROMES

Design. The Effect of Temperature and Altitude of Aerodrome in the Taking off of Aeroplanes, P. G. Gundry. Aeronautical Jl., vol. 25, No. 126, June 1921, pp. 290–300, 7 figs. Design of aerodromes suitable for conditions in South Africa. Paper read before South African Assn. for Advancement of Science.

AERONAUTICAL INSTRUMENTS

Steering Gages. German Gyro Gauges, Alfred Gradenwitz. Aeronautics, vol. 20, no. 401, June 23, 1921, pp. 451–452, 3 figs. Description of Drexler aircraft steering gage fitted on large fighting aeroplanes of German army.

AEROPLANE ENGINES

ABC Wasp. Standard Engine Report on ABC Wasp Radial Aeronautical Engine Rated at 170 Hp. at 1800 R.P.M. U. S. War Dept., Air Service Information Circular, vol. 2, no. 197, April 30, 1921, 23 pp., 26 figs. Results: Normal hp. full throttle, 169.5 at 1800 r.p.m.; fuel consumption at normal hp., 0.592 lb. per hp-hr. at 1800 r.p.m.; brake m.e.p. at normal speed, 111.2 lb. per sq. in. at 1800 r.p.m.; total dry weight, 289.15 lb.; dry weight per hp., 1705 lb.

Developments. The Requirements of Aeronautic Powerplant Development, G. J. Mead and L. E. Pierce. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 23–32, 2 figs. Review of developments of various engine types, analysis of effect of their characteristics on aeroplane performance and consideration of proper installation of powerplants in aeroplane.

French. French Aeroplane Engines in 1920 (Les moteurs d'aviation français en 1920), M. Martinot-Lagarde. Aéronautique, vol. 3, nos. 19–20, Jan. 1921, pp. 296–305, 11 figs. Panhard-Levassor, Schneider, Renault, Salmson, Bréguet, Henri-Paul and Rhône.

Fuels. The Use of Commercial Low-Test Automobile Gasoline in Aviation Engines. U. S. War Dept., Air Service Information Circular, vol. 3, no. 216, April 30, 1921, 12 pp., 6 figs. With commercial low-test automobile gasoline power developed was 7 per cent less at normal speed than that obtained with domestic aviation gasoline. With mixture of low-test automobile gasoline and 6 per cent xylidine by volume, 5-hr. run with regular operation was obtained.

Heaters. Test of Airplane Engine Heater. U. S. War Dept., Air Service Information Circular, vol. 3, no. 232, May 25, 1921, 4 pp., 2 figs. Object of test was to determine possible cause of unsatisfactory service rendered by engine heaters.

Manifold. Eliminating Crankcase Dilution by Manifold Development, G. P. Dorris. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 35–36, 4 figs. Type of manifold in which admission pipe is cast integrally over exhaust pipe. Exhaust ports form hot spot immediately above carburetor inlet.

Starting Switches. Operating Tests of Magnetically Operated Starting Switches U. S. War Dept., Air Service Information Circular, vol. 3, no. 214, April 30, 1921, 6 pp., 6 figs. Bijur switch was found unsatisfactory. Hart switch, U. S. L. switch and Diamond-H switch proved satisfactory for production.

Supercharging. An Analysis of the Effect of Supercharging. U. S. War Dept., Air Service Information Circular, vol. 2, no. 195, April 15, 1921, 11 pp., 8 figs. Analysis of typical performance of aeroplane fitted with supercharging device.

Some Experiments on Supercharging in a High Speed Engine, Harry R. Ricardo. Automobile Engr., vol. 11, no. 151, June 1921, pp. 219–224, 20 figs. Comparative graphic study of performance with supercharging device and normal.

AEROPLANE PROPELLERS

Wheel. Wheel Propeller for Aircraft. Aeronautics, vol. 20, no. 399, June 9, 1921, p. 414, 6 figs. Patented wheel propeller built in such a manner that number of wing planes placed in vicinity of periphery of wheel and parallel to wheel axis, adjust themselves during rotation of wheel and become active only during half revolution of wheel, while during other half of revolution of wheel their position will be tangential to wheel.

AEROPLANES

Aerofoils. Airfoil Data on American and British Airfoils. U. S. War Dept., Air Service Information Circular, vol. 2, no. 197, April 30, 1921, 129 pp., 63 figs. Tables of coefficients and graphs of angle of incidence for 32 American models and 32 British models.

All-Metal. The All-Metal Aeroplane in Germany (L'avion métallique en Allemagne), Roger Couturier. Aéronautique, vol. 3, no. 24, May 1921, pp. 194–200, 9 figs. Junkers types.

Corrosion of Metal Parts. Methods for Preventing the Corrosion of Metal Parts of Aeroplanes. Aerial Age, vol. 13, no. 16, June 27, 1921, pp. 369–370, 1 fig. Graph giving results of comparative experiments on lasting qualities of various protecting methods. Air Service Information Circular.

Preliminary Report on Investigation of Methods for Preventing the Corrosion of Metal Parts of Airplanes. U. S. War Dept., Air Service Information Circular, vol. 3, no. 211, April 30, 1921, 4 pp., 1 fig. Corol compound was found to be best organic corrosion preventative. Zinc plating, it was determined, offers best protection against corrosion of metallic coatings tested.

Design. Some Possible Refinements in Design, W. R. Douglas Shaw. Aeronautics, vol. 20, no. 401, June 23, 1921, pp. 453–454, 10 figs. Suggestions in regard to airscrew distribution, balanced ailerons, wing section and seating accommodation.

The Loads and Stresses in Aeroplanes, John Case. Aeronautics, vol. 20, no. 402, June 30, 1921, pp. 475–477, 6 figs. Model experiments with elevators of different sizes. (Continuation of serial.)

French Commercial Types. New French Commercial Airplanes. Aviation, vol. 11, no. 2, July 11, 1921, pp. 48. Spad-33 6-Seater and Potez-IX 5-Seater.

Performance. Airplane Performance and Design Charts, L. V. Kerber. Aviation, vol. 10, nos. 24 and 25, June 13 and 20, 1921, pp. 748–751, 2 figs., and 780–784, 15 figs., June 13: Graphical solution of empirical-theoretical method of predicting performance of aeroplane of which are known weight, area, horsepower and external characteristics; also method for determining weight and area of aeroplane of given horsepower and external characteristics which is to be designed to realize a required performance. June 20: Charts for computing rate and time of climb for aeroplanes fitted with Liberty 12, Hispano-Suiza and similar engines.

Steady Motion, Theory of. General Theory of the Steady Motion of an Airplane, George de Bothezat. Nat. Advisory Committee for Aeronautics, report no. 97, 1921, 70 pp., 27 figs. Development of chart representing aeroplane steady-motion performance.

Wings. Ground-Plane Influence on Airplane Wings, A. F. Zahm and R. M. Bear. Aviation, vol. 10, no. 26, June 27, 1921, pp. 807–808, 5 figs. Test made on single British R.A.F. 6 aerofoil at 40 m.p.h. in wind tunnel at Washington navy yard. From Jl. Franklin Inst.

The Handley Page Wing. Aeronautical Jl., vol. 25, No. 126, June 1921, pp. 263–278 and (discussion) 279–289, 31 figs. Record of experimental work carried out with a view to overcoming phenomenon of "burbling."

Stresses. The Deflection of Supporting Planes and Stress of Material (Tragflächendurchbiegung und Stoffbeanspruchung), A. Pröll. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 10, no. 11–12, June 28, 1919, pp. 121–124, 6 figs. Calculation of increase of stress due to deflection of supporting planes.

Zeppelin Passenger. The 1000-Hp. Passenger Aeroplane of the Zeppelin Works in Staaken (Das 1000 PS-Verkehrsflugzeug der Zeppelinwerke in Staaken), Ad. K. Rohrbach. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 23, June 4, 1921, pp. 591–594, 12 figs. Monoplane, designed by author and made entirely of duralumin, reached on trial flight a speed of 211 km. per hr. with engines somewhat throttled. The four 260-hp. Maybach engines are placed side by side on wing.

AIR COMPRESSORS

Hydraulic. Experiences in Construction and Operation of Hydraulic Compressors in the Harz (Germany) (Bau- und Betriebserfahrungen mit Hydrokompressoren im Harz), K. Rubach. Glückauf, vol. 57, no. 16, Apr. 16, 1921, pp. 361–367, 9 figs. Development of theory of hydraulic compressors and operating experiences, based on which suggestions are drawn for their constructional arrangement. Future possibilities of their use.

Small. A Small Compressor (Klein-Kompressor), M. Prölss. Chemiker-Zeitung, vol. 45, no. 27, Mar. 3, 1921, p. 220, 3 figs. Small air compressor exhibited at Leipzig fall exhibition, constructed in four sizes for supplying 3, 10.6, 12.7, and 29.5 cu.m. of air per hour at pressure of 6 atmos. Advantages of its use in laboratories, repair workshops, etc.

AIR LIFT

Raising Liquids. Compressed-Air Lifts for Raising Liquids, A. T. Cross. Mech. World, vol 69, No. 1798, June 17, 1921, pp. 462–463, 3 figs. Formulas and graphs for computing efficiency of installation.

AIRCRAFT CONSTRUCTION MATERIALS

Plymetl. A New Structural Material. Elec. Ry.

NOTE.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Jl., vol. 57, no. 24, June 11, 1921, pp. 1091–1092. Composite of wood and sheet steel manufactured by cementing thin sheet-metal faces to relatively thick core of light-weight material. Suggested for car roof, interior panels, bins and shelves.

Streamline Wire. The Effect of Zinc Plating on the Physical Properties of Streamline Wire. Aerial Age, vol. 13, no. 16, June 27, 1921, pp. 368–369, 1 fig. From results of bend and torsion tests it is concluded that zinc plating makes streamline wire brittle. Air Service Information Circular.

AIRSHIPS

Performance. Comparative Study of Performance of Various Dirigibles (Étude comparative du rendement des divers dirigeables), M. Champsaur. Aéronautique, vol. 3, no. 24, May 1921, pp. 189–193 7 figs. French and German types.

R38. H.M. Airship R38. Engr., vol. 131, no. 3415, June 10, 1921, pp. 610–611 and 620, 5 figs. Characteristics: Length, 695 ft.; diameter, 85 ft. 4 in.; capacity, 2,700,000 cu. ft.; total normal lift, 83 tons; disposable lift, 50 tons; endurance at full speed, 5000 mi.; estimated ceiling, 25,000 ft.

ZR.2. "ZR.2" ("R.38"). Flight, vol. 13, no. 23, June 9, 1921, pp. 287–289, 6 figs. Characteristics; Length, 695 ft.; diameter, 85 ft. 4 in.; capacity 2,700,000 cu. ft.; total lift under normal conditions, 83 tons; total horsepower, 2100.

ALCOHOL

Industrial. Industrial (Including Power)—Alcohol Charles H. Bedford. Jl. Royal Soc. of Arts, vol. 49, no. 3577, June 10, 1921, pp. 472–482 and (discussion) pp. 482–486. Possibilities of establishing within British Empire industrial alcohol industry.

Industrial Alcohol and Prohibition Enforcement Chem. & Metallurgical Eng., vol. 24, no. 25, June 22, 1921, pp. 1088–1093. Before Committee on Industrial Alcohol, Am. Chem. Soc. Administration and enforcement of existing law are denounced.

Industrial Alcohol (L'alcool industriel), Charles Blanchet. Revue de l'ingenieur et Index Technique, vol. 28, no. 5, May 1921, pp. 211–219. Economics of alcohol synthesis from acetylene. (Concluded.)

ALCOHOL ENGINES

Tests. Tests with Alcohol Engines (Undersökningar å Spritmotorer), E. Hubendick. Teknisk Tidskrift (Mekanik), vol. 51, nos. 2, 3 and 4, Feb. 9, Mar. 9, and Apr. 13, 1921, pp. 25–31, 45–52 and 69–73, 23 figs. Comparison of efficiency and weight of engines for alcohol and for gasoline with same dimensions and same power. Basic principles of design. Results of tests show degree of compression to be from 7 to 9 for alcohol alone or mixed with gasoline or benzol. In spite of high degree of compression, output remains practically unchanged. Alcohol engines with flywheel are 20 per cent heavier than gasoline engines and 15 per cent dearer. Denaturing of alcohol.

ALLOY STEELS

Tests. Comparative Tests of Steels at High Temperatures, R. S. MacPherran. Chem. & Metallurgical Eng., vol. 24, no. 26, June 29, 1921, pp. 1153–1155, 13 figs. Determination of comparative properties of various alloy steels at high temperatures with a view to obtaining information as to best material for use under operating conditions of 600 to 1000 deg. fahr. It was found that introduction of metals forming carbides tends to strengthen steels at high temperatures. Paper read before Am. Soc. for Testing Matls.

ALLOYS

Microstructure. Micrographic Study of Alloys and of the Structure of Tungsten Steels by Their Slow Cooling (L'emploi des refroidissements très lents pour l'étude micrographique des alliages et la structure des aciers au tungstène), A. Portevin. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 61, April 18, 1921, pp. 964–967, 2 figs. Record of experiments.

[See also BEARING METALS; COPPER ALLOYS; IRON ALLOYS; MONEL METAL; NON-FERROUS METALS.]

ALUMINUM

Casting Losses. Losses in Aluminum and Aluminum-Alloy Melting, Robert J. Anderson. Brass World, vol. 17, no. 6, June 1921, pp. 154–156. Method of estimating metal and fuel losses in melting aluminum.

ALUMINUM ALLOYS

Melting Losses. Aluminum-Alloy Melting Loss Great, Robert J. Anderson. Foundry, vol. 49, no. 13, July 1, 1921, pp. 520–522. Description and estimation given of losses sustained in melting aluminum and aluminum alloys. Oxidation and heavy fuel consumption due to inefficient furnace operation principal causes. Report prepared for United States Bureau of Mines.

Reverberatory Furnaces. Aluminium and Its Alloys in Engineering—V, John G. A. Rhodin. Engr., vol. 131, no. 3414, June 3, 1921, pp. 586–589, 4 figs. Description of aluminum reverberatory furnaces.

Uses. Aluminium and Its Alloys in Engineering, John G. A. Rhodin. Engr., vol. 131, nos. 3415 and 3416, June 10 and 17, 1921, pp. 622–623 and 635–636. June 10: Behavior of aluminum castings. June 17: Principles of designing dies for facilitating their use in the foundry.

AMMONIA

Properties. The Isometrics of the Ammonia Superheated Region and the Vapor Pressure of Liquid Ammonia, Frederick G. Keyes. A.S.R.E. Jl., vol. 7, no. 5, Mar. 1921, pp. 371–379, 1 fig. Experiments at research laboratory of Mass. Inst. of Technology.

APPRENTICES, TRAINING OF

Railways. A Railway Company's System of Engineering Apprenticeship. Eng. & Indus. Management, vol. 5, no. 24, June 16, 1921, pp. 692–694. Practice of Orleans Ry. Co. Translated from Revue générale des Chemins de Fer.

Systems. Apprenticeship System of the Southern Pacific Railway, Frank A. Stanley. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 12–15, 8 figs. Methods of instruction. Rates of pay while learning. Summary of periods of instruction.

Programs of Apprenticeship and Special Training in Representative Corporations, J. V. L. Morris. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1081–1083, 1 fig. Plan of instruction followed in plant of Westinghouse Air Brake Co., Wilmerding, Pa.

ARTILLERY

Anti-Aircraft. The future of Anti-Aircraft Artillery, Robert V. Morse, Jl. U. S. Artillery, vol. 54, no. 6, June 1921, pp. 583–593, 3 figs. Future developments.

AUTOGENOUS WELDING

Low-Carbon Steel. The Influence of Foreign Substances in Low-Carbon Steel on Its Weldability in Melting Flame (Ueber den Einfluss der Fremdkörper im Flusseisen auf seine Schweissbarkeit in der Schmelzflamme), C. Diegel. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 24, June 11, 1921, pp. 626–629, 5 figs. Influence of C, Si, Mn, P and S in low-carbon steel on quality of seam with autogenous welding. Results so far of tests being carried out by Julius Pintsch Corp. show injurious influence of silicon.

AUTOMOBILE ENGINES

Air-Cooled. Fins for Air-Cooled Engines. Automobile Engr., vol. 11, no. 151, June 1921, p. 213, 1 fig. Formulas for determining dimensions of fins.

Gas-Producer Plant. Suction Gas-Producer Plant for Motor Vehicles. Engineering, vol. 111, no. 2894, June 17, 1921, pp. 739–741, 18 figs. Parker plant manufactured by Producer-Gas Plants, of London.

High-Compression. Developing a High-Compression Automotive Engine, Fred C. Ziesenheim. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 5–19, 16 figs. Experimental work in development of mechanical injection system conducted at Carnegie Inst. of Technology, Pittsburgh.

Manifold Design. Intake Manifold Practice in Europe, W. F. Bradley and S. Gerster. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1370–1375, 41 figs. Based mainly on French practice.

Pistons. A Novel Piston. Automobile Engr., vol. 11, no. 151, June 1921, pp. 212–213, 4 figs. Allen design, aiming at minimum ring friction and even pressure.

Research. A Suggested Programme for Automobile Research, Geo. W. Watson. Automobile Engr., vol. 11, no. 151, June 1921, pp. 225–230. Utilization of low-grade fuel; alcohol, ether, benzol, and mixtures thereof; and solid fuels. Study of materials for valves, and design of pistons, piston rings and cylinders; cooling systems; silencers; lubrication; shafts; bearing metals; gears; spring suspension; brakes and transmission.

Vibrating Force. Running Balance and Uniformity of Crankshaft Effort in 8-Cylinder 60 Degree Vee Engines, P. M. Heldt. Automotive Industries, vol. 44. no. 26, June 30, 1921, pp. 1427–1429, 4 figs. Analytical study of vibrating forces in 8-cylinder Vee engine. One conclusion reached is that maximum vibrating force of 60 deg. eight-cylinder engine is only 61.2 per cent of that of 90 deg. 8-cylinder Vee engine.

AUTOMOBILE FUELS

Benzol. Nearly 65 Miles on One Gallon of Benzol, W. F. Bradley. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1364–1365, 2 figs. New record is established in French "grand prix" fuel-consumption test by Gregoire, Citroen and other small cars, as well as by some larger cars. Nearly all makes entered in 183-cu. in. class and smaller make over 30 m.p.h.

Research. Influence of Various Fuels on Engine Performance—IV, H. R. Ricardo. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 8–13 and 17, 6 figs. When all fuels are used with same compression ratio, power output is proportional to energy content of charge, but fuels which can be used with higher compression ratios without detonation are capable of developing higher maximum power than those which detonate at lower pressures. From Automobile Engr.

Where Are We Getting in Efforts to Solve the Fuel Problem? Herbert Chase. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1241–1250, 15 figs. Review of research and development work covering results of tests and improvements in design made public during past year, together with comments on future developments that appear to be promising.

[See also AEROPLANE ENGINES, Fuels; BENZOL.]

AUTOMOBILES

Body Suspension. A New Method of Automobile Body Suspension, George J. Mercer. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1261–1263, 4 figs. There are two supports on each side for connecting body to frame and body sills are outside frame.

Examples of European Practice in Three- and Four-Point Suspension, M. W. Bourdon. Automotive Industries, vol. 44, no. 26, June 30, 1921, pp. 1419–1420, 6 figs. Tendency is toward three-point type, though majority of cars still employ four-point arrangement. One maker employs self-aligning ball bearing as support for extended front end of crankcase.

Propulsive Suspension of Automobile Body (La voiture a suspension propulsive), Pierre Maréchal. Nature (Paris), no. 2456, April 30, 1921, pp. 279–282, 4 figs. There are no shafts common to wheels on opposite sides, and each of rear wheels is driven by separate mechanism. Body is supported by springs engaging in rod attached to wheel pointing at small angle toward direction of motion. Obstacles force rods against springs, which transmit impact by elasticity to car in direction of motion.

Design in U. S. The Trend of Design in the United States of America. Automobile Engr., vol. 11, no. 151, June 1921, pp. 215–217, 20 figs. Notes on 1921 New York automobile show.

Four-Wheel Brakes. Engineering Analysis of European Four-Wheel Brakes, W. F. Bradley and S. Gerster. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1267–1273, 20 figs. Engineering features of chief types and results of tests.

Front-End Drive. Problems of the Front-End Drive in Automobiles, J. Edward Schipper. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1296–1301, 16 figs. Typical three-wheel Morse silent chain drive. Present and future trend in front-end drive.

Manufacture. Manufacturing Methods on a Light Car. Automobile Engr., vol. 11, no. 151, June 1921, pp. 206–211, 18 figs. Tooling equipment at works of A.B.C. Motors, Ltd., Surrey, England.

Shock Absorbers. Suspension Shock Absorber fo, Automobiles. Sci. Am. Monthly, vol. 4, no. 1r July 1921, pp. 69–70, 5 figs. Construction employing differential lever principle to meet variable conditions.

Starting and Lighting System. Oscillograph Measurements of Instantaneous Values of Current and Voltage in the Battery Circuit of Automobiles, George W. Vinal and C. L. Snyder. U. S. Dept. of Commerce, Technologic Papers of Bur. of Standards, no. 186, May 2, 1921, 23 pp. 28 figs. Oscillograms of instantaneous and average values of current and voltage.

Transmission Gears. A New Transmission Designed to Facilitate Gear Shifting. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1366–1367, 6 figs. Secondary clutch completely disconnects transmission from propeller shaft during interval of gear shafting. Shifting is accomplished by imparting rotary motion to slotted camshaft in gear box which actuates shifting yokes. Shifting lever mounted on steering column.

AVIATION

Civil, Australia. Commercial Aviation in Australia, R. A. Hendy. Aviation, vol. 11, no. 2, July 1921, pp. 49. There are nearly sixty companies or persons engaged independently in aviation.

Civil, Canada. Civil Aviation in Canada. Aviation, vol. 11, no. 2, July 11, 1921, pp. 45, 1 fig. Summary of Canadian civil aviation certificates and licenses issued during 1920 and the first five months of 1921.

Commercial. Commercial Aviation 1920 (La navigation aérienne commerciale en 1920), M. Emile Pierrot. Aéronautique, vol. 3, nos. 19–20, Jan. 1921, pp. 307–316, 8 figs. European developments.

France. French Aviation in 1921, Capt. de Lavergne Aviation, vol. 10, no. 24, June 13, 1921, pp. 745–747. Developments in military and civil aviation.

French Aerial Navigation Regulations. Organization of French Aeronautics. Aerial Age, vol. 13, no. 16, June 27, 1921, pp. 367–368 and 365. Regulations for aerial navigation in France. Establishment of Nat. Meteorological Bur. Note from Nat. Advisory Committee for Aeronautics.

International Law. Aerial Navigation and International Law (La navigation aérienne et le droit international), Henri Bouché. Aéronautique, vol. 3, no. 24, May 1921, pp. 216–220. Study of protocols before French senate. Centrifugal study.

Legislation. Air Navigation Directions—I. Aeronautics, vol. 20, no. 400, June 16, 1921, pp. 442–444. Survey of air-navigation acts enacted from 1911–1919.

London-Paris Service. London-Paris Service. Aeronautics, vol. 20, no. 400, June 16, 1921, pp. 428–431, 3 figs. Report on installation work on engines, oil, water and gasoline systems, engine design, aeroplane design, etc. (To be continued.)

Safety and Economy on the London-Paris Air Service. Flight, vol. 13, no. 24, June 16, 1921, pp. 408–409. Report of committee appointed by Royal Aeronautical Society "to discuss what is required to insure the safe and economical working of an aeroplane carrying mails and passengers between London and Paris.

Radiogoniometry. Aerial Navigation by Radiogoniometry (La navigation aérienne par la radiogoniométrie). Vie technique & industrielle, vol. 2, no. 21, June 1921, pp. 214–217, 8 figs. Operation of radiogoniometry.

Soaring Flight. Soaring and Gliding Experiments in Germany. Stanley Yale Beach. Aviation, vol 11, no. 1, July 4, 1921, pp. 13–14, 2 figs. Records of flights made.

Technique. The Technique of Flight—II, R. M. Hill. Aeronautical Jl., vol. 25, no. 126, June 1921, pp. 301–311, 2 figs. Analysis of longitudinal balance of aeroplane.

AVIATORS

School for Flight Surgeons. Report of the Medical Research Laboratory and School for Flight Surgeons for the Calendar Year 1920. Air Service Information Circular, vol. 3, no. 231, May 20, 1921, 12 pp.

BALANCING

Turbines. Four Years of Balancing Practice, N. W. Akimoff. Jl. Am. Soc. of Naval Engrs., vol. 33, no. 2, May 1921, pp. 261-267, 6 figs. Summary of facts established.

BEAMS

Non-Uniform Section. Deflection of Beams of Non-uniform Section. U. S. War Dept., Air Service Information Circular, vol. 3, no. 213, April 30, 1921, 10 pp., 10 figs. Comparison of graphical and analytical methods of design.

Reinforced-Concrete. Reinforced-Concrete Beams —I, T. C. Broom. Mech. World, vol. 69, no. 1799, July 24, 1921, pp. 484-486, 1 fig. Graph for designing rectangular concrete beam with single reinforcement.

Trussed. The Calculation of Trussed Beams (Zur Berechnung von Fachwerkträgern), L. Gensen. Zentralblatt der Bauverwaltung, vol. 41, no. 44, June 1, 1921, pp. 273-275, 11 figs. Following theorem is derived: The mobility of a biaxial symmetrical link polygon inscribed in a circle is finite.

BEARING METALS

Alloys. Bearing Metals (Ueber Lagermetalle), Bruno Simmersbach. Chemiker-Zeitung, vol. 45, no. 27, Mar. 3, 1921, pp. 216-219. Bronze, white metals and phosphor bronze are said to be best adapted for bearing metals. Review of various patented alloys which have been successfully used.

Self-Lubricating. New Self-Lubricating Bearing Material. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 15, 3 figs. Mixture of bronze and graphite developed by General Electric Co.

White-Metal. Some Properties of White Metal Bearing Alloys at Elevated Temperatures, John R. Freeman, Jr., and R. W. Woodward. U. S. Dept. of Commerce, Bur. of Standards, Technologic Papers, no. 188, April 5, 1921, 16 pp., 7 figs. Apparatus for determining yield point and ultimate strength of white-metal bearing alloys at temperatures up to 100 deg. cent. Record of tests.

BEARINGS

Automobile Engines. Automobile Engine Bearings, W. Betterton. Metal Industry (Lond.), vol. 18, no. 24, June 17, 1921, pp. 461-464, 7 figs. Formula for computing dimensions.

BEARINGS, BALL

Types. Comparison of Various Types of Ball Bearings, H. R. Reynolds and R. W. Sellew. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1065-1067, 7 figs. Relation between overall width tolerances and radial play mathematically demonstrated. Difference in radial play before and after mounting.

BELT DRIVE

Tension Rollers. Indirect Friction-Disk Drive by Means of Tension Rollers (Tension-Roller Belt Drive) [Indirekter Reibscheibenantrieb durch Druckrollen (Druckrollen-Riementrieb)], H. Schömburg. Der praktische Maschinen-Konstrukteur, vol. 54, no. 10, Mar. 10, 1921, pp. 45-48, 11 figs. Improved tension-roller belt drive patented by Koch & Co. Machine Works, Remscheid-Vieringhausen, Germany.

BENZOL

Specifications. British Standard Specification for Benzol for Motor Fuel. British Eng. Standards Assn., no. 135, Jan. 1921, 9 pp., 3 figs. Defined as liquid consisting essentially of mixture of benzene and not more than 30 per cent by volume of toluene and xylenes.

BLAST-FURNACE GAS

Pressure Regulation. Automatic Gas Regulation with the Aid of the Reineke Regulator (Selbsttätige Gasreglung mit Hilfe des Reglers von Reineke), R. Goetze. Glückauf, vol. 57, no. 8, Feb. 19, 1921, pp. 169-174, 9 figs.

BLAST FURNACES

Design. Designing Hot Blast Stoves, W. E. Groume-Grjimailo. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1677-1680, 3 figs. Proportioning passes and brickwork of checkers for work they have to do. Combustion and heat-transfer problems.

BOILER FEEDWATER

Degassing. Degassing and Purification of Boiler Feed-Water, Paul Kestoer. Proc. Instn. Mech. Engrs., no. 4, June 1921, pp. 291-330 and (discussion) pp. 330-360, 21 figs. Physical and chemical study of reactions involved. Classification and description of methods.

Purification. Boiler Feed Water Purification, S. B. Applebaum. Chem. and Met. Eng., vol. 25, no. 1, July 6, 1921, pp. 23-26. Outline of respective merits of various methods used for boiler feedwater treatment, with special reference to advantages of Zeolite water-softening process.

BOILER FIRING

Oil Fuel. Liquid Fuel for Steam-Raising, N. A. Anfilogoff. Jl. Soc. Chem. Ind., vol. 40, no. 11, June 15, 1921, pp. 205R-209R, 4 figs. Typical conversion of Babcock and Wilcox boiler to oil fuel without alteration of brickwork.

BOILER OPERATION

Draft Regulator. Wilkins Pressure Regulator. Power, vol. 53, no. 26, June 28, 1921, pp. 1041, 3 figs. Apparatus for draft and stoker control.

Factor of Evaporation. The Calculation of Boiler Performance, W. B. Campbell. Power House, vol.

Heat Balances. Calculating Boiler Heat Balances, H. D. Fisher. Combustion, vol. 5, no. 1, July 1921, pp. 18-24, 7 figs. Graphs.

Water Meters. The Use of Water Meters in Steam-Boiler Operation (Die Verwendung von Wassermessern im Dampfkesselbetriebe). Elektrotechnischer Anzeiger, vol. 38, no. 72, May 7, 1921, pp. 455-457. Details of recent types of open and closed water meters, both of which systems are said to give good results.

BOILERS

Cleaning. The Influence of Soot and Scale Removal on the Economy of Steam-Boiler Plants (Der Einfluss der Reinigung auf die Wirtschaftlichkeit der Dampfkesselanlage), M. Schimpf. Glückauf, vol. 57, no. 15 Apr. 9, 1921, pp. 345-346. Results of tests carried out on a double-flue boiler showing saving of 15 per cent of fuel through cleaning.

The Removal of Sludge from Steam Boilers (Das Abschlammen des Dampfkessels). Chemiker-Zeitung, vol. 45, no. 3, Jan. 6, 1921, p. 30, 1 fig. Discusses unobserved losses in steam operation and importance of sludge removal from boilers. Details and advantages of blow-off valve constructed by firm of Gustav F. Gerdts, Bremen, Germany.

Electrically Heated. Useful Possibilities of the Electric Boiler (Något om den elektriska ångpannans användningsmojligheter), Otto Stålhane. Teknisk Tidskrift, vol. 51, no. 4, Apr. 6, 1921, pp. 56-61, 8 figs. Describes boiler types and discusses three possibilities, namely (1) complete reconstruction of boiler through installation of resistances in the tubes and walling up of the smoke flues; (2) installation of boilers which can be electrically heated part of year and with coal when electric current is not constantly available; and (3) if current is constant, but not available at all times of the day, the use of a special electric boiler. Electric boilers offer possibility for complete utilization of water power.

Marine. See MARINE BOILERS.

Vertical. The Construction of Small Vertical Boilers (Ueber den Bau von kleinen stehenden Kesseln), E. Höhn. Zeit. des Bayerischen Revisions-Vereins, vol. 25, no. 10, May 31, 1921, pp. 84-86, 3 figs. Explosion occurring in Switzerland in 1915 was attributed to poor quality of welded seam between smoke tube and fire box end, and to use of bumped heads. To prevent recurrence of similar accidents regulations have been adopted by Swiss boiler manufacturers.

Water Concentration. Concentration of Water in Steam Boilers, Victor J. Azbe. Power, vol. 54, no. 2, July 12, 1921, pp. 46-48, 4 figs. Description of densimeter, an apparatus for determining water concentration by sodium chloride method.

BOILERS, WATER-TUBE

Vertical. The Piedboeuf Vertical Water-Tube Boilers (Der Biedboeuf-Steilrohrkessel), Paul Koch. Der praktische Maschinen-Konstrukteur, vol. 54, no. 11, Mar. 17, 1921, pp. 81-82, 2 figs. Vertical water-tube boilers with improved Garbe tube sheets pressed to provide flat surface for tube holes.

BORING MACHINES

Taper Head. A New Taper Head for Boring and Turning Mills. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 332-333, 5 figs. Device patented by Geo. Richards & Co., Manchester, England.

BRAKES

Electric vs. Pneumatic. Experiences with Different Types of Brakes on the Berlin Street Railway (Erfahrungen mit verschiedenen Bremsarten bei der Berliner Strassenbahn), E. Kindler. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 10, May 24, 1921, pp. 112-114, 1 fig. Experiences with pneumatic and electric brakes, from which it is concluded that the electric brake is best adapted for street-railway operation because of its simplicity and low cost of maintenance.

Train. Improvements in Train Braking. Sci. Am., vol. 124, no 26, June 25, 1921, pp. 506-507, 4 figs. Combination of straight and automatic air braking designed for control of train on steep grades.

Virginian Demonstration of Double-Capacity Brake. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 428-432, 8 figs. Train of 16,000 tons handled down 1.5 per cent. grade.

BRASS

Lead Determination. The Determination of Small Amounts of Lead in Brass, Francis W. Glaze. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 553-554. Electrolytic method for determination of lead as lead dioxide.

High-Resistance. High Resistance Brass, Pendleton Powell. Brass World, vol. 17, no. 6, June 1921, pp. 151-153. Manufacture of special brasses and bronzes to resist large stresses, especially bronzes for ship propellers. Translated from Bulletin Technologique des Arts et Métiers.

BUILDING CONSTRUCTION

Cost Accounting. Construction Accounting under Uniform System. Elec. Rev. (Chicago), vol. 79, no. 1, July 2, 1921, pp. 6-9. Each item of expenditure classified and recorded in form to segregate costs on various plants and lines and on various specific parts of such plants and lines. Examples of accounts.

Construction Costs, W. N. Connor. Jl. Boston Soc. Civil Engr., vol 8, no. 5, May 1921, pp. 157-197, 12 figs. Suggested forms for keeping records of costs in building construction.

Steel-Frame. Reducing the Cost of Steel-Frame Building, R. Fleming. Jl. Western Soc. of Engrs.,

C

CABLEWAYS

Aerial. Aerial Cableways (Les transporteurs aériens a cables), F. Cretio. Génie Civil, vol. 78, no. 19, May 7, 1921, pp. 385-390, 4 figs. Study of stresses in cable and resistance of carriage to travel. Notes on design.

CAR DUMPERS

German. Devices for the Unloading of Railway Cars (Vorrichtungen zur Entleerung von Eisenbahnwagen), G. W. Koehler. Fördertechnik u. Frachtverkehr, vol. 14, nos. 10 and 11, May 13 and 27, 1921, pp. 110-112 and 124-126, 15 figs. Describes several types.

CARS

Armored Ends. Great Central Railway Vehicles with Armoured Ends, Collision Buffers and Interlocking Fenders. Ry. Gaz., vol. 34, no. 23, June 10, 1921, p. 883, 1 fig. Object of construction is to provide buffing and interlocking arrangement whereby underframes of carriages are prevented from getting out of alignment and any tendency to mounting or over-riding is prevented.

Buffer Plates. Avoiding Rupture of Buffer Plates by Proper Heating Treatment (Studio sulla fragilita e sulla rigenerazione per ricottura dei respingent ferroviari), P. Forcella. Rivista tecnica delle Ferrovie Italiane, vol. 19, no. 5, May 15, 1921, pp. 130-134, 16 figs. on 3 supp. plates. Based on photomicrographic examinations of broken surfaces.

Couplings. Impact and Its Relation to Damage Claims, J. A. Pilcher. Ry. Age, vol. 71, no. 2, July 9, 1921, pp. 77-79, 1 fig. Graph showing relation between speed at which cars are coupled and force of impact. Evils are avoided when speed does not exceed 2 miles an hour.

Dump. Large Dump Cars for Use in the Absolute-Removal System of Stripping Overburden from Coal. Coal Age, vol. 19, no. 25, June 23, 1921, pp. 1117-1118, 3 figs. Car will carry rocks up to 18 tons weight, gives 5-ft. clearance for dumping and will hold 43 cu. ft. of material and discharge running or standing and right or left.

Heavy Types. Heavy Locomotives for the Southern Pacific. Ry. Age, vol. 71, no. 1, July 2, 1921, pp. 15-17, 4 figs. Pacific and Santa Fe types. Characteristics: Pacific, tractive effort, 43,660 lb.; cylinders, 25 in. by 30 in.; weight, total engine, 297,800 lb.; wheelbase, driving, 13 ft.; Santa Fe, tractive effort, 75,150 lb.; cylinders, 29½ in. by 32 in.; weight, total engine, 385,900 lb.; wheelbase, driving, 22 ft. 10 in.

Insulation. Insulation of Freight and Passenger Cars, Wm. N. Allman. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 444-449, 3 figs. Theoretical and practical considerations; values of various materials; calculating heat transmission.

CARS, FREIGHT

All-Steel. New All-Steel Wagon Stock for India. Ry. Gaz., vol. 34, no. 24, June 17, 1921, pp. 930-931, 4 figs. High-capacity hopper and rail wagons constructed by Midland Ry. Carriage & Wagon Co., Birmingham, for Bengal-Nagpur Ry. Dimensions: Extreme length over buffers, 44 ft. 11 in.; length of body, 35 ft.; width over underframe solebars and inside body, 9 ft.; tare weight, 21 tons 17 cwt.

Draft-Gear Tests. Draft Gear Tests of the Railroad Administration. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 435-441, 6 figs. Car-impact tests at T. H. Symington Co. testing plant at Rochester, N. Y. Methods of combining and interpreting records.

Reinforced-Concrete. Reinforced-Concrete Railway Cars (Eisenbahnwagen aus Eisenbeton), A Kleinlogel. Verkehrstechnik, vol. 38, no. 4, Feb. 5, 1921, pp. 45-48, 3 figs. Economical advantages, construction and useful scop of reinforced-concrete cars.

CARS, MAIL

Unit-Container. Epoch-Making Experiments with Unit-Container Mail Cars. Transportation World, vol. 3, no. 4, June 1921, pp. 11-12, 2 figs. Removable container cars operated by New York Central.

CARS, PASSENGER

Disinfection. The Disinfection Plant of the Vienna Municipal Street Railway (Entkeimungsanlage der Wiener städtischen Strassenbahnen im Bahnhof Simmering). Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 73, no. 20-21, May 28, 1921, p. 141. Cleaning of railway cars, etc., is effected by means of formalin vapors with vacuum in boiler, with which a thorough and rapid disinfection is insured without damage to cars.

Heating. Two-Part Coupling for Car Steam Hose ("Unikum," Kupplung für zweiteilige Dampfheizschläuche), L. Peuser. Organ für die Fortschritte des Eisenbahnwesens, vol. 58, no. 8, Apr. 15, 1921, pp. 78-79, 4 figs. Couplings adopted by Czecho-Slovakian State Railway for cars of the Kaschau-Oderberg railway.

CARS, REFRIGERATOR

Inspection. Transportation Economics of the Refrigerator Car, H. R. Newlean. A.S.R.E. Jl., vol. 7, no. 5, Mar. 1921, pp. 383-389. Inspection practice of Fruit Dispatch Co., vendors for United Fruit Co.

CARBURETORS

Tests. Trials of German Carburetors for Using Non

Volatile Fuels, Benno R. Dierfeld. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 4–5, 2 figs. Winning instruments in competitive tests made partly on road and partly on laboratory testing stand.

CAST IRON

Research. British Iron Research Association Meets, Joseph Horton. Foundry, vol. 49, no. 13, July 1, 1921, pp. 531–532. Progress made in development of British Cast Iron Research Association.

CEMENTS

Acid-Proof. Acid-Proof Cements (Säurefeste Kitte). H. Kleinlogel. Chemiker-Zeitung, vol. 45, no. 54, May 5, 1921, pp. 432–433. Satisfactory results obtained from tests with cements from firm of Rössler, Bensheim, Germany, to be used for lining reinforced-concrete containers for different kinds of acids.

CENTRAL STATIONS

Operation. Organization and Operation of Interconnected Electric Plants (L'esprit des groupements de centrales, leur organisation—Leur exploitation), Fernand Courtoy. Association des Ingénieurs électriciens sortis de l' Institut Electro-technique Montefiore, vol. 3, no. 5, 1921, pp. 99–146, 15 figs. Regulations for establishment of corporations to engage in exploitation of centralized electrical systems. Technical and financial study.

Southern U. S. The Industrial Load in the Southern States. Elec. World, vol. 77, no. 26, June 25, 1921, pp. 1473–1477, 2 figs. Industrial plants of this section of nation have adopted electric service to marked extent during past decade. Seventy-five per cent of electrical energy consumed is purchased from central-station systems.

CENTRIFUGALS

Water-Driven. Some Recent Developments in Water-Driven Centrifugals, F. J. Broadbent, Engineering, vol. 111, no. 2894, June 17, 1921, pp. 744–745, 6 figs. Pelton-wheel-driven machines with cage of 72 in. diameter.

CHEMICAL INDUSTRIES

Prohibition and. Alcohol and the Chemical Industries, J. M. Doran. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 564–565. Plea for regulation of prohibition in such a manner as not to interfere with chemical industries.

CLUTCHES

Design. American and British Practice in Clutch Design, Herbert Chase. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1302–1313, 28 figs. Advantages and disadvantages of various types of clutches are discussed and merits and demerits of many design features pointed out. Notes on theory of design and tabulation of dimensions, pressures, capacity, etc. of many makes.

Practice and Theory in Clutch Design, Herbert Chase. Jl. Soc. of Automotive Engrs., vol. 9, no. 1, July 1921, pp. 39–52, 28 figs. Comparative study of American and British practices in clutch design.

Hydraulic. High-powered Hydraulic-Clutch for Diesel-Driven Tankers. Motorship, vol. 6, no. 7, July 1921, pp. 579, 1 fig. Tests by British Admiralty of Hele-Shaw device for motorships.

COAL

Boghead. Boghead Coals (Die Bogheadkohle). H. Winter. Glückauf, vol. 57, nos. 12 and 13, Mar. 19 and 26, 1921, pp. 257–261 and 285–288. Results of investigation show that the boghead mineral is a coal similar to cannel coal, but with considerably higher content of available hydrogen.

COAL BREAKERS

Hard, Low-Volatile Coal. Sizing and Preparing a Hard Low-Volatile Coal in the Broad Top Region to Compete with Anthracite, Donald J. Baker. Coal Age, vol. 19, no. 26, June 30, 1921, pp. 1151–1154, 8 figs. Breaker built to prepare five different sizes.

COAL DUST

Sampling. Coal-Dust Sampling and Methods Adopted in Practice, R. C. Smart. Iron & Coal Trades Rev., vol. 101, no. 2779, June 3, 1921, pp. 753–754, 3 figs. Regulations of British Navy. Paper read before South Wales Inst. Engrs.

COAL HANDLING

China. Coal-Handling Plant for the Han-Yeh-Ping Iron and Coal Company, China. Iron & Coal Trades Rev., vol. 102, no. 2780, June 10, 1921, pp. 779–780, 6 figs. Electrically operated plant.

German Plant. Mechanical Coal-Handling Installation for a Steam-Boiler Plant Mechanische Kohlenbeschickeinrichtung für eine Dampfkesselanlage, gebaut von W. Fredenhagen in Offenbach (Main), Ernst Blau. Fördertechnik u. Frachtverkehr, vol. 14, no. 10, May 13, 1921, pp. 108–110, 5 figs. Automatic installation constructed by W. Fredenhagen, Offenbach, Germany, consisting of an inclined elevator and two scraper conveyors.

Piers. Mechanical Trimmers Facilitate Coal Loading, P. G. Lang, Jr. Ry. Age., vol. 70, no. 25, June 24, 1921, pp. 1433–1436, 5 figs. Baltimore & Ohio installation at Curtis Bay piers, Md.

COAL POCKETS

Concrete. A Concrete Coal Bin of Unusual Design and Construction. Am. Architect, vol. 119, no. 2369, June 8, 1921, pp. 621–627, 13 figs. Coal bin of 1900-ton capacity designed for storage of pulverized coal.

COAL STORAGE

Fire Fighting. Extinguishing Fires in Coal Stores (Die Bekampfung von Kohlenlagerbränden), H. Immerschitt. Feuerungstechnik, vol. 9, no. 16, May 15, 1921, pp. 145–149. Discusses effectiveness of the three different methods of combating fires, namely, through water, through smothering, and through cooling with salt solutions.

COAL TAR

By-Products. Tetralin and Dekalin. Sci. Am. Monthly, vol. 4, no. 1, July 1921, pp. 65–66, 2 figs. Illuminant and lubricant obtained from coal tar.

COAL TIPPLES

Construction. Among Other Preparation Devices at Diamond Mines Is One for Picking Each Separately, Donald J. Baker. Coal Age, vol. 19, no. 25, June 23, 1921, pp. 1111–1116, 8 figs. Cars brought to feeder by rope are fed to dump which revolves completely over, cars being held by wheel clamps. Reciprocating screens hang from rods and do not rest on rollers.

COBALT STEEL

Analysis. The Determination of Cobalt and Nickel in Cobalt Steels, G. E. F. Lundell and J. I. Hoffman. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 540–543. Method based on electrodeposition of cobalt and nickel in solution freed from iron, chromium, tungsten, molybdenum, vanadium and copper.

COKE

Breeze. Boiler Fuel Mixture Tests, John Blizard and James Neil. Gas Rec., vol. 19, no. 12, June 22, 1921, pp. 25–27 and 34, 3 figs. Experiments conducted at Bur. of Mines to determine steaming value of coke breeze when mixed with Pittsburgh coal and fired by hand.

Metallurgical. Notes on the Value of Metallurgical Coke, G. Deladriere. Colliery Guardian, vol. 121, no. 3154, June 10, 1921, pp. 1668–1669, 4 figs. Graphs comparing relative values of different grades of coal. Translated from Revue universelle des mines.

COKE-OVEN GAS

Benzol Content. Determination of Benzol Content in Coke-Oven Gas (Die Benzolbestimmung im Koksofengas), A. Thau. Glückauf, vol. 57, nos. 22, 23 and 24, May 28, June 4 and 11, 1921, pp. 505–511, 529–536 and 550–562, 19 figs. Discussion and comparison of various domestic and foreign processes. Account of tests for determination by physical means, and description of an indicating or recording device for photometric determination of benzol in gas.

COKE OVENS

By-Product. Adaptability in Coke Oven Practice, C. R. Meissner. Gas Age, vol. 47, no. 12, June 25, 1921, pp. 503–506, 5 figs. Among features of Hazelwood plant are concrete casings for exhausters and boosters and flushing of collecting mains with condensate.

Plants. New Coke Ovens at St. Louis, Hector Prud'homme. Gas Rec., vol. 19, no. 12, June 22, 1921, pp. 19–23, 5 figs. Eight Piette type of ovens installed at plant of Laclede Gas Light Co. for test purposes. Thirty-day test run shows splendid results.

COLD SAWS

Use in Steel Works. The Use of High-Speed Cold Saws with Toothless Blade in Steel Works and Foundries (Verwendung schnellaufender Kaltsägen mit zahnolsem Sägeblatt in Hüttenwerken und Stahlgiessereien), A. Lobeck. Werstattstechnik, vol. 15, no. 12, June 15, 1921, pp. 351–353, 12 figs. Describes new cutting method for use with steel castings of a given shape and hardness.

COMBUSTION

Air Regulation. Industrial Comburimetry (La comburimétrielle industrielle), M. André Grebel. Chateur et Industrie, vol. 2, no. 13, May 1921, pp. 272–276, 3 figs. Apparatus for regulating amount of air necessary for combustion. (Concluded.)

Flue-Gas Analysis. Determination of Excess Air from Flue-Gas Analysis, R. Brown. Combustion, vol. 4, no. 6, June 1921, pp. 24–25, 1 fig. Construction of excess air chart.

Surface. Introduction of Surface Combustion in the German Industry (Zur Einführung der "flammenlosen Oberflächenverbrennung" in die deutsche Industrie), Rudolf Schnabel. Chemiker-Zeitung, vol. 45, no. 57, May 12, 1921, p. 457. Refers to organization of German Society for Surface Combustion possessing the rights of American, English and German patents.

COMPRESSED AIR

Waste. Saving Fuel by Decreasing Air Waste, N. A. Craigue. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 418–421, 3 figs. Methods of reducing waste and diminishing leaks in compressed air systems.

CONCRETE

Alkali Action. Progress in Investigation of Alkali Action on Concrete, E. C. Bebb. Concrete Products, vol. 20, no. 6, June 1921, pp. 27–29. Investigations conducted by Bur. of Standards, Reclamation Service, Drainage Investigations Office of Dept. of Agriculture and Portland Cement Assn.

Oven Drying. Effects on Concrete of Immersion in Boiling Water and Oven Drying, W. J. Schlick. Iowa State College of Agriculture & Mechanic Arts Official Publication, vol. 19, no. 44, Mar. 30, 1921, 24 pp., 13 figs. Experiments. Boiling without previous drying caused reduction in weight, while boiling following oven drying caused increase in weight, there having been marked loss in strength in each case.

Tests. Formula for Determining the Strength of Cement Concrete (Om en Fremgangsmaade til Bedömmelse af Mörtelmaterialers Egenskaber). Ingeniören, vol. 30, no. 18, Mar. 2, 1921, p. 133. Method used by Peter Lind & Co., Westminster, to test probable strength of concrete used for concrete ships during war.

Waterproofing. Some Methods of Securing Impermeability in Concrete, Ewart S. Andrews. Concrete & Constructional Eng., vol. 16, no. 6, June 1921, pp. 369–374. Classification of methods for securing impermeability. Paper read before Concrete Inst.

Waterproofing Concrete—I, J. H. Burgess. Commonwealth Engr., vol. 8, no. 8, Mar. 1, 1921, pp. 248–250. Permeability tests.

CONCRETE CONSTRUCTION

Gravity Plants. Graphic Wattmeter Checks Gravity Plant Operation. Eng. News-Rec., vol. 86, no. 25, June 23, 1921, pp. 1067–1068, 3 figs. Details of distant operations indicated on chart at construction engineers' desk.

CONCRETE CONSTRUCTION, REINFORCED

Developments. Modern Reinforced Concrete Industrial Structures (Moderne strutture industriali in cemento armato), Luigi Santarella. Industria, vol. 35, no. 8, April 30, 1921, pp. 175–179 and 180–181, 16 figs. Typical factory constructions.

CONDENSERS, STEAM

Cleaning. Removing Scale from Surface Condenser Tubes with Hydrochloric Acid, Norman G. Hardy. Power, vol. 51, no. 1, July 5, 1921, pp. 22–24, 1 fig. Apparatus and process described.

Acid Cleaning of Condensers, Norman G. Hardy. Elec. World, vol. 78, no. 2, July 9, 1921, pp. 64, 1 fig.

Developments. Recent Improvements in the Design of Condensers for Steam Engines (Recents perfectionnements des appareils de condensation des machines à vapeur d'eau), L. Jauch. Chaleur et Industrie, vol. 2, no. 13, May 1921, pp. 239–246, 3 figs. Technical study and historical survey. (To be continued.)

Water Screens. Largest Traveling Screens Installed at Cincinnati. Power, vol. 54, no. 2, July 12, 1921, pp. 62–64, 3 figs. Screening capacity is 200,000 gal. per min.

CONNECTING RODS

Machining Methods. Another Method of Machining Connecting Rods, Fred H. Colvin. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1068–1069, 5 figs. Methods and fixtures. Facing both ends of boss at once. Drilling machine with special attachment. Boring two rods in one operation.

Machining Connecting Rods. Eng. Production, vol. 2, no. 38, June 23, 1921, pp. 744–746, 11 figs. Methods employed at leading automobile factories.

CONVEYORS

Workshop. Mechanical Conveyors for Workshops, Hubert Hermanns. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 316–319, 10 figs. Types used in German workshops.

COPPER

Gases, Action on. The Action of Reducing Gases on Heated Copper, H. Moore and S. Beckinsale. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 729–732, 8 figs. Results obtained in experiments showed that injurious effect of reducing gases on heated copper is result of their interaction with cuprous oxide always present in commercial copper. Markedly injurious effect is produced even when oxygen content of copper does not exceed 0.026 per cent. Paper read before Inst. of Metals.

COPPER ALLOYS

Copper-Tin. The Constitution of the Alloys of Copper with Tin—III and IV, John L. Haughton. Engineering, vol. 111, no. 2895, June 24, 1921, pp. 789–793, 23 figs. Transformations occurring below eutectic temperature. Photomicrographs.

Cupro-Vanadium. Non-Ferrous Applications of Vanadium, Kirby Thomas. Raw Material, vol. 4, no. 5, May 1921, pp. 167–168. Cupro-vanadium being used in brasses and bronzes.

CORROSION

Concrete Reinforcement. Reinforcing Steel in Cements Containing Blast-Furnace Slag (Eiseneiolagen in hochofenschlackenhaltigen Zementen), Richard Grün. Stahl u. Eisen, vol. 41, no. 17, Apr. 28, 1921, pp. 577–579. Laboratory tests show that an injurious rusting of iron in alkaline cement masses is impossible providing construction is sufficiently airtight. Practical experience shows that in properly prepared reinforced concrete of blast-furnace cement or of portland cement, the core iron remains permanently unchanged.

Protective Treatments. Notes on Oxydizing Cementation, Galvanization, Sherardizing and Metalizing Spraying (La cémentation oxydante. La galvanisation. La shérardisation. La métallisation par pulvérisation), J. Arnoul de Grey. Chaleur et Industrie, vol. 2, no. 13, May 1921, pp. 255–262. Exposition and comparative study of methods of protecting metallic objects against corrosion. (To be continued.)

Steam Pipes. A Case of Rust Formation (Ein Fall von Rostbildung), E. Sauer. Chemiker-Zeitung vol. 45, no. 53, May 3, 1921, p. 421. Describes case of corrosion of a steam pipe caused by carbonic-acid content of the steam, demonstrating importance of removal of gases, especially of carbon dioxide from feedwater.

COST ACCOUNTING

Overhead Costs. Budgeting Factory Overhead,

pp. 31–34, 4 figs. Experience in operation of budget plans of Fairbanks, Morse & Co. and of A. O. Smith Corp.

Uniform System. Advises Use of Uniform Cost System, Robert E. Belt. Foundry, vol. 49, no. 13, July 1, 1921, pp. 524–526. Economical advantages of introducing uniform cost system in manufacturing plants. Paper read before National Industrial Cost Conference.

COUPLINGS

Whitney Free Floating. Whitney Free Floating Coupling. Power, vol. 54, no. 1, July 5, 1921, pp. 24, 2 figs. Designed to allow for misalignments, either parallel or angular. Coupling consists of two hubs and special design of driving link.

CRANES

Tower. Tower Crane for Handling Timber. Engr., vol. 131, no. 3415, June 10, 1921, pp. 624–625, 1 fig. Designed to deal with loads of 5 tons at radius of 50 ft. and of 3 tons at radius of 100 ft.; with clear height of lift of 52 ft.

CRANKCASES

Machining Operations. Details of Crankcase Work. Am. Mach., vol. 54, no. 25, June 23, 1921, pp. 1088–1090, 9 figs. Different types of reaming fixtures. "Hand" reaming by pneumatic motor. Running in crankshaft bearings by power. Roller conveyors as labor savers.

CUPOLAS

Clays for Daubing. Cupola Daubing Clay Affects Iron, Carl Buberl. Foundry, vol. 49, no. 13, July 1, 1921, pp. 533–534. Poor and good clays for daubing cupola are defined and results of tests showing detrimental effects of poor grade of refractory given. Aluminum additions improve quality.

Oil Firing. Oil Lowers Cost of Fuel in Cupola, Karl K. Berthold. Foundry, vol. 49, no. 13, July 1, 1921, pp. 530–531. Experience at Austrian Foundry. Oil was introduced as adjunct to coke in cupola and cost of fuel was decreased in consequence as well as metal with lower sulphur content was obtained. Translated from Stahl u. Eisen.

Operation. Fitting the Cupola to Its Work, Y. A. Dyer. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1675 and 1727–1729. Cupola operation. Physical and chemical factors as related to efficiency. Position of fusion zone.

CUTTING TOOLS

Design. Metal Cutting Tools—XII, A. L. DeLeeuw. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 4–9, 13 figs. Form tools; plate tools, bar tools and circular form tools. Advantages and disadvantages of each. Shaving tools and their action.

D

DIE CASTING

Developments. Latest Developments in the Die-Casting Industry. Raw Material, vol. 4, no. 5, May 1921, pp. 156–163, 13 figs.

DIESEL ENGINES

North British. The North British Diesel-Engine, Motorship, vol. 6, no. 7, July 1921, pp. 568–569. 4 figs. Four-cycle, single-acting, crosshead type developing 2300 hp.

Solid-Injection. Injection and Combustion of Fuel-Oil—IV, C. J. Hawkes. Motorship, vol. 6, no. 7, July 1921, pp. 573–574, 1 fig. Experiments with solid injection and air blast in marine Diesel-engines. (Continuation of serial.)

Standardized. Standardized Diesel Engines—V, H. R. Setz. Mar. Eng., vol. 26, no. 7, July 1921, pp. 548–552, 7 figs. Discussion of double-acting two-cycle engine and its possibilities.

DRAWINGS

Filing. Systems for Indexing and Filing Drawings. Eng. & Contracting, vol. 55, no. 25, June 22, 1921, pp. 609–611, 4 figs. Systems used by five prominent engineering and manufacturing enterprises. Paper read before Cleveland Eng. Soc.

DRILLING MACHINES

High-Power. High-Power Drilling Machines with Central Drive (Hochleistungs-Bohrmaschine mit Zentralantrieb), P. Castenholz. Der praktische Maschinen-Konstrukteur, vol. 54, no. 12, Mar. 24, 1921, pp. 49–51, 5 figs. Machine constructed by Gebhard Bischof Machine Works, Reutlingen, Germany, for single-pulley drive through vertical shaft in column.

Manufacture. Building Drilling Machines. Eng. Production, vol. 2, no. 36, June 9, 1921, pp. 694–703, 24 figs. Methods at works of Associated British Machine Tool Makers, Halifax.

Multiple-Spindle. Drilling Two Different Parts on One Machine, J. H. Moore. Can. Machy., vol. 25, no. 25, June 23, 1921, pp. 25–27, 9 figs. Uses and advantages of multiple-spindle drilling machines. Typical examples of work.

Heavy Multiple-Head Drilling Machines. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 714 and 716, 2 figs. Designed by Beyer, Peacock & Co., Manchester, England, to meet requirements of locomotive and marine engine shops.

DROP FORGING

Ingots for. Billets for the Drop Forger, Harry Brearley. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 307–313, 13 figs. Cracks, blowholes, pipe and segregates in ingots, and laps, roaks, burning discussed.

Plants. Drop-Forge Plant Lay-Out and Equipment. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1039–1044, 9 figs. Drop-forging plant arranged for handling large quantities of work.

DUST

Measurement of Dustiness. The Shinizu-Wilson Cloud-Condensation Apparatus. Elecn., vol. 86, no. 2247, June 10, 1921, pp. 720, 2 figs. Apparatus for measuring dustiness of atmosphere. Modifications of Wilson cloud-condensation apparatus.

E

EDUCATION, ENGINEERING

Problem of. How Should the Engineer Be Educated? F. L. Bishop, Knox Taylor, Comfort A. Adams, W. C. Spruance, Moorhead C. Kennedy, R. E. Anderson and Donald A. Hampson. Am. Mach., vol. 54, no. 26, June 30, 1921, pp. 1105–1109. Résumé of remarks expressed at joint meeting of Am. Soc. of Mech. Engrs. and Am. Inst. of Elec. Engrs.

United States. Engineering College Registration Shows 4-Per cent Gain. Eng. News-Rec., vol. 86, no. 26, June 30, 1921, pp. 1104–1106, 3 figs. Census by Eng. News-Rec. covered 48,312 students in 81 institutions located in 36 states. Mechanical engineering was most popular course.

ELASTICITY

Moduli. Elasticity. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 701–702, 13 figs. Derivation of formula expressing relation between moduli of elasticity.

ELECTRIC DRIVE

Cement Industry. Electrified Cement Industry Aids Western Construction, Lloyd W. Chapman. Jl. Electricity & Western Industry, vol. 47, no. 1, July 1, 1921, pp. 7–10, 5 figs. Methods of manufacturing portland cement at Santa Cruz Portland Cement Co.

Logging Industry. Electric Applications in the Logging Industry of the Northwest, E. P. Whitney. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 631–638, 8 figs.

Pumps. Electric-Motor Drives for Pumps, Gordon Fox. Power, vol. 54, no. 1, July 5, 1921, pp. 2–5, 5 figs. Advantages of reciprocating and centrifugal pumps. How to figure capacities and power required. Operating characteristics. Types of motor to use for different kinds of service.

Textile Industry. Selection of Polyphase Motors, Benjamin F. Bailey. Elec. World, vol. 78, no. 1, July 2, 1921, pp. 16–19, 7 figs. Electric drive in textile industry. Comparison of electrical and physical characteristics that affect service requirements. Choice of speed, frequency weight and rating are considered. Squirrel-cage compared with wound-rotor motor.

ELECTRIC FURNACES

Arc. A New Indirect Arc Furnace. Metal Industry (Lond.), vol. 18, no. 23, June 10, 1921, pp. 442–443, 2 figs. Three-phase gyrating furnace manufactured by Volta Mfg. Co., Welland, Ont.

Inductive. Recent Progress in High-Frequency Inductive Heating, E. F. Northrup. Chem. & Metallurgical Eng., vol 24, no. 25, June 22, 1921, pp. 1097–1100, 5 figs. Notes on design, operation, melting rate and power input of electric furnaces using high-frequency inductive heating. Electric furnaces are being used for melting precious metals at U. S. Mint and by leading silver broker. Paper read before Am. Electrochemical Soc.

Laboratory. Electric Muffle Furnaces for Laboratory Use, H. C. Kremers. Jl. Indus. & Eng. Chemistry, vol. 13, no. 6, June 1921, pp. 561, 2 figs. Muffle made up of nickel-chromium alloy wire wound around glass cylinder covered with asbestos.

Tagliaferri. Tagliaferri Electric Furnace (Le four electrique "Tagliaferri"), Mario-Marantonio. Journal du Four Electrique, vol. 30, no. 7, May 1 & 15, 1921, pp. 53–58, 9 figs. Operation and heat distribution are regulated by auxiliary electrodes. Patented by Société anonyme de Fours électriques.

ELECTRIC PLANTS

Interconnection. Power Administration Effects Economy, Fred B. Lewis. Elec. World, vol. 78, no. 2, July 9, 1921, pp. 57–58, 4 figs. Methods which have been adopted in California to operate steam and hydroelectric plants for maximum efficiency and economy of resources.

ELECTRIC WELDING, ARC

Castings. Application of Arc Welding in Machinery Construction, A. M. Candy. Elec. Rev. (Chicago), vol. 79, no. 1, July 2, 1921, pp. 1–5, 7 figs. Heavy castings damaged in shop or in operation repaired with speed by welding process. Forging weld increased its strength and quality. Paper before Soc. of Refrigerating Engrs.

Railway Shops. Electric Arc Welding in Railroad Shops, A. M. Candy. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 456–458, 7 figs. Explanation of the characteristics of arc-deposited metal and some samples of welding.

ELECTRICAL INDUSTRY

Developments. Personal Observations in the Industry, Arthur W. Berresford. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 7, July 1921, pp. 555–560. Suggestions in regard to furthering industrial progress.

Industrial. The Use of Electricity in Special Industries in the West. Jl. Electricity & Western Industry, vol. 46, no. 12, June 15, 1921, pp. 612–624, 34 figs. Eighty-six per cent of energy sold by western power companies goes to industrial consumers. Survey of conditions.

ELEVATORS

Freight, Safeguarding. Freight Elevators. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 667–669, 3 figs. Safeguarding shaftways, cables, counterweights and operation. Prepared by eng. staff of Nat. Safety Council.

Governors. Electric Elevator Machinery, Overspeed Governors, M. A. Myers. Power, vol. 54, no. 2, July 12, 1921, pp. 50–51, 13 figs. Types of safety governors.

EMPLOYMENT MANAGEMENT

Testing Employees. Industrial Psychotechnology (Industrielle Pyschotechnik), A. Wallichs. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 25, June 18, 1921, pp. 648–651. Development of adaptability tests; related methods and their utilization. Discussion of results already obtained and prospects of future development.

ENAMELING

Steel. The Vitreous Enamelling of Steel and Iron, Charles M. Bowes. Metal Industry (Lond.), vol. 18, no. 23, June 10, 1921, pp. 441–442. Outline of processes.

ENGINEERS

Licensing. Ethical and Practical Considerations Regarding the Engineering Corporation. Eng. News-Rec., vol. 86, no. 26, June 30, 1921, pp. 1109–1111. Holds that ethical questions are not essentially different from those confronting individual consultants.

EXHAUST STEAM

Utilization. Generating Power with Exhaust from Mill Engines. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 641–646, 10 figs. Mixed-pressure turbines and regenerators installed at plant of National Enameling & Stamping Co.

EXPLOSIVES

Liquid Oxygen. The Potentialities of Liquid Oxygen Explosives, Robert G. Skerrett. Compressed Air Mag., vol. 26, no. 6, June 1921, pp. 10103–10107, 7 figs. Use of liquid oxygen in German mines.

F

FACTORIES

Reinforced Concrete. A Modern Multi-Storied Shop for Building Machine Tools, Fred H. Colvin. Am. Mach., vol. 54, no. 26, June 30, 1921, pp. 1114–1118, 11 figs. Five-story building of reinforced concrete. Notes on lighting, heating and ventilating systems, also on method of handling chips.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FIRE PREVENTION

Exposed Woodwork. Ignitions of Combustible Materials, Especially Exposed Woodwork, by Heat-Producing Apparatus, C. E. Worthington. Safety Eng., vol. 41, no. 6, June 1921, pp. 256–263, 2 figs. Protecting devices, notably for metal smokestacks and insulation for smoke pipe.

FIRECLAYS

Thermal Expansion. The Reversible Thermal Expansion of Fireclay and Other Refractory Materials, H. S. Houldsworth and John W. Cobb. Jl. Soc. Glass Technology, vol. 5, no. 17, May 1921, pp. 16–38 and (discussion) pp. 38–44, 12 figs. Reversible thermal expansion up to 100 deg. cent. were determined for fireclay, fireclay mixtures, ganister, alumina magnesia and carborundum.

FLUE-GAS ANALYSIS

Determination of Sulphur Dioxide and Trioxide. The Determination of Sulphur Dioxide and Sulphur Trioxide in Flue Gas and Fuming Sulphuric Acid (Ueber die Bestimmung von Schwefeldioxyd neben Schwefeltroxyd in Röstgasen und Oleum), A. Sander. Chemiker-Zeitung, vol. 45, no. 33, Mar. 17, 1921, pp. 261–263, 1 fig. Method developed by author for determination of sulphur dioxide alongside of sulphur trioxide with use of only one apparatus and a single titration liquid, based on influence of mercuric chloride on sodium bisulphide.

FOREMEN

Training. Practical Methods of Training Foremen, S. Gordon Taylor. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 23–26. Experience in organization of welfare work in shipyard.

FORGING PLANTS

Layout. Building a Forge Shop for Custom Work, E. L. Shaner. Iron Trade Rev., vol. 68, no. 26, June 30, 1921, pp. 1786–1790, 7 figs. Layout of forge plant producing miscellaneous steel drop forges and forges for railroad car equipment, oil-and-gas well supply manufacturers, etc.

FORGINGS

Metal Involved. Chart for Determining Metal Involved in Forgings, H. Kilborn. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 314–315, 1 fig.

FRAMES

Reinforced-Concrete. Axial versus Center Moment in the Calculation of Reinforced-Concrete

Frames (Ein Beitrag zur der Frage: Achsen-oder Mittelmoment bei der Berechnung von Eisenbetonrahmen), Horst Wolf. Bauingenieur, vol. 2, no. 11, June 15, 1921, pp. 304–306, 2 figs. Points out that in calculation of a frame the most accurate results can in all cases be obtained when center line is assumed to be axis of frame.

FREIGHT HANDLING

German vs. American Practice. Railway Freight Traffic (Leistungen im Eisenbahn-Güterverkehr), H. Wernekke. Fördertechnik u. Frachtverkehr, vol. 14, no. 10, May 13, 1921, pp. 107–108. Figures showing efficiency of German and American railways in freight-train traffic, from which it is concluded that while American railways show heavier traffic, German railways show a much more thorough and efficient utilization of rolling stock.

FUELS

Heat Value. Calculation of Heat Value from the Constitution of Compound (Studien über die Berechnung des Heizwertes aus der Konstitution der Verbindung), F. Otto H. Binder. Chemiker-Zeitung, vol. 45, no. 18, Feb. 10, 1921, p. 141. Discussion based on the Dulong formula for calculation of theoretical heat value of a fuel from its elementary composition.

[See also OIL FUEL; PULVERIZED COAL.]

FURNACES

Recuperator. An Automatic Recuperator Furnace. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 303, 2 figs. Gas furnace designed for utilizing waste flue gases as aid to combustion.

FURNACES, ANNEALING

Oil-Fuel-Burning. Anneals Malleable with Fuel Oil, William F. Hoernke. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1728–1730, 4 figs. Conversion of coal burning annealing ovens into oil burning ovens. Operation shows that although oil is more expensive fuel, it requires less labor in handling and firing.

FURNACES, BOILER

Insulation. Boiler Furnace Insulation, Frank W. Sterling. Jl. Am. Soc. of Naval Engrs., vol. 33, no. 2, May 1921, pp. 268–284, 10 figs. Methods of testing furnace insulation.

Lignite-Burning. New Lignite Furnaces (Neue Feuerungen für Rohbraunkohle). Der prakitsche Maschinen-Konstrukteur, vol. 54, no. 12, Mar. 24, 1921, pp. 89–90. Adjustable semi-producer-type step grate constructed by Jacques Piedboeuf, Ltd., Düsseldorf, which is said to insure proper distribution and regulation of air required for combustion and for obtaining maximum gas temperatures in furnaces, easy manipulation and cleaning facilities, especially with regard to removal of ashes and slag.

The Adaptation of Furnace Installations to Use of Lignite (Wie stelle ich am besten meine Feuerungsanlage auf Rohbraunkohlen um?), O. Binder and R. Scharf. Chemiker-Zeitung, vol. 45, no. 30, Mar. 10, 1921, pp. 237–239. Recommends installation of economically operated stepped-grate furnace.

Turbine. Cochran Boiler Fitted with the Turbine Furnace. Iron & Coal Trades Rev., vol. 103, no. 2780, June 10, 1921, p. 788, 2 figs. Tests on turbine patented furnace built by Turbine Furnace Co., London.

FURNACES, HEATING

Automatic Firing. Air Furnace Is Fired Automatically. Foundry, vol. 49, no. 13, July 1, 1921, pp. 515–517, 4 figs. Coal dumped into hopper which feeds specially designed grate as coal burns. Only manual labor necessary is that required for pulling ashes.

Continuous. Heating Furnaces and Annealing Furnaces, W. Trinks. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 320–324, 6 figs. Comparison of different types of continuous furnaces. Test results.

FURNACES, HEAT-TREATING

Gas. The Value of Gas for Heat Treating, F. F. Cauley. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 328–331, 8 figs. Typical modern installations.

FURNACES, HOT-AIR

Research. Investigation of Warm-Air Furnaces and Heating Systems, A. C. Willard, A. P. Kratz, and V. S. Day. University of Ill. Bul., vol. 18, no. 29, Mar. 21, 1921, 145 pp., 49 figs. Determination of efficiency and capacity of commercial warm-air furnaces under conditions similar to those existing in actual installations with leaders, stacks, and registers, to form complete system; study rating furnaces and investigations of value of insulating materials as affecting economy of furnace.

G

GAGES

Industrial. Study of Industrial Gages at International Bureau of Waste and Measures (L'étude des calibres industriels au bureau international des poids et mesures), Albert Pérard. Genie Civil, vol. 78, no. 23, June 4, 1921, pp. 477–480, 11 figs. Types of gages employed. (To be continued.)

Inspection. The Delco Inspection System, Erik Oberg. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1032–1034 8 figs. Description of methods used in tool and gage designing dept. of Dayton Eng. Laboratories Co., and standards of gaging adopted.

Lever. The Accuracy of Multiple Lever Gages (Die Genauigkeit mehrfacher Fühlhebel), G. Berndt. Werkstattstechnik, vol. 15, no. 12, June 15, 1921, pp. 347–350, 2 figs. Comparison of accuracy of single and multiple levers. States that, when possible, instead of using several levers with smaller gear ratios, it is better to use a double or single lever with gear ten times as great.

GAS MANUFACTURE

Producer Process, Loss in. Thermal Losses in the Gas Producer Process, N. E. Rambush. Jl. Soc. Chem. Industry, vol. 40, no. 12, June 30, 1921, pp. 129T–137T, 5 figs. Principles by means of which it is possible to determine thermal efficiency of gasification of a given fuel without large-scale tests.

GAS MASKS

Charcoal. The Occlusion of Water by Gas-Mask Charcoal, Ben E. Brown. Physical Rev., vol. 17, no. 6, June 1921, pp. 700–706, 2 figs. Variation of amount of water with temperature was determined between 102 and 140 deg. cent. at pressure of 74 cm. of mercury. About ⅓ of water came off between 112 and 114 deg. cent.

GAS TURBINES

Combustion Chambers. Gas-Turbine Combustion Chambers, Glenn B. Warren. Power, vol. 53, no. 26, June 28, 1921, pp. 1059–1060, 2 figs. Experiments at University of Wisconsin on four types of combustion chambers.

GEAR CUTTING

Bevel-Gear Planer. Gleason 37-In. Two-Tool Bevel-Gear Planer. Am. Mach., vol 54, no. 26, June 30, 1921, pp. 1123–1125, 5 figs. Automatic machines intended for general work. Tools cut on opposite sides of tooth.

Continuous Machines. Generating Gear Teeth for Industrial Uses, J. H. Moore. Can. Machy., vol. 25, no. 23, June 9, 1921, pp. 25–27, 8 figs. Continuous type of gear-cutting machines.

Helical Gears. Cutting Large Double Helical Gears, C. S. Pettit. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 308–309, 4 figs. Machines developing continuous teeth by means of rack cutter using reciprocating motion.

GEARS

Bevel. The Spiral Bevel Gear. Machy. (Lond.), vol. 18, no. 456, June 23, 1921, pp. 352–354, 3 figs. Matterson type of spiral bevel gear. Criticism of article in Machy. (Lond.), May 12, p. 174.

Design. Calculation of Special Gears, Speeds of Which Are in Geometrical Progression (Berechnung besonderer Getriebe, deren Umläufe nach einer geometrischen Reihe abjestuft sind), H. Vorwerck. Der praktische Maschinen-Konstrukteur, vol. 54, no. 10, Mar. 10, 1921, pp. 42–44, 5 figs. Method of calculation.

Frictional. Frictional Gearing (Friktionsvorgelege). Der praktische Maschinen-Konstrukteur, vol. 54, no. 22, June 2, 1921, pp. 95–96, 6 figs. Variable-speed gear constructed by Ferdinand Wiss, Valendar, Germany, for transmission of small amounts of power.

Inspection. A New System of Gear Grinding and Gear Inspection, P. M. Heldt. Automotive Industries, vol. 44, no. 26, June 30, 1921, pp. 1430–1431, 4 figs. Great accuracy of tooth and more rolling with less sliding action are claimed. Grinding machine works on generating principle and means for compensating for wear of grinding wheel are provided.

Involute. The Evolution of the Involute Gear Tooth—VI, A. Fisher. Machy. (Lond.), vol. 18. no. 456, June 23, 1921, pp. 363–366, 7 figs. Influence of pressure angle on strength of teeth.

Maag. The Maag Gears and Their Use in Street-Railway Operation (Maagzahnräder und ihre Verwendung in Strassenbahnbetriebe), Rudolf Wahn. Elektrotechnik u. Maschinenbau, vol. 39, no. 22, May 29, 1921, pp. 267–269, 6 figs. Describes Maag method of making gears and advantages of this type which is now in use on 65 street-railway lines in Switzerland. Paper read before Int. Street and Narrow-Gage Ry. Congress, Vienna.

Non-Metallic. Design and Manufacture of Non-Metallic Gears, Fred R. Daniels. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1005–1011. Characteristics of gears made from rawhide and fabric-base materials. Methods employed by Van Dorn & Dutton Co., Cleveland, O., in manufacture of nonmetallic gears.

Skew. Skew Gear Design, F. E. Lindsay. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 652, 5 figs. Graphical method.

Spur. Spur Gear Erosion, F. W. Lanchester, Engineering, vol. 111, no. 2894, June 17, 1921, pp. 733–734, 7 figs. Limitations to conditions under which it is desirable to use rolling rather than sliding contact. Difficulties which are liable to be associated with rolling conditions.

Testing Teeth. The Odontometer for Testing Gear Teeth, Earle Buckingham. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1029–1031, 6 figs. Apparatus consists of section of straight-sided rack with two parallel effective faces, one being fixed and other movable. Third face, set at angle to two working faces, is used to hold fixed working face in contact with flank of gear tooth.

GRINDING MACHINES

Continuous. The Churchill Continuous Rod Grinding Machine. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 335–336, 3 figs. Machine manufacture by Churchill Machine Tool Co., Manchester, England.

H

HANDLING MATERIALS

Liquids. Handling and Measurement of Liquids in Factories (Bewegung und Messung von Flüssigkeiten innerhalb der Fabrik), H. Rahe. Chemiker-Zeitung, vol. 45, nos. 21 and 21, Feb. 17 and 24, 1921, pp. 165–169 and 191–193, 16 figs. Devices for handling, that is, conduction and measurement of liquids, such as acids, alkalies, salt solutions, hydrocarbons, and a large number of organic and inorganic liquids, such as chlorine and other liquefied gases, alcohol and ether.

Small Plants. Purchasing and Handling Material in the Small Plant—II and III, Guy V. Sweet. Indus. Management, vol. 61, no. 11, and vol. 62, no. 1, June 1 and July 1, 1921, pp. 399–402. 6 figs., and 18–21, 7 figs. June 1: Forms for keeping records and making requisitions. July 1, Forms of material record cards.

HEAT TRANSMISSION

Building Walls. The Calculation of Heat Transmission Coefficients (Ueber die Berechnung von Wärmedurchgangszahlen), Réti Mór. Gesundheits-Ingenieur, vol. 44, no. 22, May 28, 1921, pp. 262–263, 2 figs. Points to difficulties and lack of satisfactory calculating method. In supplementary article by Karl Hencky (pp. 263–264, 1 fig.) writer explains system of coefficients developed by him.

HEATING

Industrial, Local. Industrial Applications of Local Heating with the Pyrotip, E. A. Wagner. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 628–631, 10 figs. Heat is generated at tip of carbon rod and is transmitted by conduction to material; it is produced by resistance of carbon tip to passage of electric current.

HEATING AND VENTILATION

Humidifying Apparatus. Humidifying Apparatus for Textile Factories. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 648, 3 figs. Cleworth-Wheal air-humidifying apparatus.

HEATING, ELECTRIC

Ovens and Hot Plates. Some Thermal Characteristics of Electric Ovens and Hot-Plates, Ezer Griffiths, and F. H. Schofield. Jl. Instn. Elec. Engrs., vol. 59, no. 300, April 1921, pp. 361–372, 14 figs. Specifications for conducting tests on cooking ovens.

HELICOPTERS

Design. Helicopters and Aeroplane-Helicopters (Hélicoptères et avionshélicoptères), M. Lamé. Aéronautique, vol. 3, nos. 19–20, Jan. 1921, pp. 277–281, 5 figs. Aerodynamic study of helicopter, especially of support without speed, stability and propulsion.

Oemichen. The Oemichen Helicopter (L'hélicoptère Oemichen). Aéronautique, vol. 3, no. 24, May 1921, pp. 213–214, 2 figs. Ascensional force is derived from small balloon and two horizontal propellers rotating in opposite directions.

HOISTS

Electric. Susquehanna Installs Electric Slope Hoist and at a Shaft Replaces Steam by Electric Drive. Lewis W. LeGrand. Coal Age, vol. 19, no. 21, May 26, 1921, pp. 941–944, 6 figs. To serve two radically different degrees of slope a "two-speed" hoist was installed. At shaft steam hoist was altered to electric drive by adding motor, gears and coupling.

HOUSES, CONCRETE

Construction Methods. New and Successful Method of Constructing Concrete Houses, D. V. Weed, Jr. Concrete Products, vol. 20, no. 6, June 1921, pp. 13–15, 4 figs. Lamouldette system employing interchangeable light steel forms or units, specially rolled and shaped for maximum strength which may be set up to either vertical or horizontal position and quickly clipped together by ingenious device to form rigid mold into which concrete is poured and structure cast as monolith.

Design. A Concrete House Scheme. Concrete & Constructional Eng., vol. 16, no. 6, June 1921, pp. 353–359, 7 figs. Typical English design.

HOUSING

Industrial. The Calder Report on the Building Situation. U. S. Dept. of Labor, Monthly Labor Rev., vol. 12, no. 6, June 1921, pp. 96–100. Report to U. S. Senate of Select Committee on Reconstruction and Production. Among recommendations is creation of "a bill to establish in Dept. of Commerce a division for the gathering and dissemination if information as to the best construction practices and methods, technical and cost data, and matters relating to city planning, etc., in order to encourage standardization and improved building practices throughout the country."

HYDRAULIC MACHINERY

Manufacture. Building Hydraulic Machinery. Eng. Production, vol. 2, no. 38, June 23, 1921, pp. 749–754, 15 figs. Procedure at representative works.

HYDRAULIC TURBINES

Francis Type. Kern River Three Development has Highest Head Francis Turbines Installed. Power, vol. 53, no. 25, June 21, 1921, pp. 996–999, 5 figs. Two vertical-shaft 22,500-hp. Francis-type turbines operating under effective head of 800 ft. Two runners are provided for each unit, one for 50-cycle and one for 60-cycle operation. Water is carried through series of tunnels aggregating 60,000 ft. in length, longest single bore being 7,132 ft.

HYDROELECTRIC PLANTS

France. Hydroelectric Installation on the Arly

River (Installation hydro-électrique de l'Arly), Francis Babey. Électricien, vol. 37, no. 1274, April 15, 1921, pp. 169–174, 8 figs. Development of 800 hp. for metallurgical works.

New England. Rebuilding an Old New England Water-Power Plant, E. H. Swett. Eng. News-Rec., vol. 86, no. 25, June 23, 1921, pp. 1062–1066, 6 figs. Special construction problems in new hydroelectric station for Jackson mills long supplied with power from individual wheels taking water from Nashua River.

Niagara Falls. Hydroelectric Development at Niagara Falls, John L. Harper and J. A. Johnson Jl. Am. Inst. Elec. Engrs., vol. 40, no. 7, July 1921, pp. 561–576, 33 figs. Also abstracts in Power, vol. 54, no. 1, July 5, 1921, pp. 26–28, 6 figs. Historical survey. Possibility of more efficient utilization of water power available for development according to international treaty, which permits utilization of 20,000 cu. ft. per sec. on American side and 36,000 cu. ft. per sec. on Canadian side.

Northwestern U. S. Electrical Construction Work in Northwestern States, W. A. Scott. Elec. Rev., (Chicago), vol. 79, no. 1, July 2, 1921, pp. 11–12, Expansion and reconstruction of hydroelectric plants.

I

ICE PLANTS

Brine Tanks. Concrete Brine Tanks, H. C. Boyden. A.S.R.E. Jl., vol. 7, no. 5, Mar. 1921, pp. 390–400. Advantages of concrete brine tanks. Principles that should be observed in their design.

South Chicago. Consumers New Ice Plant at South Chicago, Gilbert Sellers. Power, vol. 53, no. 26, June 28, 1921, pp. 1038–1040, 3 figs. Synchronous-motor-driven ammonia compressors require 25.8 kw-hr. per ton of ice.

INDICATORS

Internal-Combustion Engines. A Pressure Indicator for Internal Combustion Engines, J. Okill. Power, vol. 54, no. 1, July 5, 1921, pp. 10–11, 2 figs. Modified form of steam-engine indicator.

INDUSTRIAL MANAGEMENT

Germany. The Taylor System and Scientific Management in Germany (Das Taylor-System und die deutsche Betriebswissenschaft), G. Schlesinger. Werkstattstechnik, vol. 15, no. 11, June 1, 1921, pp. 313–317. Discusses form in which Taylor system and the Gilbreth motion studies can best be adapted to German conditions.

Graphic Methods. The Ratio Chart and Its Applications—I, Percy A. Bivins. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 10–14, 11 figs. Exposition of construction and uses of ratio charts.

Personnel. Personnel Management of the Metropolitan Life Insurance Co., Lawrence Washington. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 27–32, 8 figs.

Production Systems. Analyzing Tool Production Problems, Albert A. Dowd and Frank W. Curtis. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1671–1673, 9 figs. Method of analysis. Results of alternative methods of machining and set-up.

Budgeting Business, Park Mathewson. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 404–407, 3 figs. Planning production quotas by means of budget system.

Graphic Production Control for the Small Shop, R. J. Rahn. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 432–436, 3 figs. Control sheet.

How and Why Production Methods Increase Shop Production, E. T. Spidy. Jl. Eng. Inst. of Canada, vol. 4, no. 7, July 1921, pp. 404–408, 5 figs. General outline of modern production methods, with particular emphasis on importance of shop schedule.

The Economy of Standard Quantities, Paul E. Holden. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 34–36, 2 figs. Avoiding too frequent machine set-ups and unbalanced stocks.

Rate Setting. Serial Rate-Setting, H. P. Losely. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 409–415, 10 figs. Determining time rates on varying sizes of similar parts.

Stores Organization. Stores Organisation. Eng. Production, vol. 2, no. 38, June 23, 1921, pp. 739–742, 9 figs. Forms for keeping records.

[See also TIME STUDY.]

INDUSTRY

Selection of Industrial Sites. Choosing the New Plant Location, H. H. McCanna. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 396–398, 2 figs. Factors affecting selection of industrial sites.

INSPECTION

Managing Department. Managing an Inspection Department, George S. Radford. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 422–426, 1 fig. How to handle personnel and routine.

Methods. The Delco Inspection System, Louis Ruthenburg. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 289–293, 4 figs. Methods used by Dayton Engineering Laboratories Co. for inspection of raw meterials, purchased parts, tools, equipment and gages, and manufactured product.

INTERNAL-COMBUSTION ENGINES

Temperature Measurement. Measuring Temperatures in Internal-Combustion Engines (La tecnica delle misure di temperatura nei motori a combustione interna), P. Ferretti. Rivista Marittima, vol. 54, no. 1, Jan. 1921, pp. 41–102, 37 figs. Describes hydrogen gas thermometer, resistance thermometer and Callendar, Burstall, Peterson and Wolff instruments and various results obtained by these experimenters. Deals in detail with thermoelectric thermometer and experience of Bams, Stronhal and others with this apparatus. Bibliography.

[See also ALCOHOL ENGINES; AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; INDICATORS, Internal-Combustion Engines; MARINE ENGINES, Oil; REFRIGERATING PLANTS.]

IRON

Bars, Fractures in. Unusual Fractures in Iron Bars (Merkwürdige Brucherscheinungen bei Eisenstäben), J. Grimme. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 23, June 4, 1921, pp. 603–604, 12 figs. Results of tests with iron bars which were stressed during several hundred hours. Cause for the regularly occurring fracture without defects in material has not yet been found.

Magnetic Properties. Magnetic Properties of Compressed Powdered Iron, Buckner Speed and G. W. Elmen. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 7, July 1921, pp. 596–609, 22 figs. Magnetic material specially suited to construction of cores in small inductance coils and transformers such as used in telephone plants. Material is formed by grains of powdered iron, insulated and compressed. Tables and curves are given showing magnetic, electrical and mechanical properties of material.

IRON ALLOYS

Magnetic Properties. On the Influence of Low Temperatures on the Magnetic Properties of Alloys of Iron with Nickel and Manganese, Kamerlingh Onnes, Robert A. Hadfield and H. R. Woltjer. Proc. Royal Soc., vol. 99, no. A698, June 1, 1921, pp. 174–196, 11 figs. Experiments showed that iron-manganese alloys, containing higher percentages of manganese, cannot be made magnetic at atmospheric temperature by cooling to boiling point of liquid hydrogen or liquid helium.

IRON CASTINGS

Cleaning. Cleaning and Dressing Castings, F. W. Wilson. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 725–727. 13 figs. Procedure and equipment. Paper read before Manchester Assn. Engrs.

IRON INDUSTRY

Germany. German Iron and Steel in Reconstruction, H. Cole Estep. Iron Trade Rev., vol. 69, no. 1, July 7, 1921, pp. 25–30, 3 figs. Pig-iron production in first 5 months of 1921 was 6,000,000 metric tons; steel ingot production, 6,400,000 metric tons. Corresponding figures for 1913 were 19,300,000 and 18,940,000 metric tons.

J

JIGS

Design. Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 54, nos. 25 and 26, June 23 and 30, 1921, pp. 1078–1080, 5 figs., and 1119–1122, 7 figs. June 23: Closed jigs for annular and straight holes. Locating and assembling jigs. June 30: Design of drill jigs, indexing and trimming jigs; drilling and reaming indexing fixtures and four-sided jigs for accurate work.

Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 18–22, 11 figs. Design of drill jigs. Principles and methods of indexing. Index plungers and latches. Combined index and latch. Specific examples of indexing jigs.

L

LABOR

Italy. Labor Unrest in Italy, Alfred Maylander. U. S. Dept. of Labor, Monthly Labor Rev., vol. 12, no. 6, June 1921, pp. 137–259. Rôle played by labor organization and political bodies in present unrest among industrial and agricultural labor. Extent to which economic causes have operated to bring about labor unrest, and measures that have been taken to abate it. Developments in syndicalist control of industries.

LABORATORIES

Research. The Rudge-Whitworth Research Laboratory. Machy. (Lond.), vol. 18, no. 454, June 9 1921, pp. 301–303, 5 figs. Measuring instruments developed at research laboratory of Rudge-Whitworth Manufacturers of steel balls, ball bearings, pedal and motorcycles and detachable wire wheels.

LATHE WORK

Time Allowances. Suggestions for Turning Operations (Drehakkorder), F. Lohage. Werkstattstechnik, vol. 15, no. 12, June 15, 1921, pp. 355–358, 4 figs. Notes in determination of working time for turning operation, turning spindles and bolts, and cutting threads on lathe. Includes table for determination of working time for cutting Whitworth threads.

LATHES

Relieving. The Importance of Relieving Lathes in High-Grade Machine Construction (Die Bedeutung der Hinterdrehbank für den hochwertigen Maschinenbau), C. E. Berck. Der praktische Maschinen-Konstrukteur, vol. 54, no. 22, June 2, 1921, pp. 89–92, 15 figs. Details of lathe constructed by Schüttoff & Bässler, Chemnitz, Germany, for backing off the teeth of milling cutters, hobs, etc.

LIGNITE

Briquetting. Fuel Loss through the Briquetting of Lignite (Der Brennstoffverlust durch die Brikettierung der Braunkohle), H. Berner. Chemiker-Zeitung, vol. 45, no. 42, Apr. 7, 1921, pp. 333–335. It is shown that fuel consumed in briquet factory does not represent fuel loss, and results of calculations show that from original fuel consumption in factory of from 17 to 31 per cent. the actual fuel loss due to savings through heat used for drying, etc., is only about 8 per cent. Report of expert committee of Central German Lignite Syndicate.

German Industry. The Rhenish Lignite Industry. (Grundlinien der rheinischen Braunkohlenindustrie), Rudolf Adrian. Braunkohle, vol. 19, nos. 31, 32, 33, 35 and 36, Nov. 13, 20, 27, Dec. 11, and 18, 1920, pp. 381–384, 394–399, 407–411, 431–434 and 445–447. Points to increasing importance of Rhenish lignite in comparison to anthracite as fuel. Long-distance supply of electric energy from the lignite mines; organization of the Lignite Briquet Sales Assn., its effects on prices, production, etc. Suggestions for future development; transportation problem.

Research. Researches upon Brown Coals and Lignites. Part I—Heat Treatment at Temperatures below 400 Deg. C. as a Possible Method for Enhancing Their Fuel Values, William A. Bone. Proc. Royal Soc., vol. 99, no. A698, June 1, 1921, pp. 236–251. Treatment was found to improve fuel values of brown coals and lignites.

LOCOMOTIVE BOILERS

Heat Transmission in Flues. Heat Transfer in Flues—a Graphic Method of Calculation, A. J. V. Umanski. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 702–703, 2 figs. Graphs for computing temperature drop in flues of various diameters.

LOCOMOTIVES

Baldwin Locomotive Works. Baldwin Builds Forty Locomotives for Southern Pacific. Ry. Rev., vol. 68, no. 26, June 25, 1921, pp. 966–968, 3 figs. Pacific type, 2–10–2 type for heavy freight traffic and switching locomotives.

Canadian Pacific Railway. A Locomotive Designed for Rigorous Operating Conditions, W. H. Winterrowd. Ry. Rev., vol. 68, no. 25, June 18, 1921, pp. 929–936, 14 figs. Pacific type locomotive designed for Canadian Pacific Ry. Characteristics: Cylinder, diameter and stroke, 25 in. by 30 in.; boiler pressure, 200 lb. per sq. in.; diameter drivers, 75 in.; weight engine, total 299,000 lb.; heating surface, total 3529.6 sq. ft.

Consolidation Type. Consolidation Locomotives for the Western Maryland. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 419–422, 8 figs. Characteristics: Cylinders, 27 in. by 32 in; boiler type, straight top; boiler diameter, 88 in.; working pressure, 210 lb. per sq. in.; tractive effort, 68,200 lb.; total weight, 294,900 lb.

The New Consolidation Locomotive of the Belgian State Railway (Les nouvelles locomotives "Consolidation" des chemins de fer de l'etat belge), M. E. Minsart. Bulletin technique de l'Association des Ingénieurs sortis de l'Ecole Polytechnique de Bruxelles, vol. 17, no. 2, 1920–1921, pp. 117–127, 3 figs. Manufactured in America. Characteristics: Cylinders, 610 mm. diameter by 711 mm. stroke; interior diameter of boilers, 1727 mm.; heating surface, total, 172.2 sq. m.; superheating, 51.1 sq. m.; total weight in working order 84500 kg.; tractive effort at 65 per cent of boiler pressure, 15,840 kg.

Cut-off Control. The Automatic Control of Locomotive Cutoff, E. S. Pearce. Ry. Age, vol. 70, no. 25, June 24, 1921, pp. 1451–1456, 11 figs. Tests conducted by Big Four Ry.

Driving Wheels. Methods Used in Locomotive Driving Wheels, Axle and Crankpin Work, Frank A. Stanley. Am. Mach., vol. 54, no. 25, June 23 1921, pp. 1070–1072, 8 figs. Present practice on several classes of work in Southern Pacific shops. Allowance required for shrinking tire on driving wheels.

Feedwater Heating. Developments in Locomotive Feed Water Heating. Ry. Rev., vol. 69, no. 2, July 9, 1921, pp. 44–46, 3 figs. Refinements in design facilities return of condensate to feedwater and elimination of water stops.

Locomotive Feedwater Heating (Die Speisewasservorwärmung im Lokomotivbetriebe), R. Sanzin. Verkehrstechnik, vol. 38, no. 7, Mar 5, 1921, pp. 85–87. Advantages of feedwater heating. Drummond, Caille-Potonié, Worthington and Knorr systems.

Power of Increasing. Vitalizing Locomotives, George M. Basford. Official Proc. New York Railroad Club, vol. 31, no. 7, May 20, 1021, pp. 646, 12 figs. Increasing power of locomotives as means for remedying transportation congestion.

Repairs. Manufacturing Standard Locomotive Repair Parts, M. H. Williams. Ry. Mech. Engr., vol. 95, no. 7, July 1921, pp. 451–455, 7 figs. Method of standardizing and manufacturing locomotive repair parts in central production shops.

Shops. Railway Machine Shop Practice — I. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 312–325, 12 figs. Methods employed in locomotive shops of Great Western Ry. Co., England.

Speed Indicators. The Best Relative Variable in Registration of Speed in Railway Operation (Die zweckmässigste Bezugsvariable bei der Geschwindigkeitsregistrierung im Eisenbahnbetrieb), W. Hort. Verkehrstechnik, vol. 38, no. 1, Jan. 5, 1921, pp. 1–3, 4 figs. Diagrams measured with different speed indicators comparing use of time or

distance as relative variable. In Bruhn system distance and speed are recorded directly whereas time acceleration and retardation are computed from diagram.

Superheater. Pyrometers Promote Locomotive Efficiency. Ry. Mech. Engr., vol. 95, No. 7, July 1921, pp 433, 2 figs. Tests showing values of pyrometers applied to superheater locomotives.

Spiral Tubes and Superheaters in Connection with Fuel Economy in Steam Locomotives and Fire-Tube Boilers (Essrohre und Spiralüberhitzer und Brennstoffersparnis bei Dampflokomotiven und Heizröhrenkesseln), K. E. Nordling and R. Bengtzon. Analen für Gewerbeu. Bauwesen, vol. 88, no. 10, May 15, 1921, pp. 83–87, 3 figs. Spirally corrugated tube known as the Ess tube, manufactured by the Uddeholms Aktiebolag, Uddeholm, Sweden.

Valve Gear. Poppet-Valve Gear for Steam Locomotives (Ventilsteuerung für Dampflokomotiven), H. Wittfeld. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 24, June 11, 1921, pp. 623–625, 10 figs. Describes Lentz valve gear which can be installed in existing locomotives in place of piston valves without alteration of cylinder and driving rod. Results of extended experimental operation.

LUBRICATING OILS

Mineral. The Improvement of the Lubricating Properties of Mineral Oils, J. H. Hyde. Engineering, vol. 111, no. 2893, June 10, 1921, pp. 708–709, 10 figs. Improvement of lubricating properties of mineral oils by addition of fatty oils and acids. From experiments conducted at British Nat. Physical Laboratory.

Research. Investigation into Properties of Lubricating Oils. Automotive Industries, vol. 45, no. 1, July 7, 1921, pp. 16–17. Report of tests made by British committee covers measurement of coefficient of friction at various temperatures and with oils of various viscosities. Comparisons of vegetable, animal and mineral oils with and without addition of refined or deflocculated graphite are included.

Tests. Endurance Test of Force Feed Oils, J. G. O'Neill. Jl. Am. Soc. of Naval Engrs., vol. 33, no. 2, May 1921, pp. 248–260, 9 figs. It is concluded that mineral lubricating oils, derived from asphaltic base crude or paraffin base crude and of same viscosity at operating temperatures, will give same service in force-feed lubrication system.

LUBRICATION

Bearings. Oil Consumption and Friction Losses (Oelverbrauch und Reibungsverluste), W. Torau. Verkehrstechnik, vol. 38, no. 6, Feb. 25, 1921, pp. 75–76, 2 figs. Lubricating device said to have been successfully used in transmission-gear construction, machine tools, etc. Device is suitable for railway cars and their drives.

Tests. Measures for Improvement of Lubrication on the Berlin Street Railway (Massnahmen zur Verbesserung des Schmiermittelverbrauchs bei der Berliner Strassenbahn), H. Simmrock. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 10, May 24, 1921, pp. 114–115. Results of tests with lubricants and lubricating devices carried out with a view to devising method for reducing consumption of oil.

M

MACHINE SHOPS

Power-Plant. Power Plant Machine Shops, W. O. Rogers. Power, vol. 54, no. 1, July 5, 1921, pp. 12–19, 26 figs. Machine tools found in use in representative power-plant machine shops.

Railways. Railway Machine Shop Practice—II Machy. (Lond.), vol. 18, no. 456, June 23, 1921, pp. 349–351, 6 figs. Methods employed in locomotive shops of Great Western Ry. Co., England.

Railway Machine Shop Practice—IV. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1015–1017, 7 figs. Methods used in machining crown brasses, driving-boxes, and shoes and wedges.

MACHINE TOOLS

Drive. Machine-Tool Driving, J. D. Hope. Mech. World, vol. 69, no. 1798, June 17, 1921, Pp. 459–460. Individual electric driving arrangements versus group system of driving.

MALLEABLE IRON

Casting. American Malleable Cast Iron—XIII, H. A. Schwartz. Iron Trade Rev., vol. 68, no. 26, June 30, 1921, pp. 1792–1797, 5 figs. Electric furnace melting. Kranz triplex process.

MARINE BOILERS

Manufacture. Marine Boiler Construction—II. Machy. (Lond.), vol. 18, no. 454, June 9, 1921, pp. 295–300, 12 figs. Methods and machines employed in representing English shops.

MARINE ENGINES

Oil. Modern Marine Oil Engines—I. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 633–635 and 644, 5 figs. Doxford 3000-i.hp. opposed-piston type.

MEASURING INSTRUMENTS

Internal Measurements. New Light on Internal Measurements, John Bath. Am. Mach., vol. 54, no. 26, June 30, 1921, pp. 1110–1114, 4 figs. Forms of contacts for measuring cylindrical surfaces. Results induced by presence of oil on surfaces in contact.

Pneumercator. The Pneumercator System. Ship building & Shipping Rec., vol. 17, no. 24, June 16, 1921, pp. 745–746, 5 figs. Method of recording height or weight of liquid at distant point.

METAL DRAWING

Seamless Vessels. The Drawing of Seamless Vessels and the Tools Therefor (Das Ziehen von nahtlosen Gefässen und die Werkzeuge hierfür), Alfred Wildner. Der praktische Maschinen-Konstrukteur, vol. 54, no. 22, June 2, 1921, pp. 93–95, 1 fig. General rules are set forth and suitable tools described.

METALS

Calorizing. Treating Metal to Resist Heat, Arthur V. Farr. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1724–1727, 13 figs. Calorizing process. Material is placed in rotary retort which contains finely divided aluminum, and there heated in reducing atmosphere. Resultant alloy surface is thus formed that withstands abrasion.

METEOROLOGY

Cloud Systems. Cloud Systems (Sur les systèmes nuageux), Ph. Schereschewsky. Comptes rendus des Séances de l'Académie des Sciences, vol. 172, no. 23, June 6, 1921, pp. 1429–1431. Method of studying cloud systems. International classification.

Weather Forecasting. Weather Forecasting (Le probleme de la prevision du temps), L. Dunoyer and G. Reboul. Journal et Physique et le radium, vol. 2, no. 5, May 1921, pp. 129–131, 1 fig. Experience of Meteorological Service of French army.

METRIC SYSTEM

apan. The Metric System in Japan, J. H. Blakey. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 673. Obligatory adoption of metric system in Japanese empire. Translated from Comptes rendus de l'Académie des Sciences.

MILLING CUTTERS

Screw-Thread. Helical Cutters for Milling Screw Threads (Rilleofräser zur Gewindeherstellung). Der praktische Maschinen-Konstrukteur, vol. 54, no. 12, Mar 24, 1921, pp. 51–56, 8 figs. Shows why such cutters should be made only with straight chip flutes. Reprinted in full from Loewe-Notizen, published by Ludw. Loewe Corp.

MILLING MACHINES

Drum Type. Manufacturing Applications of Ingersoll Drum-Type Milling Machines, J. V. Hunter. Am. Mach., vol. 55, no. 1, July 7, 1921, pp. 23–27, 21 figs. Fixtures for holding work. Automatic clamping devices.

MOLDING METHODS

Green Sand. Costs Dictate Changes in Molding, Pat Dwyer. Foundry, vol. 49, no. 13, July 1, 1921, pp. 501–509, 16 figs. Experience of Muncie Foundry & Machine Company, Muncie, Ind. Dry sand has been abandoned in favor of green-sand method for molding automobile cylinders.

MONEL METAL

Latent Heat of Fusion. The Latent Heats of Fusion of Nickel and Monel Metal, Walter P. White. Chem. and Met. Eng., vol. 25, no. 1, July 6, 1921, pp. 17–21. Experimental determination of latent heats of nickel and monel metal and of their specific heats for intervals to 1360 and 1260 degs. cent., respectively. Latent heat of nickel was 73 calories per gram and that of monel metal 68 calories per gram.

MOTOR BUSES

Operation. Akron's Motor Bus Route. Elec. Ry. Jl., vol. 57, no. 26, June 25, 1921, pp. 1164–1167, 7 figs. Non-competitive route operated in connection with housing development.

Trolley. Electrification at Edinburgh. Elec. Ry. Jl., vol. 58, no. 1, July 2, 1921, pp. 12–14, 3 figs. Gasoline motor buses and electric railway cars replace cable operation. Choice was determined by traffic power and price conditions.

Pioneer Trackless Trolley Installation. Elec. Ry. Jl., vol. 57, no. 26, June 25, 1921, pp. 1158–1161, 7 figs. Experimental trolley buses operated in conjunction with rail service at Richmond, Va.

Trackless Trolley Line in Austria (Elektrische Oberleitungs-Automobillinie Pötzleinsdorf-Salmanns dorf), Ernst Findeis. Elektrotechnik u. Maschinenbau, vol. 39, no. 22, May 29, 1921, pp. 270–271, 1 fig. Interurban bus line in vicinity of Vienna with overhead current supply, according to Austro-Daimler-Stoll system, in use since 13 years, with less cost of installation and operation than in the case of street-railway line and gasoline-burning buses. Address before Int. Street and Narrow-Gage Ry. Congress, Vienna.

MOTOR PLOWS

German. Modern German Motor Plows (Neuere deutsche Motorpflüge), Richard Bussien. Oel- u. Gasmaschine, vol. 18, no. 6, June 1921, pp. 81–96, 21 figs. Details of various types.

MOTOR TRANSPORT

Trains. A Self-Propelled Highway Freight Train of 30-tons Net Load (Der Müllerzug), E. Fränkel. Verkehrstechnik, vol. 38, no. 13, May 5, 1921, pp. 165–170, 5 figs. The separate trucks, which are electrically driven by current generated in leading truck by a steam or internal-combustion engine, run in track of first car, due to a special stearing gear. Use of train as feeder for railway lines and for testing traffic in planned routes not yet built. Trains with heavy steam cars in England reached a speed of 10 to 12 km. per hr. on a 70-km. stretch.

MOTOR TRUCKS

Leyland Steam Wagon. The Leyland Steam Wagon, Engr., vol. 131, no. 3415, June 10, 1921, pp. 616–617, 7 figs. Hydraulic tipping steam wagon manufactured by Leyland Motors, Ltd., Leyland, England.

Manufacture. Fits, Tolerances and Heat Treatments Applied in Production, C. T. Bates. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1314–1326, 9 figs. Data covering actual practice employed by many manufacturers in production of all parts used in heavy truck. Same fits, tolerances and heat treatments are applicable in production of parts for passenger cars, light trucks and other automotive vehicles.

MOTORCYCLES

British. Review of Engineering Features of British Motorcycles, M. W. Bourdon. Automotive Industries, vol. 44, no. 25, June 23, 1921, pp. 1376–1381, 6 figs. Types exhibited at Olympia show.

MOTORSHIPS

German-Built. Germany to Build High Powered Diesels. Mar. Eng., vol. 26, no. 7, July 1921, pp. 545–547, 3 figs. Motorship under construction in Germany that is to carry two 3000-b.hp. Sulzer Diesel engines.

N

NICKEL

Plating Solutions. "Black Nickel" Plating Solutions, George B. Hobagoom, T. F. Slattery and L. B. Ham., U. S. Dept. of Commerce, Bur. of Standards, Technologic Papers, no. 190, April 4, 1921, 9 pp. Results of experiments on plating solutions used to produce "government bronze" finish on military hardware.

NON-FERROUS METALS

Ship Construction. Non-Ferrous Metals and Compositions, Horace Holden Thayer. Mar. Eng., vol. 26, no. 7, July 1921, pp. 524–533. Composition of metals used in ship construction. Table of brasses, bronzes and bearing metals for ship specifications.

O

OIL FIELDS

Argentina. Geological Study of Comodoro Rivadavia Oil Fields Being Exploited by Argentina Government (Estudio geológico de la zona de reserva de ea explotación nacional de petróleo en Comodoro Rivadavia), Ricardo Wichmann. Ministerio de Agricultura de la Nación, bul. no. 25, 1921, 19 pp., 3 figs.

India. Petroleum in the Punjab and North-West Frontier Province, E. H. Pascoe. Memoirs of Geological Surveyof India, vol. 40, part 3, 1920, 493 pp., 20 figs. Geological and physical features of oil fields.

Mexican. The Production and Combustion of Mexican Fuel Oil—II, J. M. Pettingell and J. R. Carlson. Combustion, vol. 4, no. 6, June 1921, pp. 18–23, 9 figs. Notes on drilling wells and transporting oil.

Peru. Peruvian Oil Fields, Vernon F. Marsters. Eng. & Min. Jl., vol. 111, no. 26, June 25, 1921, pp. 1073–1075, 1 fig. Geological description of fields and statistics of production.

Spain. Petroleum in Spain (Petroleos en España), Pablo Fábrega. Revista minera metalurgica y de Ingenieria, vol. 72, no. 2782, May 1, 1921, pp. 245–247. Account of explorations.

OIL FUEL

Coal vs. Relative Efficiencies with Coal and Fuel Oil, A. W. Darter. Power Plant Eng., vol. 25, no. 13, July 1, 1921, p. 657. Comparative boiler tests with Texas lignite and with Mexican fuel oil.

OIL SHALES

Distillation. A Study of the Saturated and Unsaturated Compounds of Shale Oils, C. W. Botkin. Petroleum Times, vol. 5, no. 126, June 4, 1921, pp. 659–663. Determination of saturates and unsaturates. Distillations of crude asphaltic shale oil. Effect of distillation of oil on saturates and unsaturates and their distillation.

The Distillation of Oil Shale, A. H. Low. Petroleum Times, vol. 5, no. 127, June 11, 1921, pp. 689–690, 1 fig. Method adopted in Colorado School of Mines.

Testing. Anglo-Persian Activity in New Brunswick Oil Shales, Alexander Gray. Can. Min. Jl., vol. 42, no. 24, June 17, 1921, pp. 474–479. Eight ton testing plant in operation. Technical staffs to be increased and larger plans to be framed when results satisfactory.

P

PARACHUTES

Types. New Types of Parachutes, Alfred Gradenwitz. Aviation, vol. 11, no. 1, July 4, 1921, pp. 22, 3 figs. Designs developed by German army.

PETROLEUM INDUSTRY

By-Products. The Development of an Oil By-Product Industry, Eric K. Rideal. Chem. Age. (Lond.), vol. 4, no. 104, June 11, 1921, pp. 666–668. Possibility of establishing by-product industry in connection with oil in much the same way as is done with coal.

PIPE LINES

Hot-Oil Transportation. Pipe-Line Transportation of Hot Oil, Leonard L. Barrett. Chem. & Metallurgical Eng., vol. 24, no. 26, June 29, 1921, pp. 1148–1152, 3 figs. Study of thermal losses in hot petroleum transit lines. Calculations based on d'Arcy's hydraulic formula for spacing pumping and heating stations. Curves of hydraulic gradient for insulated and uninsulated 8-in. lines.

PIPE, STEEL

Centrifugally Cast. Mold Serves as Electric Furnace, E. C. Kreutzberg. Iron Trade Rev., vol. 69, no. 1, July 7, 1921, pp. 33–35, 6 figs. Cammen patented process. Metal is melted electrically in the same mold in which it is cast. Process will be used at plant of Metal Alloys Co., Elizabeth, N. J., for manufacturing aluminum-bronze tubes of all diameters.

PISTONS

Aluminum. Problems and Possibilities of the Aluminum Piston, Walter Rosenhain. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1264–1266 and 1301. Advantages of and limitations of aluminum piston for automobile and aeroplane engines.

Crank-Driven. Results Obtained with Crank-Driven Planers, Edward K. Hammood. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1052–1056, 9 figs. Methods of operating machines possessing features of both planer and shaper.

PLANING

Production System. Production Planing in Machine Tool Plants. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 326–330, 6 figs. Importance of using adequate number of stops in setting up planer work. Tables of planing speeds and feeds for roughing cuts in various materials.

POLES, WOODEN

Specifications. British Standard Specification for Red Fir Wood Poles for Telegraph and Telephone Lines, British Eng. Standards Assn., no. 139, Feb. 1921, 8 pp. Methods of creosoting.

PLATES

Deflection. The Deflection of a Rectangular Plate under Single Loads (Ueber die Biegung der rechteckigen Platte durch Einzellasten), A. Nádai. Bauingenieur, vol. 2, no. 11, June 15, 1921, pp. 299–304, 6 figs. Determination of deflection and distribution of stress in a fixed-in plate strip with concentrated load. Application to different cases of stress in rectangular plates.

Stresses. Strength of Flat Elliptical Plate Loaded Uniformly and Supported at the Perimeter, Tzuruzo Matsumura. Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 24, no. 68, May 1921, pp. 31–40, 1 fig. Calculations.

PULVERIZED COAL

Application to Boilers. Pulverized-Coal Furnaces for Steam Boilers (Die Kohlenstaubfeuerung für Dampfkessel), F. Schulte. Glückauf, vol. 57, no. 18, Apr. 30, 1921, pp. 413–419, 4 figs. Describes plants for drying and crushing of coal and for conveying of pulverized coal to furnace burners. Favvorable and unfavorable conditions for burning pulverized coal.

Boiler Firing. Boiler Tests with Pulverized Illinois Coal, Henry Kreisinger and John Blizard. Coal Industry, vol. 4, no. 6, June 1921, pp. 291–293, 2 figs. Results of series of 11 tests made on 468-hp. Edgemoor boiler equipped with Foster superheater and fired with pulverized coal. Tests were made by Fuel Section of U. S. Bur. of Mines in coöperation with Research Dept. of Combustion Eng. Corp. Results indicated that it is not necessary to pulverize to fineness of 85 per cent through 200 mesh screen in order to obtain efficiency.

Operation with Pulverized Coal, A. J. Dixon. Power, vol. 54, no. 1, July 5, 1921, pp. 24–25, 1 fig. Test to determine commercial efficiency of pulverized coal as boiler fuel being conducted at power plant of Rialto Bldg., St. Louis, Mo.

Oil Fuel on Hull Tramways: Comparison with Coal Consumption, E. S. Rayner. Tramway & Ry. World, vol. 49, no. 830, June 16, 1921, pp. 289–293. Comparative cost and results of operating boilers in power house 14 days under oil fuel and 14 days under coal.

Pulverized Firing in Steam Generation, F. J. Crolius. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 6, June 1921, pp. 161–168 and ((discussion) pp. 188–198. Survey of developments. Classification of methods into indirect firing and direct firing. Design of combustion chambers. Economies of using pulverized coal.

Stoker Firing vs. Pulverized Coal versus Stoker Firing, F. P. Coffin. Power, vol. 54, no. 2, July 12, 1921, pp. 52–54, 2 figs. From forthcoming book on "The Utilization of Coal on a Multiple-Products Basis."

Uses. Heating with Pulverized Coal (Le chauffage au charbon pulvérisé), P. Frion. Chaleur et Industrie, vol. 2, no. 13, May 1921, pp. 278–284. Survey of developments on Europe and America. (To be continued.) Report prepared under auspices of French Interministerial Committee appointed to study best utilization of fuels.

Industrial Heating with Pulverized Coal (Le chauffage industriel au charbon pulvérisé), Paul Frion. Revue générale de l'Électricité, vol. 9, nos. 23 and 24, June 4 and 11, 1921, pp. 817–824 and 856–862. Typical installations. Advantages of pulverized coal and possibilities of its application in various industries. (Concluded.) Report of French Interministerial Committee appointed to study best utilization of fuels.

Use of Pulverized Coal for Heating Furnaces and Boilers (L'emploi du charbon pulvérisé pour le chauffage des fours et des chaudières). Génie Civil, vol. 78, no. 22, May 28, 1921, pp. 459–462. Developments in Europe and America. Report of Committee on Economical Combustion of Fuel, appointed by French Government. From Journal Officiel.

PUMPING ENGINES

Corliss. Triple Corliss Pumping Engine for Margate Waterworks. Engr., vol. 131, no. 3414, June 3, 1921, pp. 588–590, 5 figs. Hathorn, Davey & Co. standard vertical triple Corliss pumping engine forcing water to surface from depth of 130 ft. and forcing it a distance of nearly 15 miles against head of 300 ft.

PUMPS

Rotary Exeter. Suction Pump Operates upon New Principle. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1723, 2 figs. Description of Exeter rotary pump manufactured by Exeter Machine, West Pittston, Pa.

Turbine-Driven. Jennings Turbine-Driven Return-Line Heating Pump. Power, vol. 54, no. 1, July 5, 1921, p. 6, 3 figs. Designed for use in connection with heating or drying systems.

PUMPS, CENTRIFUGAL

Design. Increased Output with Centrifugal Pumps and Blowers (Gesteigerte Leistung bei Schleuderpumpen und -gebläsen), Edmund Pocher. Fördertechnik u. Frachtverkehr, vol. 14, no. 11, May 27, 1921, p. 119–121, 7 figs. Discusses inflow and outflow in suction and pressure pipes of pumps and blowers, and use of suction funnels and conical pressure pipes and diffusors, advantages of which are demonstrated. Deals also with inflow and especially outflow from impeller and emphasizes importance of experimental results for internal design of pumps and blowers.

Efficiency. New Method of Determining Efficiency of Centrifugal Pumps, Allen F. Sherzer. Eng. News-Rec., vol. 86, no. 26, June 30, 1921, pp. 1114–1115, 3 figs. Efficiency contours for centrifugal pumps in terms of gallons per minute and specific speeds. Graphs showing relation between capacity and efficiency and relation between specific speeds and efficiency for horizontal centrifugal pumps.

Water Leakage. On the Leakage of Water through the Clearance Rings in a Centrifugal Pump, Otogoro Miyagi. Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 24, no. 68, May 1921, pp. 15–29, 3 figs. Technical study.

R

RAILS

Alloy-Steel. On the Question of Special Steels, W. C. Cushing. Bul. Int. Ry. Assn., vol. 3, no. 6, June 1921, pp. 577–640. Comparative study of suitability of various steel alloys for rail manufacture, from records of experience of railways in different parts of the world.

Hardening "In Situ." The Sandberg "In Situ" Rail Hardening Process, A. E. Shirter. Acetylene Jl., vol. 23, no. 1, July 1921, pp. 15–17, 2 figs. Hand propelled truck fitted with equipment for heat-treating rails by blowpipes. Experience of British Electric Railway.

Wooden. The Widegren Wooden Rail System (Transportbane - System Widegren), K. A. Widegren. Teknisk Tidskrift (Veckoupplagean), vol. 51, no. 14, Apr. 9, 1921, pp. 161–164, 7 figs. Track consists of roughly hewn beams, resting on a trestle or ties. Wheels have rubber tires without flanges. Railway has proved to be very safe; trucks run smoothly, wear and tear is not great, and cost of installation is about 35 to 50 per cent that of steel railways.

RAILWAY ELECTRIFICATION

Brazil. Electrification of the Paulista Railway, Brazil, S. A. W. D. Bearce. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 620–627, 7 figs. Motor power equipment consists of eight freight locomotives weighing 100 tons each and four passenger locomotives weighing 120 tons each.

Substituting Water Power for Wood Fuel in Brazil, W. D. Bearce. Ry. Rev., vol. 69, No. 1, July 2, 1921, pp. 1–5, 5 figs. Electrification of Paulista railway with American equipment.

3,000-Volt Electrification on Paulista, S. B. Cooper and W. D. Bearce. Elec. Ry. Jl., vol. 57, no. 24, June 11, 1921, pp. 1075–1084, 24 figs. Railway electrification of 28-mile section of double-track main-line of Brazilian railway. Details of Westinghouse and Gen. Elec. locomotives used.

Europe. Railway Electrification in Europe, J. V. Dobson and F. E. Wynne. Elec. Ry. Jl., vol. 57, no. 24, June 11, 1921, pp. 1068–1074, 12 figs. Impressions of present practices and tendencies gathered by writers on trip through England, Norway, Sweden, Germany, Switzerland, Italy and France. Summary of points of difference between American and European railway usage.

High-Tension Direct-Current. Note on the Electrification of French Railways (Note sur l'électrification des réseaux de chemins de fer français), M. A. Ferran. Revue genérâle des Chemins de Fer et des Tramways, vol. 40, no. 5, May 1921, pp. 313–352, 18 figs. Study of electric traction by high-tension direct surrent.

High-Voltage. Railroad Electrification at High Voltage, F. H. Shepard. Ry. Age, vol. 70, no. 25, June 24, 1921, pp. 1441–1444, 6 figs. Development of alternating-current equipment and its relation to power supply.

RAILWAY MAINTENANCE

Organization. On the Question of Maintenance and Supervision of the Track, Chas. J. Brown. Bul. Int. Ry. Assn., vol. 3, No. 6, June 1921, pp. 663–690, 21 figs. Report from railways on their system of organization of staff and their methods of carrying out the work of maintenance of track.

RAILROAD MANAGEMENT

Economies. Possible Economies in Railroad Management, W. Jett Lauck. Indus. Management, vol. 62, no. 1, July 1, 1921, pp. 7–9. Argument on behalf of railroad employees before U. S. R. R. Labor Board.

Legislation, Switzerland. Federal Law Regulating Organization and Management of Federal Railways (Loi fédérale réglant l'organisation et l'administration des chemis de fer fédéraux). Bulletin technique de la Suisse romande, vol. 47, no. 12, June 11, 1921, pp. 136–140. Project of law evolved by Swiss Dept. of Railways and submitted to Federal Chambers in June 1921.

RAILWAY MOTOR CARS

Internal-Combustion-Engines. Railway Motor Coach with Internal Combustion Engine. Engr., vol. 131, no. 3415, June 10, 1921, pp. 612–613, 6 figs. Direct drive by internal-combustion engine. Translated from Génie Civil.

RAILWAY OPERATION

Car Service. The Delaware and Hudson's New Car Service Rules. Ry. Age, vol. 71, no. 2, July 9, 1921, pp. 73–75, 3 figs. Revised rules for promoting prompt car movement simplified for the benefit of yardmasters.

Cost Accounting. Remedies for Wastes in Railway Operation, F. J. Lisman. Ry. Age, vol. 71, no. 2, July 8, 1921, pp. 59–63. Suggestions in regard to cost-keeping methods.

Train Control. The Train Control System for the North British Railway. Ry. Gaz., vol. 34, no. 22, June 3, 1921, pp. 835–846, 20 figs. Total mileage of railway is 1399.

Train Dispatching. On the Question of Slow-Freight Traffic, Mr. Guerber. Bul. Int. Ry. Assn., vol. 3, no. 6, June 1921, pp. 641–662, 4 figs. Report on organization of train service.

RAILWAY SIGNALING

Repetition of Signals on Locomotive. Automatic Stopping of Trains and Repetition of Signals on Locomotives (Arrêt automatique des trains et répétition des signaux sur les locomotives), C. Vandevelde. Annales de l'Association des Ingénieurs sortis des Ecoles speciales de Gand, vol. 11, no. 5, 1921, pp. 45–62. Advantages and disadvantages of automatic brakes. Necessity of developing simple system for reproducing track signals on locomotives.

Interlocking. New Traffic Locking on C. & O. Relieves Congestion, H. E. Johnson. Ry. Age, vol. 71, no. 1, July 2, 1921, pp. 25–26, 3 figs. Interlocking by alternating current of 125 cycles.

RAILWAY TRACK

Standardization of Material. Standardization of Track Material by French Railways (La standardisation du matériel des voies des chemins de fer français). Génie Civil, vol. 78, no. 22, May 28, 1921, pp. 458–459, 7 figs. Profiles and dimensions of three standard rails and corresponding fishplates proposed by engineering committee appointed by Ministry of War.

RAILWAYS

Rolling-Stock Material Specifications. British Standard Specifications for Railway Rolling Stock Material. British Eng. Standards Assn., no. 24, Mar. 1921. Part 1, 27 pp., 7 figs.: Locomotive, carriage and wagon axles. Part 2, 16 pp., 8 figs.: Locomotive, carriage and wagon tires. Part 3, 24 pp., 7 figs.: Laminated, volute and helical springs, and steel for laminated springs. Part 4, 19 pp., 7 figs.: Steel forgings, blooms and castings. Part 6, 28 pp., 17 figs.: Steel plates, angles, etc., and rivets for locomotives, carriages and wagons.

REDUCTION GEARS

Performance. Reduction Gears for Ship Propulsion, Robert Warriner. Mar. Eng., vol. 26, no. 7, July 1921, pp. 532–538, 5 figs. Performance of single and double reduction gears. Comparison with other methods of propulsion. (Abstract.) Paper read before Soc. of Naval Architects and Mar. Engrs.

REFRIGERATING PLANTS

Internal-Combustion Engines for. Internal-Combustion Engines as Prime Movers for Refrigeration Plants, W. H. Motz. Power, vol. 54, no. 2, July 12, 1921, pp. 58–60, 6 figs. Economy of producer-gas-engine plant.

RESEARCH

Foundry. Research in the Foundry, Engineering, vol. 111, no. 2894, June 17, 1921, pp. 749–750. Work recently undertaken by British Government.

Industrial. Research in Industry, L. A. Hawkins. Jl. Soc. of Automotive Engrs., vol 9, no. 1, July 1921, pp. 20–22. Practice of Gen. Elec. Co.

ROLLING MILLS

Sheet Mills. Milwaukee Sheet Mill Has New Features, Gilbert L. Lacher. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1681–1685, 8 figs. Bar storage and shipping department are under roof.

Western Sheet Mill New Rolling, George H. Manlove. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1715–1719, 9 figs. Installation of Milwaukee Rolling Mill Co. built in two units. Balanced roughing rolls are provided. Bar shear equipped with mechanical piler.

ROPE DRIVE

Bollen Cable Pulley. The Bollen Cable Pulley. Engineering, vol. 111, no. 2895, June 24, 1921, p. 771, 6 figs. System built up of two independent wheels and a movable race. When pulley is in operation, pull on cable causes movable race to be forced inward on side at which pressure comes and as a result rims of two wheels close together and grip cable.

RUDDERS

Kitchen Type. The Kitchen Reversible Propeller (Le gouvernail a changement de marche kitchen). Génie Civil, vol. 78, no. 19, May 7, 1921, pp. 396–397, 6 figs. Rudder is surrounded by system of two cylindrical deflectors mounted on common pivots and capable of rotating jointly or separately about rudder.

S

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Tools. The Calculation of Circular Form Tool Diameters Having Top Rake, A. Washington. Machy. (Lond.), vol. 18, no. 455, June 16, 1921, pp. 337–338, 3 figs. Formulas.

SCREW THREADS

Cutting. The Problem of Accurate Thread Cutting, B. M. W. Hanson. Machy. (N. Y.), vol 27, no. 11, July 1921, pp. 1012–1014, 4 figs. Requirements to fulfill in fitting threaded parts. Work of engineering committees in establishing tolerances within so-called commercial limitations.

SCREWS

Specifications. Report on British Standard Heads for British Association Screws. British Eng. Standards Assn., no. 57, Dec. 1920, 7 pp., 9 figs. Schedule of dimensions of various types of heads for small screws for sizes 0 to 15 B. A. covering range of diameters from 6 mm. to 0.9 mm. (0.236 in. to 0 035 in.).

SEARCHLIGHTS

Advertisement Projector. A New Type of Advertising Searchlight ("Atrax"), H. Geitel. Elektrotechnischer Anzeiger, vol. 38, no. 79, May 19, 1921, pp. 509–516. Details of advertisement projector constructed by the Atrax Co., Berlin, said to have a novel and attractive light effect and to be economical in consumption of power.

Naval Targets. Tactical Organization and Employment of Searchlights against Naval Targets, John S. Pratt. Jl. U. S. Artillery, vol. 54, no. 6, June 1921, pp. 525–567, 24 figs.

SHAFTS

Design. Graphical Determination of Shaft Diameters, N. Barnes Hunt. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1036–1037, 2 figs. Charts for graphically finding proper diameters of shafts subjected to combined tension and torsion. Sizes from 15/16 in. to 5 7/16 in. inclusive.

SHIP PROPULSION

Internal-Combustion Engines. Internal Combustion Engines Applied to Propulsion, John F. Metten and J. C. Shaw. Mar. Eng., vol 26, no. 7, July 1921, pp. 542–545. Comparative earning capacities of motorships and oil-burning steamers. Machinery equipment of motorship William Penn.

Methods. Ship Propulsion, T. C. Phillips. Jl. Eng. Inst. of Canada, vol. 4, no. 7, July 1921, pp. 396–404. Modern methods of ship propulsion, reciprocating engine, steam turbine, internal-combustion engine and electric drive.

SHIP PROPULSION, ELECTRIC

Merchant Marine. Electric Propulsion for Merchant Marine, Wilfred Sykes. Jl. Western Soc. Engrs., vol. 26, no. 6, June 1921, pp. 211–219. Comparative fuel requirements of reciprocating engines, gear turbines, electric drive, direct-connected Diesel engines and Diesel-electric drive.

SHIPS

Refrigerator. Balsa Insulation for Refrigerator Ships. Mar. Eng., vol. 26, no. 7, July 1921, pp. 557–560, 3 figs. Standard insulation plans.

SOLDERS

Soft. War Experience with Soft Solders, Hans Schulz. Metal Industry (Lond.), vol. 18, no 23, June 19, 1921, pp. 443–444. Experiments conducted during war by German Naval Dept. on tin-lead, cadmium, Matulot, Thyssen and magnesium solders.

STACKS

Concrete-Encased. Conservation of Corrosion Weakened Steel Stacks by Encasing with Concrete, John V. Schaefer. Eng. & Contracting, vol. 55, no. 25, June 22, 1921, pp. 619–620, 3 figs. Experience South Works of Ill. Steel Co.

STEAM

Flow in Pipes. Handy Steam Velocity and Steam Flow Tables, V. F. Davis. Mar. Eng., vol. 26, no. 7, July 1921, pp. 522. Capacities of steam pipes in pounds per minute with steam-flow velocity of 6000 ft. per min.

Properties. The Specific Volume of Dry Steam, M. J. Eichhorn. Power, vol. 53, no. 25, June 21, 1921, pp. 1006–1007, 1 fig. Nomogram for specific volume dry steam.

STEAM-ELECTRIC PLANTS

Glasgow, Scotland. The Dalmarnock Power Station. Engineering, vol. 111, nos. 2894 and 2895, June 17 and 24, 1921, pp. 736–738, and 748, 12 figs., and 767–771, 6 figs. June 17: Turbo-alternator, 15,000 kw. capacity. June 24: Electrical equipment.

STEAM ENGINES

25,000-Hp. Three-Cylinder, 25,000-Hp. Steam Engines for Rolling Mill Drive (Machine à vapeur à trois cylinders de 25,000 chevaux pour la commande d'un train de laminoir). Génie Civil, vol. 78, no. 23, June 4, 1921, pp. 469–472, 6 figs. Installation in Middlebrough Steel Works, England.

Uniflow. New Unaflow Engine Design. Power, vol. 53, no. 26, June 28, 1921, pp. 1042–1043, 4 figs. Equipped with high-lift poppet valves of small diameter, which are operated from valve shaft, geared to run at twice speed of main engine shaft.

STEAM ROLLERS

Manufacture. Modern Methods on Steam Roller Construction. Eng. Producton, vol. 11, no. 37, June 16, 1921, pp. 725–729, 13 figs. Interchangeable manufacturing processes at representative works.

STEAM TURBINES

British Thomson-Houston. Recent Improvements in Steam Turbine Design—IV. Engr., vol. 131, no. 3414, June 3, 1921, pp. 592–593 and 596, 8 figs. Recent types manufactured by British Thomson-Houston Co.

Lubrication. Lubrication of Steam Turbines—I. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 651–655. Principles of oil lubrication with special reference to turbine bearings, consideration being given to effects of speed, clearance, cooling by means of oil circulation, viscosity and emulsification.

Parsons. Recent Improvements in Steam Turbine Design—V, C. A. Parsons and Co. Engineer, vol. 131, no. 3416, June 17, 1921, pp. 640–642, 5 figs. Typical installations of Parsons turbines.

[See also BALANCING.]

STEEL

Alloy. See ALLOY STEELS.

Cobalt. See COBALT STEEL.

Fatigue. The Fatigue of Steel. Iron Age, vol. 107, no. 25, June 23, 1921, pp. 1687. Progress made in research and in explanation of causes. Paper read before Am. Inst. Min. & Metallurgical Engrs.

Impact Tests. Study Impact Tests on Cast Steel, F. C. Langenberg. Foundry, vol. 49, no. 13, July 1, 1921, pp. 512–524 and 519, 6 figs. Results given of investigations of impact tests on cast steels of varied compositions and heat treatments. Higher shock strength obtained from low-phosphorus material. Paper read before American Society for Testing Materials.

Stainless. The Uses of Stainless Steel. Engr., vol. 131, no. 3414, June 3, 1921, pp. 598–599. Uses in aeroplane engines, surgical instruments, turbine blades, optical work, drawing instruments, pumps, etc.

STEEL, HEAT TREATMENT OF

Flaws in Straightening. Flaws Resulting in Steel Pieces during Straightening (Les criques de rectification), Léon Guillet, Jean Galibourg and Pierre Beuret. Revue de Métallurgie, vol. 18, no. 4, April 1921, pp. 213–220, 13 figs. Flaws attributed to heating metal under rollers.

High-Speed Steel. Heat-Treatment of High-Speed Steel Cutting Tools of Intricate Design, A. J. Langhammer. Chem. and Met. Eng., vol. 25, no. 1, July 6, 1921, pp. 30, 3 figs. Comparison of various methods

STEEL INDUSTRY

France. The French Iron and Steel Industry. U. S. Dept. of Commerce, Commerce Reports, no. 145, June, 23, 1921, pp. 1709–1715. Statistics of production. Condition of plants and number of workmen.

Prices. The Cause of Industrial Depressions, George Huntington Hull. Indus. Management, vol. 61, no. 11, June 1, 1921, pp. 386–391, 5 figs. Why iron is barometer of trade, and why heavy cut in steel prices is now inevitable.

STEEL MANUFACTURE

Basic Steel. The Behavior of Sulphur in the Thomas Converter (Das Verhalten des Schwefels in der Thomasbirne), E. Herzog. Stahl u. Eisen, vol. 41, no. 23, June 9, 1921, pp. 781–788 and (discussion) pp. 788–789, 2 figs. States that the cooling of pig-iron bath brought about by the addition of lime causes a strong segregation of sulphur in form of sulphide of manganese; in further process of decarbonizing period the sulphur returns to bath in form of sulphide of iron.

Electric Furnaces. Accounting for Electric Alloy and Tool Steel, G. Harvey Porter. Jl. of Accountancy, vol. 32, no. 1, July 1921, pp. 1–15. Tabulation of control accounts, and method of drawing up details of 14 records.

Processes. Development of Iron Ore into Iron and Steel, S. C. Dickerhoff, Jr. Forging & Heat Treating, vol. 7, no. 6, June 1921, pp. 336–337. Chart indicating prices.

STEEL WORKS

England. British Iron and Steel Centers—IV, Joseph Horton. Iron Trade Rev., vol. 68, no. 25, June 23, 1921, pp. 1720–1722, 1 fig. District of South Wales and Monmouthshire.

France. Steel Works at Hagondange, near Metz (Les aciéries Thyssen a Hagondange, prés Metz). Génie Civil, vol. 78, no. 19, May 7, 1921, pp. 393–396, 9 figs. partly on supp. plate.

Power Generation. Power Generation in Steel Mills and Its Relation to Frequency, D. M. Petty. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 6, June 1921, pp. 199–212, 2 figs. Blast-furnace-gas power station. Selection of frequency.

STOKERS

Mechanical. Limitations of Mechanical Stokers. Power Plant Eng., vol. 25, no. 13, July 1, 1921, pp. 674–675. Limitations of mechanical stokers utilizing Mid-West coals.

STRUCTURAL STEEL

Compression Members. Tests with Compression Members (Versuche mit Druckstäben), H. Grüning Bauingenieur, vol. 2, no. 11, June 15, 1921, pp 285–290, 5 figs. Account of two tests carried out by the Steel Construction Testing Committee, showing effect of use of different grades of iron (with varying elasticity) in bar, and also influence of system of articulation.

SUBMARINES

German U-Boats. The Construction of U-Boats in the Germania Shipyard (der Bau von Unter seebooten auf der Germaniawerft), H. Techel. Zeit. des Vereines deutscher Ingenieure, vol. 64, no. 52, Dec. 25, 1920, pp. 1097–1103, 26 figs., 8 on supp. plate. Notes on the first U-boats built in the Germania shipyards; the Forelle, built in 1902 for Russia, three other Russian submarines, the Karp, Karras and Kambala, put in service in 1907, and the first German U-boat, built in 1904. The first U-boats built for the German navy with Diesel engines and the development of this type during the war. (Concluded.)

SUBSTATIONS

Automatic. Automatic Substations Entering Electric Service Field, R. J. Wensley. Elec. World, vol. 78, no. 1, July 2, 1921, pp. 14–15, 4 figs. It is said automatic substation has definitely proved success in industries. Advantages claimed are saving in feeder copper and good service rendered.

Brief Review of Automatic Substation Experience on the Aurora Elgin & Chicago R.R., S. E. Johnson. Gen. Elec. Rev., vol. 24, no. 7, July 1921, pp. 610–612, 1 fig. Inspection periods are seven days apart and control equipment is adjusted to furnish maximum of power throughout 24 hours.

SUPERHEATED STEAM

Steamships. Superheated Steam on Steamships, C. H. Peabody. Mar. Eng., vol. 26, no. 7, July 1921, pp. 539–541, 4 figs. Comparison with locomotive and shore practice. Results with reciprocating engines and Scotch boilers.

SWAGING

Cold. Cold Swaging—II. Machy. (N. Y.), vol. 27, no. 11, July 1921, pp. 1018–1021, 8 figs. Methods employed by Torrington Co., Torrington, Conn., in making swaging dies.

T

TANKS MILITARY

Caterpillar. Caterpillar Vehicles. Automobile Engr. vol. 11, no. 151, June 1921, pp. 198–200, 5 figs. Recent developments of flexible track scheme.

TAR OIL

Creosote Content. The Determination of the Acid Components in Tar Oils, Especially in Low-Temperature-Tar Oils (Ueber die Bestimmung der sauren Bestandteile in Teerölen, insbesondere in Urteerölen), A. Lazar. Chemiker-Zeitung, vol. 45, no. 25, Feb. 26, 1921, pp. 197–199. Improved gravimetric and differential methods for more accurate determination of creosote content in tar oils.

TELEGRAPHY

Multiplex. Multiplex Telegraphy and Telephony on High-Frequency Lines (Multipletelegraphie und -telephonie auf Leitungen mit Hochfrequenz), Karl Willy Wagner. Ingenieur, vol. 36, no. 24, June 11, 1921, pp. 453–464, 34 figs. Account of tests begun in Telegraph Testing Station of Berlin. Experiences with multiplex high-frequency telephone lines between Berlin and Hanover, Berlin and Frankfort, etc. In writer's opinion, high-frequency telegraphy is a much simpler technical problem than ordinary telegraphy. Details of apparatus for operation of the new high-frequency lines.

TERMINALS LOCOMOTIVE

M. K. & T. Ry. New Locomotive Terminal for the M. K. & T. Ry., at Oklahoma City. Ry. Rev., vol. 68, no. 26, June 25, 1921, pp. 959–966, 16 figs. Terminal includes 10-stall roundhouse, machine shop, power plant, water treating plant, reinforced-concrete coaling station, storehouse and track scale built in reclaimed land together with new cut-off line which will obviate necessity for track elevation.

TERMINALS, RAILWAY

Chicago. New Freight Terminal Nearing Completion in Chicago. Ry. Age, vol. 71, no. 2, July 9, 1921, pp. 65–69, 7 figs. Multiple-story construction and elevators are features of Chicago & Alton project.

TIDAL POWER

Utilization. Economics of Tidal Power Develop-

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Engineering Index (Continued)

ments (L'utilisation de la houille bleue et le probleme financier), R. Gouédard. Vie technique & industrielle, vol. 2, no. 21, June 1921, pp. 201–205, 5 figs. Reasons why Government should subsidize tidal power plants.

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Machine-Tool Construction. The Piece-Rate Determination in Machine Construction (Die Stücklohnbestimmung im Maschinenbau), Paul Bischoff. Werkstattstechnik, vol. 15, no. 12, June 15, 1921, pp. 345–347, 3 figs. Methods for predetermining working time on lathes, drilling machines and other machine tools.

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Thomas Automatic. Tinning Methods and Tin House Equipment, Clement F. Poppleton. Iron Age, vol. 107, no. 3, Jan. 20, 1921, pp. 187–191, 11 figs. Machine automatically feeds, pickles and polishes four plates at once. Plates travel straight forward throughout process.

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Cylindrical Fits. Tolerance Systems for Cylindrical Fits, P. M. Heldt. Automotive Industries, vol. 44, no. 24, June 16, 1921, pp. 1274–1280 and 1283, 3 figs. Discussion of systems in use.

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Organization. The Organization of Toolrooms (L'organisation de l'échange des outils dans un atelier d'outillage), M. Danty-Lafrance. Vie technique & industrielle, vol. 2, no. 21, June 1921, pp. 227–231, 2 figs. Scheme for recording distribution of tools and operations performed on them.

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Renault. Renault Now Producing Wheel Type Tractor, W. F. Bradley. Automotive Industries, vol. 44, no. 26, June 30, 1921, pp. 1417–1418, 3 figs. Wing-type model lighter than earlier machines. Built-up frame and axle with bevel and planetary reduction are employed.

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Emergency. Valves for Emergency Service, W. H. Wakeman. Power, vol. 54, no. 1, July 5, 1921, pp. 7–10, 10 figs. Typical designs.

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Spring. Belleville Spring Washers. Machy. (Lond.), vol. 18, no. 456, June 23, 1921, pp. 354–355, 1 fig. Table giving dimensions of washers of Belleville type to conform with prescribed loads and deflections.

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Industrial, Disposal of. Disposal of Industria Wastes and Stream Pollution, C. A. Emerson, Jr. Jl. Franklin Inst., vol. 191, no. 6, June 1921, pp. 807–818. Recent developments and present tendencies.

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[See also AUTOGENOUS WELDING; ELECTRIC WELDING, ARC.]

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ZINC METALLURGY

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MECHANICAL ENGINEERING

Volume 43 October, 1921 Number 10

Application of the Law of Kinematic Similitude to the Surge-Chamber Problem

By W. F. DURAND,[1] STANFORD UNIVERSITY, CAL.

The problem of the hydraulic surge chamber gives rise to certain differential equations which do not admit of solution in analytical form. Under these conditions, various modes of treatment have been proposed. The present paper develops and describes a comprehensive experimental method utilizing the law of kinematic similitude. By this method a laboratory model of convenient dimensions is set up and subjected to a program of operation corresponding to that for the field installation. The movements of water level, times, etc., as measured for the model, are then multiplied by suitable relation factors, thus giving the results to be anticipated for the field installation.

The model may thus, in a sense, be considered as a form of mechanism which solves the equations as applied to the model form, and these results multiplied by suitable relation factors give the corresponding results to be anticipated in the field case.

The principle advantages of the model method are as follows:

1 The model is simple and readily set up. Once in operation, the most varied conditions may be quickly examined, thus making possible a range of examination in detail, the extent of which would be quite impracticable by any methods of numerical computation.

2 In all analytical methods of treatment, pipe-line friction has been assumed to vary with the square of the velocity. In the model method the friction may be taken to vary with v^n, where n is usually found to be about 1.85.

3 In analytical methods the surge chamber is usually taken as uniform in cross-section. With the model, the chamber may be of any form whatever.

4 The model method is readily extended to the case of a surge chamber with spillway or to the case of multiple chambers on one pipe line.

5 The model method provides readily for the examination of periodic fluctuations in power demand, of any amplitude and any periodicity. The examination of such fluctuating programs is beyond practical reach by numerical methods.

It is assumed in what follows that the general physical phenomena of surges and of surge-chamber operation are familiar to the reader. They have been often described both in textbooks on hydraulics and in special papers on the subject, and to such sources the interested reader may refer for more complete details.[2]

The problem of the surge chamber as a problem on hydraulics gives rise to a pair of simultaneous differential equations as follows:

$$\frac{L}{g}\frac{dv}{dt} = H - y - cv^n \qquad [1]$$

$$\frac{F}{A}\frac{dy}{dt} = v_2 - v \qquad [2]$$

where L = length of conduit
v = velocity
H = head measured from datum at bottom of chamber to level of water in supply reservoir
y = height of water level in surge chamber above datum at bottom of chamber
F = cross-section area of surge chamber
A = cross-section area of conduit
c = factor such that cv^n = sum of friction and velocity heads at velocity v
n = index in expression cv^n and usually found numerically to be about 1.85.

Regarding the factor c in Equation [1] it may be noted that the sum of the velocity and friction heads would usually be represented as the sum of two terms of the form $v^2/2g + bv^m$, where m is the index of variation for frictional resistance with velocity and b is the factor connecting v^m with loss of head due to friction and depending, primarily, on length of line, mean hydraulic radius, and character of surface. It is, however, simpler to combine these two terms into one (the first is in all practical cases relatively small), and it is quite as easy to represent the sum, as derived experimentally, by a single term of the form cv^n as it is for the friction head alone by a term of the form bv^m. In any actual case, furthermore, the values of m and n would be hardly distinguishable. The value of n thus indicated is usually found to be about 1.83 or 1.85. For very rough surfaces it will approach more nearly to 2.

It should be further noted that the actual details of the transition phenomena during the period of change of load and while settling down to new conditions will depend on the character of the governor action during the same period. At least four assumptions may be made regarding the results of such action, as follows:

(*a*) A uniform rate of flow at the amount required for the new power demand under steady flow conditions
(*b*) Constant power output from the wheel
(*c*) Constant power input to the wheel
(*d*) Control valve or gates put immediately into the position corresponding to the final steady flow condition and left unchanged during the transition period.

No one of these assumptions is accurate. If we could assume the load demand to instantaneously change and then remain uniform at the new value and if we could assume the governor capable of exercising perfect and complete control, then it would, under the new conditions, maintain constant speed and hence constant power.

No governor is, however, able to operate in this ideal manner, and the load changes are not usually instantaneous followed by uniformity at the new value. Actually the load may change suddenly, followed by minor variations in settling to something approaching a uniform value. The governor is, furthermore, chasing back and forth with a time lag between speed changes and the actual operation of gate or valve mechanism. Any attempt to include governor action in the equations for the movement of the water in the surge chamber can thus be only partial at the best, and such attempt greatly complicates the resulting equations and their treatment, no matter by what method.

Equations [1] and [2] are based on assumption (*a*), that of a constant-volume flow at the rate which, under steady conditions, would serve to give the power required under the assigned new conditions of power demand, and this assumption results in such a notable simplification in the analytical expressions involved that mathematical discussion of the problem is usually based on the equations in this form.

It does not follow, however, that for the application of the law of similitude this particular assumption is the one best suited to the experimental phase of the problem. As will be shown at a later point, assumption (*d*) is by far the most convenient for experimental realization. However, the determination of the conditions for similitude and of the numerical ratios through which the various relations are expressed is quite independent of the

[1] Professor of Mechanical Engineering, Leland Stanford Junior University. Mem. Am.Soc.M.E.

[2] Trans. Am.Soc.M.E., vol. 34 (1912), p. 319; *Western Engineering*, December 1913.

Presented at the 1921 Spring Meeting of the National Academy of Sciences, Washington, D. C., but published only in brief abstract in the Proceedings.

particular assumption which may be made regarding the results of governor action on the flow conditions during the period of change. Hence, since assumption (*a*) leads to the simplest system of Equations [1] and [2], we may conveniently use these equations for the further development of the general problem, and then at a suitable point return to the question of the consequences to be anticipated from these various assumptions regarding the results of governor action during the period of change.

As treated in the literature of the subject, furthermore, the index n is usually taken as 2. This corresponds in effect to the assumption that friction loss varies as the square of the velocity—an assumption which is well known to be definitely in error. The difficulties of analytical treatment in any form are, however, so vastly increased by the assumption of a value of n such as 1.85, that the value 2 has been commonly accepted for the index of v.

The two equations with the value $n = 2$, when combined, give rise to a differential equation of the second order and second degree and containing both the first and second powers of dy/dt. This equation does not seem to admit of analytical solution, at least in terms of present known functions.

Some years ago the author made brief mention of the possibility of treatment by experimental methods making use of the principles of kinematic similitude,[1] and at a subsequent time[2] a discussion

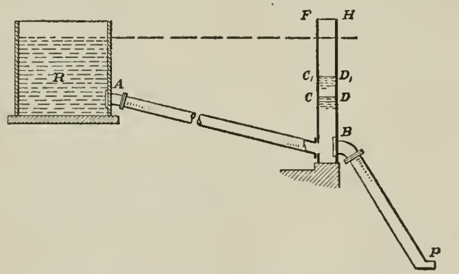

Fig. 1 Diagrammatic Representation of Reservoir, Conduit and Surge Chamber

of the problem was published covering the application of this method to the case with the index $n = 2$.

The present paper aims to generalize this mode of treatment by extension to the case with a general index n, and including likewise the possible case of two or more surge chambers connected to the same line.

It will be evident that if the equations with $n = 2$ do not admit of analytical solution, any such mode of treatment with $n = 1.85$ will be likewise and still more definitely out of the question, and if any general mode of treatment is to be found, it will needs fall under one or the other of two classes: (1) numerical, by the method of numerical quadratures, so-called; or (2) experimental, by the use of a model connected with the actual field case through the principles of kinematic similitude.[2] It is with the latter of these that the present paper deals.

Kinematic Similitude

Before attempting to develop the conditions of kinematic similitude between two cases, it is necessary first to note what is implied by this term.

To develop the idea, let Fig. 1 denote diagrammatically the characteristic elements of a given case. R denotes the reservoir supplying water through the conduit AB to a power plant at P. Let BFH denote a standpipe or surge chamber relatively near to P. Let the plant be running at a steady rate of output with a velocity of flow v_1 in AB. Then, taking the case of demanded load, let there come a sudden demand for more power and consequently more water such as would require, under steady conditions in AB, a velocity v_2. The conditions of flow in AB will, however, not permit of an immediate response. The proximity of the surge chamber

[1] Trans. Am.Soc.M.E., vol. 34 (1912), p. 319.
[2] *Western Engineering*, December 1913.

to the power house does, on the other hand, permit of prompt or sensibly immediate response and accordingly the additional amount of water required to make up the supply to the wheel, corresponding to a velocity v_2 in AB, is drawn from BFH. In consequence the level in BFH falls, occupying at a given instant of time immediately after the new power demand, some level such as CD, while the level for steady-flow conditions still remains sensibly at C_1D_1. This difference of level, the actual level lying below that for steady conditions, means the development of an accelerating head measured by the difference between these two levels. In response to this accelerating head, the velocity of flow in AB will begin to increase and such increase will continue so long as the accelerating head remains operative—that is, so long as the actual level lies below that for steady-motion conditions. In consequence the velocity v will pass gradually through a series of values on the way from v_1, the initial value, to v_2, the final value. In general, during this period the actual level will lie below the level for steady conditions with the actual velocity v, thus constituting a continuing accelerating head and in answer to which the water in AB undergoes a corresponding positive acceleration. If the conditions should be such as to bring about a gradual decrease of this accelerating head as the velocity approaches the value v_2, ultimately vanishing when $v = v_2$, then the series of transition phenomena comes to an end with this condition, and the water level remains at its new location with velocity v_2. Actually, however, these conditions are not fulfilled. When the velocity first reaches v_2 the acceleration head is still positive; that is, the actual level is below that for steady conditions with velocity v_2, and in consequence the velocity is carried on to some value greater than v_2 until finally the two levels do come together, but with a velocity $v > v_2$. This means more water is coming along AB than is required at the power plant, and in consequence the excess will be received by the surge chamber and the actual level of the water will rise above its location for steady-flow conditions, thus producing a *retarding* head and gradually reducing the velocity v from its maximum value back toward v_2 again. On reaching v_2, however, the actual level will still lie above that for steady-flow conditions, a corresponding retarding head will still be operative and the velocity will be carried beyond and below v_2 until the retarding head vanishes and becomes replaced by an accelerating head, when the velocity is again carried upward toward the value v_2. In this way there will be an indefinite number of oscillations of level about the final location and a corresponding indefinite series of oscillations of value of the accelerating head from positive to negative and back again, and a corresponding series of fluctuations of velocity above and below v_2—all of these oscillations and fluctuations of continuously diminishing amplitude, until finally they all sensibly die out together with the velocity at v_2 and the water level at the corresponding location for steady conditions.

In the case of rejected load and a sudden excess of water flowing in AB, with v_2 less than v_1 the excess water will be received by the surge chamber and will result in a rise in the actual level above that for steady-flow conditions, thus producing a retarding head. In answer to this, the velocity will become gradually *reduced* from v_1 toward v_2, passing through a series of fluctuations, with corresponding oscillations in the water level, in manner entirely similar to that for demanded load.

It will then be evident that if we should represent graphically on a time axis the essential phenomena which characterize this transition period, we should have curves as follows:

1 A time history of the movement of the actual water level CD
2 A time history of the movement of the level for steady conditions with the actual velocity v
3 A time history of the difference of these two levels, constituting in general (for demanded load) an accelerating head, and measured by the left-hand member of Equation [1]
4 A time history of the velocity v as it passes through periodic fluctuations from the initial value v_1 to the ultimate value v_2.

Suppose such a group of curves for the first part of the transition period be as represented in Fig. 2. Let us designate the physical system to which these curves correspond as system A. Now let us imagine a system B, comprising the same elements, but different

in size and proportion, and so related to A as to fulfill the following conditions:

For any time t on system A there will be a corresponding value of any one of the four characteristics above noted. Then for system B, let there be a time αt for which the value of the same characteristic will be related to the value for system A by a ratio β and where α and β are constant factors. This would mean that if curves for system B were run out similar to those for system A, then the two sets of curves would be geometrically similar, being related along the axis of abscissæ by the ratio α and along the axis of ordinates by the ratio β. It would mean, furthermore, that if the two sets of curves were plotted with suitable scale units, related for t in the relation of 1 to α and for any one of the four characteristics in the relation of 1 to the corresponding β, the two curves would become coincident. It will, of course, be understood that there will be one value of α for the time relation and two

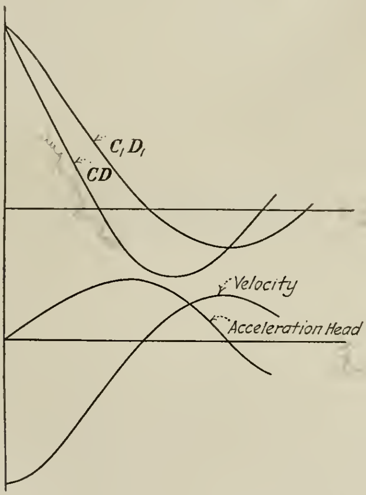

Fig. 2 Curves Representing Essential Phenomena Characterizing First Part of Transition Period

values of β, one for the three vertical dimensions or movements and one for the velocity v.

Now two systems A and B fulfilling the conditions thus indicated are said to have kinematic similitude.

It is then clear, if B, let us say, is a field case and A is of laboratory dimensions and if we can determine the coefficients α and β, that experimental observation on A will serve to determine through α and β the results to be anticipated for B.

We must next inquire as to the conditions for realizing such relation of kinematic similitude. Let us first assume that it *is* realized and by way of notation let:

p = ratio of conduit lengths = L ratio
q = ratio of the two values of c = c ratio
r = ratio of velocities = v ratio
s = ratio of the times = t ratio

Now referring to Equation [1], it has been stated (without present proof) that the expression $(L/g)(dv/dt)$ is the measure of an accelerating head; that is, the measure of the head required to produce the acceleration dv/dt. This head is, of course, a vertical dimension. Now since Equation [1] is a physical equation, it must be homogeneous in all its terms. That is, all terms must represent vertical dimensions. In fact, it is readily seen that the right-hand side of the equation is composed of members, each one of which is a vertical dimension, and the algebraic combination of which is a measure of the difference between two water levels such as CD and C_1D_1, Fig. 1, and which (as previously stated) constitutes the accelerating head.

Now suppose two such equations, one relating to system A and one to system B. Then if the conditions of similitude are fulfilled, there will subsist between the numerical values of the corresponding terms of these two equations, a constant ratio—that corresponding to vertical dimensions or vertical movements. This means specifically that the terms $(L/g)(dv/dt)$, H, y, cv^n, all represent vertical distances or movements, and that between them all, for systems A and B, there subsists the one constant ratio. If, therefore, we can determine this ratio for one, we have it for all. But with the notation assumed above, we have immediately:

$$v^n \text{ ratio} = r^n$$
$$cv^n \text{ ratio} = qr^n$$

Hence we shall have for all vertical dimensions or movements the ratio qr^n. We may denote this in general as the y ratio and have, therefore:

$$y \text{ ratio} = qr^n$$

Then since, in Equation [1], this ratio qr^n applies to each term individually, it must apply to the first term. Hence we may write:

$$\frac{L}{g}\frac{dv}{dt} \text{ ratio} = qr^n$$

But the L ratio = p, the dv ratio must equal the v ratio which is r, and the dt ratio must equal the time ratio which is s. Hence we have:

$$\frac{pr}{s} = qr^n$$

or

$$s = \frac{pr}{qr^n} = \frac{pr}{y \text{ ratio}} = \frac{p}{qr^{n-1}}$$

Again, in Equation [2], if the conditions of similitude are fullfilled, the ratio r will apply to each term individually. It must therefore apply to the first term and we may write:

$$\frac{F}{A}\frac{dy}{dt} \text{ ratio} = r$$

But the dy ratio must equal the y ratio and the dt ratio the t ratio. Hence we have:

$$\left(\frac{F}{A} \text{ ratio}\right)\left(\frac{qr^n}{s}\right) = r$$

or

$$\frac{F}{A} \text{ ratio} = \frac{rs}{y \text{ ratio}} = \frac{pr^2}{(y \text{ ratio})^2} = \frac{p}{q^2r^{2n-2}}$$

Now collecting these various ratios we have as follows:

$$L \text{ ratio} = p \quad\ldots\ldots\ldots\ldots[3]$$
$$c \text{ ratio} = q \quad\ldots\ldots\ldots\ldots[4]$$
$$v \text{ ratio} = r \quad\ldots\ldots\ldots\ldots[5]$$
$$H,y \text{ ratio} = qr^n \quad\ldots\ldots\ldots\ldots[6]$$
$$t \text{ ratio} = s = \frac{pr}{y \text{ ratio}} = \frac{p}{qr^{n-1}}\ldots\ldots\ldots\ldots[7]$$
$$\frac{F}{A} \text{ ratio} = \frac{rs}{y \text{ ratio}} = \frac{pr^2}{(y \text{ ratio})^2} = \frac{p}{q^2r^{2n-2}}\ldots\ldots\ldots\ldots[8]$$

and to which we may add:

$$F \text{ ratio} = (A \text{ ratio})\frac{pr^2}{(y \text{ ratio})^2} \text{ or } (A \text{ ratio})\frac{p}{q^2r^{2n-2}}\ldots\ldots[9]$$

or

$$D \text{ ratio} = (d \text{ ratio})\frac{p^{1/2}r}{y \text{ ratio}} \text{ or } (d \text{ ratio})\frac{p^{1/2}}{qr^{n-1}}\ldots\ldots\ldots[10]$$

$$V \text{ ratio} = (F \text{ ratio})(y \text{ ratio}) = (A \text{ ratio})\frac{pr^{2-n}}{q}\ldots\ldots[11]$$

where D = diameter of surge chamber (assumed circular)
d = diameter of conduit line (assumed circular)
V = volume movement in surge chamber.

We have thus assumed the existence of various structural ratios, of a velocity ratio and of a time ratio, and have derived the relations among these ratios necessary in order that the conditions of homogeneity among the terms of any one equation may be realized.

Suppose now the two systems A and B set up in accordance with these various structural relations. It is then readily seen that we may choose initial conditions of operation which will fulfill

the required relations throughout. That is, at the initial conditions, the requirements for kinematic similitude may be fulfilled by arbitrary adjustment. It is then readily shown that under these conditions the increments of y and v will likewise fulfill the relations for similitude, and hence the succession of values of y and v throughout the entire period of transition.

It thus results with two such systems A and B, with structural relations as specified and for which the water movements are in accordance with Equations [1] and [2], that if the conditions of similitude are fulfilled at the beginning of the movement, they will likewise be fulfilled for subsequent times throughout the movement and thus the general conditions for similitude will be realized as assumed.

Form of Relations for Similitude when $n = 2$

It will next be of interest to note the form taken by these relations if the index n is taken equal to 2, as in the more common methods of treatment of the problem. Referring to [6]–[11], we shall have—

$$y \text{ ratio} = qr^2$$

$$\text{Time ratio } s = \frac{p}{qr}$$

$$\frac{F}{A} \text{ ratio} = \frac{p}{q^2r^2}$$

$$F \text{ ratio} = (A \text{ ratio}) \frac{p}{q^2r^2}$$

$$D \text{ ratio} = (d \text{ ratio}) \frac{p^{1/2}}{qr}$$

$$V \text{ ratio} = (A \text{ ratio}) \frac{p}{q}$$

Surge Chamber with Spillway

A case possessing both interest and importance is presented by a surge chamber fitted with an overflow weir or spillway at a certain fixed height.

Let B = length of such spillway or weir

y_0 = height from datum to level of spillway edge

y = height from datum to surface of water

Then $y - y_0$ = depth of water on weir.

In time dt let the water level rise dy

In time dt the flow along conduit line $= vAdt$

In time dt the discharge over the weir $= QB\,(y - y_0)^{3/2}\,dt$

In this formula for weir discharge Q is taken as containing all factors other than B and $(y - y_0)$

We have then—

$$vAdt = Fdy + QB\,(y - y_0)^{3/2}\,dt \quad \text{[12]}$$

or

$$vA = F\frac{dy}{dt} + QB\,(y - y_0)^{3/2} \quad \text{[13]}$$

This equation together with [1] for the acceleration head will serve instead of [2] to determine the motion of the water level after the water reaches and rises above the weir edge.

To apply the principles of similitude to this case we must assume the weir coefficient Q the same for both weirs, field case and experimental set-up. We then note that each term of [13] is a quantity of the order of volume flow. Hence for similitude we must have the same ratio between the two systems A and B for each member of the equation. Thus we have:

$$vA \text{ ratio} = r\,(A \text{ ratio})$$

$$F\frac{dy}{dt} \text{ ratio} = F \text{ ratio} \times y \text{ ratio} \div t \text{ ratio}$$

or reducing,

$$F\frac{dy}{dt} \text{ ratio} = r(A \text{ ratio})$$

whence

$$[QB\,(y - y_0)^{3/2}] \text{ ratio} = r\,(A \text{ ratio})$$

and

$$B \text{ ratio} = \frac{r\,(A \text{ ratio})}{(y \text{ ratio})^{3/2}} = \frac{A \text{ ratio}}{q^{3/2}r^{3/2n-1}} \quad \text{[14]}$$

If in this case we assume the index $n = 2$ we shall have—

$$B \text{ ratio} = \frac{A \text{ ratio}}{q^{3/2}r^2} = \frac{A \text{ ratio}}{q^{1/2}(y \text{ ratio})} \quad \text{[15]}$$

The volume of water discharged over the weir will be given by the expression—

$$V = QB \int (y - y_0)^{3/2}\,dt \quad \text{[16]}$$

We have then—

V ratio = product of individual ratios for expressions making up V as in [16] hence—

$$V \text{ ratio} = \frac{A \text{ ratio}}{q^{3/2}r^{3/2n-1}}\,q^{3/2}r^{3n/2}\,\frac{p}{qr^{n-1}} = (A \text{ ratio})\,\frac{pr^{2-n}}{q}$$

and for $r = 2$,

$$V \text{ ratio} = (A \text{ ratio})\,\frac{p}{q}$$

This is seen to be the same as the volume ratio for change of volume in the surge chamber, as indeed it should be.

Case with Multiple Surge Chambers

The case with two surge chambers is indicated in Fig. 3 as a

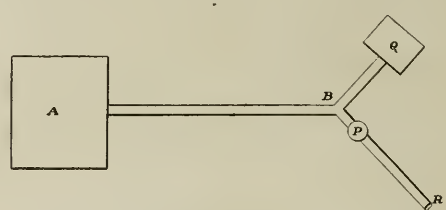

Fig. 3 Diagram of the Case of Two Surge Chambers

plan view. The main supply reservoir is at A, a small regulating reservoir at Q and a surge chamber of usual dimensions at P with the power plant lying beyond at R. With such an arrangement the reservoir Q functions as a large surge chamber, thus complicating the problem as affecting the movement of water in P.

With this combination of elements a disturbance from the conditions of steady flow involves, physically, the problem of three superimposed oscillatory systems; one by way of ABQ, one by way of ABP and one by way of PBQ. To define these conditions, six equations are required as follows:

$$\text{Motion in } AB, \quad \frac{L_1}{g}\frac{dv_1}{dt} = H - z - c_1v_1^n$$

$$\text{Motion in } BP, \quad \frac{L_2}{g}\frac{dv_2}{dt} = z - y_2 - c_2v_2^n$$

$$\text{Motion in } BQ, \quad \frac{L_3}{g}\frac{dv_3}{dt} = z - y_3 - c_3v_3^n$$

$$\text{Continuity at } B, \quad A_1v_1 - A_3v_3 = A_2v_2$$

$$\text{Continuity at } P, \quad A_2v_2 - F_2\frac{dy_2}{dt} = A_1u$$

$$\text{Continuity at } Q, \quad + F_3\frac{dy_3}{dt} = A_3v_3$$

where L_1, v_1, A_1, c_1 = respectively length, velocity, area and coefficient c for AB

L_2, v_2, A_2, c_2 = respectively length, velocity, area and coefficient c for BP

L_3, v_3, A_3, c_3 = respectively length, velocity, area and coefficient c for BQ

H = total static head from top of reservoir at A to datum at bottom of P

z = pressure head at junction B measured from datum at bottom of P

y_2 = level of water in P measured from datum at bottom of P

y_3 = level of water in Q measured from datum at bottom of P

u = velocity in AB corresponds to new demand in R.

In these equations as written, the positive directions of flow are taken as AB, BQ, BP.

Equations of this character and number are quite beyond the range of any practicable mode of mathematical attack, even by way of numerical integration. The methods by way of similitude hold, however, as with the simpler cases, and the model once set up, any condition of operation is readily examined. In setting up the model it is only necessary to use a uniform ratio of length and of diameter or area of conduit. These ratios together with the velocity ratio will then fix the ratio for all vertical distances for time and for the cross-section area of surge chamber.

For a case with more than two chambers the same general principles hold, and any such case may be examined by experimental methods through the use of a model set up with ratios as above. Such cases, however, are not likely to be met with in practice.

For the case of Johnson's differential regulator[1] the same fundamental equations, with suitable interpretation, apply as for the plain open chamber, and under these conditions the ratios and relations will be the same and the performance in detail may be investigated by means of the model method.

Special Notes on Application of Method

In the application of these methods it should be noted that the assumption of a uniform value of the ratio q does not imply the assumption of the same values of friction coefficient for large and for small pipe. It simply implies that for the large pipe the velocity-friction head may be put in the form cv^n, the value of c being constant over the range of velocity involved, and likewise that the similar head for the small pipe may be expressed in the same form, this value of c likewise being constant over the velocity range involved. The ratio between the two values of c will then be the constant q of the formulas.

Also it should be noted that in cases of design the c for the field case will usually be the subject of estimate based on judgment. This, however, is required for any computations or estimates regarding velocity of flow, capacity of line, power, etc., and the one estimate as to friction head will serve uniformly for these varied purposes. On the other hand, the value of c for the experimental model is a matter of direct measurement and in all cases should be so determined. A series of simple measurements of flow, time and drop in level between reservoir and surge chamber will serve as a basis for this determination for the model. Such observations plotted on logarithmic paper provide then a ready means for the determination of the values of c and n for the model, and this value of c compared with the assumed c (with the same n) for the field case will give the value of q as noted above.

Surge Chamber Non-Uniform in Cross-Section Area. It should be especially noted that with the experimental method, the surge chamber is not necessarily of uniform cross-section area. It may be tapering or of any form at will, so long as the model is made of corresponding dimensions. It should also be noted that the ratios of horizontal and of vertical dimensions are not in general the same. The result will therefore be geometrical similarity between the model and full-sized installation, but not the same proportions between horizontal and vertical dimensions.

It is simply necessary that, at corresponding vertical dimensions as determined by one ratio, the horizontal dimensions are also similar, as determined by the other ratio. This is further illustrated by Fig. 4 showing the relative proportions for a full-sized and a model surge chamber, the former as installed on the line of the Los Angles Aqueduct Power System.

Governor Action. At an earlier point in the paper, reference has been made to the various assumptions which may be made regarding the results of governor action during the period of change and to the fact that no assumption which can be made in precise terms will represent the real program in an actual case. Due to the relative simplicity of the equations resulting, however, assumption (a) was implied in deriving the basic Equations [1] and [2].

It should again be especially noted that no matter which of these assumptions may be made, the ratios for similitude remain unchanged. Equations of the type of [1] remain the same, while equations of the type of [2] remain the same in form with the substitution for v_2 of a velocity u in AB, suited to the particular assumptions made.

With (a), v_2 as already noted is the velocity in AB necessary to give, under final steady-flow conditions, the power required under the changed conditions.

With (b), for v_2 we must substitute a velocity u defined as the velocity in AB which would bring the water required to meet the new power requirements under the momentarily changing values of available head and the efficiency of the wheel.

With (c), the velocity u is defined the same as in (b), with the omission of the influence due to variation in efficiency of wheel.

With (d), the velocity u is defined as that corresponding to the total flow through the valve, set as specified, and with the momentarily changing value of the available head as affected by the changing level in the surge chamber.

In all of these cases the term v_2 or u is a velocity and the ratios for similitude remain the same, being unaffected by these various assumptions.

It therefore becomes a question of interest as to which of these four assumptions can be most easily realized in the manipulation of a model.

It is readily seen that assumption (d) most readily meets the requirements. For any specified power development it is a simple

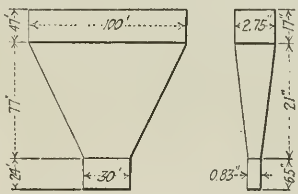

Fig. 4 Relative Proportions for a Full-Sized and Model Surge Chamber

matter to determine the volume flow required under the head corresponding to such flow. To realize the corresponding condition with the model requires simply the setting of a control valve at P, Fig. 1, in accordance with a previously determined calibration.

On the other hand, if any of the other assumptions is to be fulfilled by model, the rates of volume flow corresponding to the special conditions must be determined and the setting of the control valve determined therefrom, taking into account the height of the water in the surge chamber. The valve setting will thus depend on such height and hence the valve will require adjustment continuously during the period of transition, corresponding to the rise and fall of the water in the surge chamber.

As a manipulative program it is entirely possible to realize this through the use of a cam form of control, the movement of the cam being determined in step with the movement of the water in the chamber. Such a program of control is, however, somewhat complex in character and adds in marked degree to the time required for making and assembling the model equipment.

In order, therefore, to realize in the highest degree the advantages of the model method, it is desirable to accept assumption (d) as representing with a sufficient degree of approximation the operative conditions of the plant. An examination of the conditions of operation of a power plant will serve to show, furthermore, that with supposition (d) as compared with either (a), (b) or (c), the resulting conditions as regards surge are more severe and hence that the error will be on the side of safety. It is also evident that the influence of the variation of level of the water in the surge chamber on the general program of volume discharge or of power developed at the power house will be relatively small as the range of such fluctuation is small compared with the difference in level between water in surge chamber and power house and relatively large in the inverse case.

The whole question of the use of a model for the study of such problems turns therefore largely on the degree of closeness to which the manipulation of the model may be made to represent the proposed programs of change in the field installation, and more specifically in the actual power plant; or again on the extent to which the simple model program as indicated in asumption (d) may be

[1] Trans. Am.Soc.M.E., vol. 30, p. 457.

accepted as satisfactory for the purposes in view. As indicated above, it appears that, in all cases where the range of fluctuation of the water level in the surge chamber is small compared with the difference in level between surge chamber and power house, the simple program of (*d*) may be accepted as satisfactory for all practical purposes. If such fluctuation should, on the contrary, be large, the use of the model would presumably require such further devices as would make possible a closer approximation of the program of water flow in the model outlet to the actual or proposed program in the power house.

A further point should be here noted, and that is that the model proper in its correspondence with the field case covers only the main supply line and the surge chamber. It does not necessarily extend to the line from the surge chamber to power house. In the model the line from surge chamber to discharge valve may be considered simply as a means for realizing a desired discharge through the setting of a calibrated valve. From this view, therefore, it is simply necessary to have such size of line and such head as shall insure, through the discharge valve, the rates of flow covering the ranges contemplated. At the same time it is generally desirable to give to this discharge line a vertical dimension not widely dissimilar from that corresponding to the field case, in order that the range of fluctuation of the level in the surge chamber may bear to the difference in level between the surge chamber and power plant approximately the same ratio in both model and field cases.

Special Programs of Change. In addition to the usual problem as presented by a sudden change in power demand followed by substantially uniform conditions, the model method readily serves for the examination of two types of problem, neither of which is practically susceptible of treatment through computation methods. These are as follows:

1 Required the cumulative result of periodic changes of any specified magnitude and with any specified frequency. Thus for illustration, we might have a proposed program of additions to the load, each of 10 per cent total load, and with specified intervals. If the latter should be such as to bring the load changes into approximate synchronism with the surge-chamber movements, the cumulative results might become very serious; while otherwise the resultant movement would be relatively small. Again, we might have the condition of a surging load, alternate increase and decrease and with any proposed frequency. This again, if in approximate synchronism with the surge-chamber movements, may result in the most extreme and serious conditions in the latter.

All such problems are most readily examined by the model. It becomes necessary simply to determine the change of flow corresponding to the proposed change in power and to note the corresponding settings of the control valve. Then with the corresponding time interval known, it is simply a matter of manipulative procedure of the control valve, with corresponding note of the resultant movement of the water in the surge chamber. In this general manner the results of all forms of varied or periodic programs of change in power demand, or of flow in general, are readily examined.

2 Required the time over which a specified power change should be extended in order that the resultant surge-chamber movement may not exceed a specified amount. Thus with a proposed size of surge chamber in a given case, a sudden change of 80 per cent or of 100 per cent of the load, for example, will perhaps produce a surge-chamber movement resulting in extreme overflow at top, or in the indraft of air at the bottom. In either case it may be desired to determine the necessary duration of a specified load change in order that the surge-chamber movement may not exceed specified limits. As a manipulative program this calls simply for the movement of the control valve between specified stops gradually at an approximately uniform rate and involving such total time interval as will meet the requirements within the surge chamber. Experience of the writer shows that this is readily realized by successive trials, and that, as a problem in manipulation, it presents no serious difficulties whatever. The time interval for the model, thus determined, is then to be multiplied by the time ratio, thus giving the required time for the field installation.

Experimental Detail. The experimental program, in general, connected with an investigation of this character is simple and may safely be left to the initiative of the interested reader. A few suggestions on particular points may, however, be acceptable.

The control valve is preferably of the cone or needle type with long taper, so that a considerable stem movement will be required between closed and full open. The stem may be controlled by hand lever or otherwise as most convenient, with, in any case, an index moving over a graduated scale. The valve may then be calibrated for steady-motion discharge or velocity by simultaneous observations of valve setting and weight of water discharged in a given time. Observation of the height of water in the surge chamber for each of these settings furnishes likewise data for a series of values of the friction-velocity head, cv^n, for the model. A carefully drawn curve between discharge and cv^n will then furnish a ready means of determining discharge by a reading of water level in the surge chamber. From this point on, the valve settings should be used simply to realize approximately the conditions desired, the actual velocity or discharge being taken as that corresponding to the water level in the surge chamber under steady flow conditions.

For reading the movement of the water in the surge chamber, either a float with stem or a gage glass on the side may be employed. With the latter there is time lag and some correction may be required. The author has found the former method the preferable The stem may be furnished with an index moving in front of a suitable scale and with all usual proportions the movement is slow enough to readily permit the reading of maximum and minimum points.

Illustrative Problems

I—Suppose an actual case characterized by the following data:

Length of conduit, ft	20,000
Diameter of conduit (assumed circular), ft	10
Upper velocity, ft. per sec	10
Friction-velocity head at 10 ft. per sec. velocity (assumed), ft	50
Proposed diameter of surge chamber, ft	36

Suppose now that we propose to use for the model conduit 50 ft. of pipe 2 in. in diameter and that we select arbitrarily a velocity ratio of 2.5. Suppose further that with this pipe set up we find experimentally $n = 1.85$ and $c = 0.1695$.

Then assuming the same value of n, we find for the field case $c = 0.706$. We have then—

$p = 20{,}000 \div 50$	$= 400$
$q = 0.706 \div 0.1695$	$= 4.17$
r	$= 2.5$
r^n	$= 5.45$
y ratio	$= 22.72$
t ratio	$= 44.0$
D ratio	$= 132.0$
$D = 432 \div 132$	$= 3.27$ in.

If then we set up the model in accordance with these dimensions, we have only to carry out the program of velocity change corresponding to the proposed field program, observe vertical movements and times, multiply the former by 22.72 and the latter by 44.0 and we shall have the vertical movements and times to be anticipated in the field case.

II—Suppose that it is proposed to fit the actual chamber with a spillway 10 ft. wide with edge 6 ft. above static level in supply reservoir. What will be the width and location of the model spillway?

The edge will be located at a height above static level in the supply reservoir measured by $6 \times 12 \div 22.72 = 3.17$ in. The width ratio from [14] is 82.9, hence the width is $10 \times 12 \div 82.9 = 1.45$ in.

III—As a further example drawn from actual practice, reference may be made to Fig. 2 with dimensions as follows:

$$AB = 14{,}000\,f \qquad d_1 = 11.25\,f \qquad d_3 = 11.25\,f$$
$$BQ = 1{,}191\,f \qquad d_2 = 10.10\,f \qquad D = 35.00\,f$$
$$BP = 137\,f$$

where d, d_2, and d_3 refer respectively to AB, BQ and BP.

The area of Q varied with elevation from 120,000 to 150,000 sq. ft., constituting a small regulating reservoir. The following proportions and dimensions were taken for the model:

$$p = 240 \qquad \text{also } d_1 = 1.5 \text{ in.}$$
$$\text{hence } AB = 58.23\,f \qquad d_2 = 1.342 \text{ in.}$$

$BQ = 4.96 f$ $d_3 = 1.5$ in.
$BP = 0.57 f$ $r = 3$

By experiment c and n for the model were found to be 0.195 and 1.823.

By estimate, for the field case, c with the same value of n was taken as 0.421.

This gives $q = 2.16$ and y ratio $= qr^n = 16.00$.

We then find from the proper formulas—

$$t \text{ ratio} = 45$$
$$F \text{ ratio} = 68{,}200$$

This gives F for model = 2.04 sq. in. which corresponds to a circular chamber of diameter 1.60 in.

The same F ratio determines also the model reservoir. This was made as a wooden box with sloping sides, so adjusted as to give, over the possible range of change of level, the proper values of surface area.

The pipe of equivalent diameter 1.342 in. was made by filling in a segment of a 1.5-in. pipe to a point giving the proper area.

This combination of elements, with a suitable discharge valve, completed the set-up of the model. The investigation made possible by this model covered the entire range of flow from closure up to the full flow of 1000 sec-ft. and in both directions, demanded and rejected load. These results are shown graphically in Figs. 5 and 6. Fig. 5 relates to the combination of surge chamber and reservoir, while Fig. 6 refers to the surge chamber in operation alone, the reservoir being shut off.

For the conditions of Fig. 5 the diagram shows the maximum water movement (for the field installation) for the first swing following any sudden change of load in either direction. The vertical scale gives elevation in feet, and the horizontal scale flow of water in second-feet.

The heavy-line curve shows the level of water for steady con-

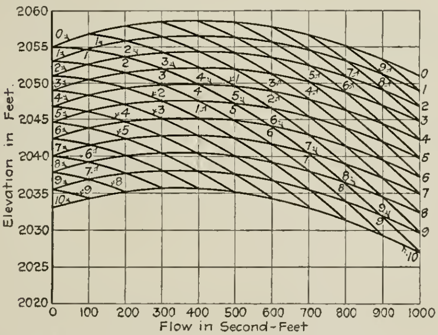

Fig. 5 Flow to be Anticipated with Sudden Change in Either Direction from Any Initial Load V_1 to Any Final Load V_2
(Surge chamber in combination with auxiliary reservoir.)

ditions for flow varying from 0 to 1000 sec-ft. The diagram shows two sets of curves:

1 Curves running clear across the sheet from left to right and crossing the heavy-line curve.

2 Curves approximately parallel to the heavy-line curve and trending, therefore, downward to the right.

Any problem involves two values of the flow—the initial flow V_1 and the final flow V_2.

To determine the surge movement for demanded load, go to point V_1 on the heavy curve and drop vertically to that curve of set 1 which cuts the heavy curve at V_2. The point thus indicated will give the water level for the first surge. If V_2 falls between the curves as plotted, the interpolated value is easily read.

Or again, with the plant in operation under flow V_1, let there be a sudden demand for an *additional* flow V. In this case we may find $V_2 = V_1 + V$ and proceed as above, or otherwise we may go to V_1 on the heavy curve and then drop vertically to that curve of set 2 corresponding to the additional flow V. The point thus indicated will give the extreme level reached.

In the case of rejected load, the operation is entirely similar except that the curves lying to the right and above the heavy line are to be employed.

In Fig. 6 for the surge chamber alone, the manner of plotting and method of use are the same as for Fig. 5.

These diagrams thus give graphically the results to be anticipated with a sudden change in either direction from any initial load V_1 to any final load V_2 and for the surge chamber either alone or in combination with the auxiliary reservoir. The influence of the latter in reducing the extent of the surge is thus brought out in a striking manner.

It is perhaps unnecessary to add that the numerical work re-

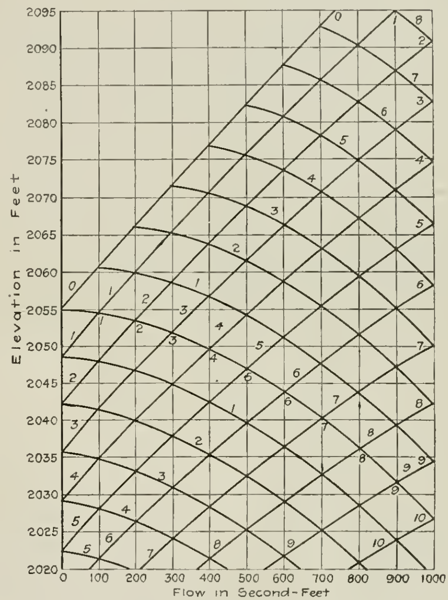

Fig. 6 Flow to be Anticipated with Sudden Change in Either Direction from Any Initial Load V_1 to Any Final Load V_2
(Surge chamber alone.)

quired to derive corresponding results from the six different equations applying to this case would be entirely prohibitive from a practical viewpoint, and if any investigation is to be made of a case of this character, the experimental model method, using the law of kinematic similitude, as herein set forth, seems to be the only recourse available.

A 68,750-hp. hydroelectric plant has been installed on the west coast of India by the Tata Hydro-Electric Power Supply Company. Each of the five main Pelton-type turbines comprising the initial installation has a capacity of 13,750 hp. The head is approximately 1700 ft. and the speed 300 r.p.m. The generators, which are direct-connected, are rated at 10,000 kva. and operate at 50 cycles, 6000 volts, three-phase. On account of the climate the extremely high average air temperature of 113 deg. fahr. had to be allowed for in the generator design, so that the 10,000-kva. units installed would, it is estimated, be capable of delivering 16,000 kva. in a more temperate climate. In spite of this condition, however, the generators are said to have shown an efficiency of 95.8 per cent. The long dry spells make water storage necessary, and three large lakes have been made at an elevation of about 1700 ft. above sea level. Power will be delivered at 100,000 volts over a 239-mile line to Bombay, where a large part of it will be used in the cotton mills there. The tailwater will be diverted into canals and will be used for irrigation purposes during the dry season.—*Power*, September 6, 1921.

Requirements in the Design of Steam Power Stations for Hydraulic Relay

The Flow or Head Deficiency Type of Relay—Effect of Growth of Load, Seasonal Variation of Flow and Pondage—Relay Stations for Minimum Flow Development and for Higher-Load-Factor Conditions—The Emergency Reserve Type of Relay

By E. B. Powell,[1] Boston, Mass.

SUPPLEMENTAL power in some form is an essential to the commercial development of our remaining unused eastern water powers and, with the possible exception of the Niagara-St. Lawrence system, an essential to the further development of such of these water powers as are now utilized in part. The nature and extent of this supplemental, or relay, power will be governed in a large measure by the character of the stream and the amount, character and location of the load and the importance of continuity in power supply.

In many instances the required relay, at least sufficient for the initial development, may advantageously be provided in the stream itself by adding reservoirs, or merely pondage, to give some artificial control of the flow. In other instances the electrical interconnection of water-power systems, so pooling the water resources of dissimilar streams, may also afford sufficient initial relay in hydraulic power. In general, however, the fullest commercial utilization of water power can only be had by the aid of independent

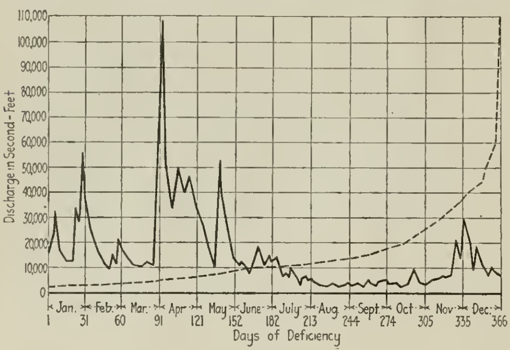

Fig. 1 Daily Hydrograph and Deficiency Curve for 1916, Hudson River at Troy Dam, New York

relay, which in the greater part of the country today is most satisfactorily and economically provided in the steam power station.

The capacity and design of such a relay station should be decided as closely as may be by the particular functions it is intended to perform. The functions of the relay, while they may vary widely, are of two general types, flow or head deficiency make-up and emergency reserve, the second being supplemental to the first. For either type of service the capacity required in any particular case will depend upon the amount and characteristics, initial and prospective, both of hydraulic development and of load. The design, while broadly determined by the usual factors, such as location, power market, water and fuel supplies, fuel costs, which control in the case of the independent central station, is in general, on account of the commonly low load factor, less dependent upon considerations of operating economy. On the other hand, character of load and dependability of delivered hydraulic power are factors of prime importance and, for proper realization of the economic possibilities of the development as a whole, the design should also be governed in many important features by the characteristics of the hydraulic development and the relation of that development to the load.

The Flow or Head Deficiency Type of Relay

Considering first the station intended solely to make up the power deficiencies of the hydraulic development, its functions may include any one or more of the following: seasonal operation to make up deficiencies in hydraulic power from low water or flood; absorption of load growth between stages of hydraulic development; operation as the main source of power. As reflected in the functions of the relay station and as affecting its design, hydraulic developments may be grouped as of four general classes:

I Minimum Flow Development. Developed hydraulic capacity equal to or exceeding maximum system load. Resultant minimum available flow only slightly, and for brief period in the year, below corresponding load requirements. Reserve provided in hydraulic station.

II Medium Flow Development. Developed hydraulic capacity equal to or exceeding maximum system load. Resultant minimum available flow below load requirements for considerable period, 40 per cent or more, of the year. Reserve provided in hydraulic station.

III Continual Relay Development. Available hydraulic capacity slightly below system load requirements throughout greater part of the year.

IV Supplemental Development. Hydraulic development merely an adjunct to the steam power station, which carries the bulk of the load.

The type of reserve referred to in Classes I and II is for relay against failure of equipment within the hydraulic station itself. Under the conditions outlined, this reserve may often advantageously be installed as part of the hydraulic station rather than in the steam station. As is well known, from 50 to 75 per cent of the cost of the average hydraulic development is fixed and independent of the capacity installed, so that sufficient capacity for this type of reserve may frequently be included at comparatively low unit cost.

Effect of Growth of Load. It will usually be found that the conditions represented by Classes I, II, and III are merely stages in approach to those of Class IV. This is especially true in the East. However, the change in relative status of the hydraulic and steam power stations may be very slow, particularly so where a series of hydraulic developments may be brought in successively, as warranted by load conditions; in which case to pass beyond the conditions of Class II may require a matter of decades. For these reasons the entire project should be studied broadly in the beginning both as to the ultimate physical possibilities and limitations of the hydraulic development, or developments, and as to the character and probable growth of the market for power. Neglect of such basic analysis in the initial planning of the development risks serious financial loss either in investment or in operating costs.

Seasonal Variation of Flow. The seasonal flow of the Hudson River in New York is so variable that the hydrographs of two successive years, 1915 and 1916, with their corresponding deficiency curves may be used in illustrating developments of all four of the classes just referred to. In Fig. 1 it will be seen that if this hydrograph is assumed to represent the year of minimum flow for a particular stream and if a flow of about 3000 sec-ft. would supply the maximum power requirement, a development providing proper equipment reserve at this flow would approximate the conditions of Class I. If growth of load raises the daily power demand above the capacity of the available minimum stream flow and this growth of load is accompanied by a corresponding increase of generating capacity of the hydraulic station to utilize, say, 8000 sec-ft.

[1] Consulting Engineer, Stone & Webster, Inc.

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with proper reserve, the conditions become those of Class II. Turning to Fig. 2, development of the hydraulic plant to utilize a flow of, say, 10,000 sec-ft. to 12,000 sec-ft. with daily load demands somewhat in excess of the mean available flow, would give the conditions of relay service under Class III. Continued growth of load with a single hydraulic development as applied to either type of stream flow will ultimately bring about the conditions of Class IV.

Reservoir Storage and Pondage. Of course, in the case of many streams, it would be feasible to provide sufficient reservoir storage to smooth out the stream flow to a very material extent, thus raising the minimum or primary capacity of the potential development beyond the maximum load demauds considered above under Classes I and II at least, and possibly beyond that considered under Class III. For purposes of the present discussion, however, reservoir storage, as distinct from pondage in the usual sense, will not be further considered.

The effect of pondage upon the relay station requirements may be judged from reference to Fig. 3, which shows a typical manufacturing-town load with the "per cent load" curve superimposed for convenience of interpretation. If the minimum flow is assumed equivalent to 50 per cent of the day's energy requirement, with full 24-hour pondage provided, the hydraulic station could take off the upper 70 per cent of the demand, permitting the relay station to carry the base load at a daily load factor approximating 90 per cent with a demand only 30 per cent of the total. On the other hand, in the absence of pondage the relay station must be designed to carry about 75 per cent of the total demand, and on this basis its daily load factor would be reduced to about 40 per cent. It is apparent that, in the absence of pondage, higher capacity will in general be required in the relay station, and the relay-station load factors, both daily and annual, will tend to lower values than where full pondage is provided.

Relay Station for Minimum Flow Development

Referring again to Fig. 1, it will be seen from the deficiency

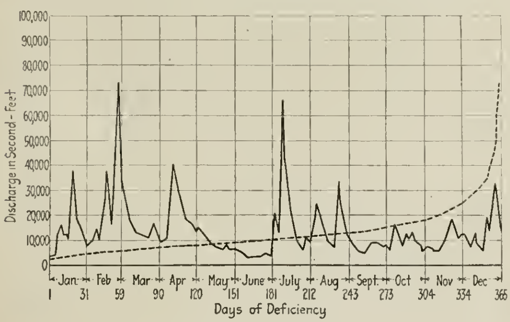

Fig. 2 Daily Hydrograph and Deficiency Curve for 1915, Hudson River Troy Dam, New York

curve that if the maximum load demand is within the capacity of the 3000-sec-ft. flow which is the developed capacity considered for Class I, the relay station except for conditions of equipment failure should not be called upon for operation in excess of 5 per cent of the year. It is not uncommon for relay stations under such conditions to stand idle an entire year. Obviously, for service of this character the actual operating economy of the relay station is of relatively small moment. The important considerations are low fixed costs and dependability.

As the load demands increase and the operating conditions for the relay station approach those of Class II, steam-power production costs are of slightly greater moment but in general are still tremendously outweighed by fixed charges and other costs independent of production. Usually it is only when the conditions of Class III are reached that the annual load factor of the relay station has risen to a value sufficient to make fuel economy as such an important factor in design.

For the extremely low load-factor conditions of Class I, type of equipment, dimensions and arrangement must all be studied with a view to attaining the desired output with minimum investment compatible with simplicity of station and low cost of attendance. Type of combustion equipment and the arrangement of furnace must of course be governed by the character of fuel available.

Coal in its more ordinary form will in general be the most satisfactory fuel. The stoking equipment should be of the forced-draft type for high capacity, either underfeed or chain grate, depending upon the class of coal. Draft facilities should be designed to take care of the maximum rate of combustion that can safely be maintained by furnace and grate over the period of peak load on the station. Economizers cannot be justified for the conditions of Class I, but it may be advisable to make provisions

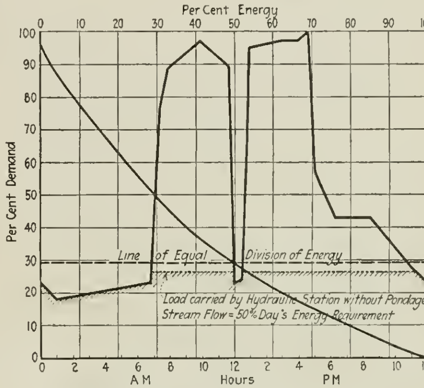

Fig. 3 Typical Manufacturing-Town Load
(24-hour load factor, 53 per cent.)

for their later installation to meet higher-load-factor conditions in the future.

The selection of type and size of boiler, decision as to total rated boiler capacity to be installed, and the proportioning of combustion equipment to boiler heating surface must take into account not merely the cost of that equipment only, but also the costs of building and all related equipment such as fuel- and ash-handling facilities, and mechanical draft. The cost curve of Fig. 4 shows that, for the particular case considered, when all related factors are taken into account boiler heating surface may be installed to the comparatively high ratio to grate area of 50 : 1 without appreciable increase of total boiler-plant cost. Higher ratios are accompanied by some increase of cost. The use of a lower ratio will result in needless waste of fuel.

Equally broad considerations should be applied to the design and proportioning of the condensing equipment. Considering the net increment cost of the boiler plant per unit of effective steam capacity and the increment cost of condensing plant for unit change of vacuum at the turbine exhaust, the condensing equipment should be designed to give the degree of vacuum under conditions of the required maximum load which will result in the lowest construction cost for the plant as a whole. In Fig. 5, which deals with a particular set of conditions, curve A shows the relative construction costs for condensing equipment to attain different degrees of vacuum, the cost of the 29-in. design being taken as 100 per cent; curve B, drawn to the same scale, the increase in boiler-plant cost resulting from the increased total steam demand which is had from different degrees of vacuum less than 29 in.; and curve C, which is a summation of A and B, still expressed in terms of 29-in. condensing-plant cost, the resultant effect upon total station cost, of designing the plant for different degrees of vacuum.

These two charts, Figs. 4 and 5, are correct, as to detail, for the particular conditions only for which they were estimated, but they clearly illustrate the interdependence of equipment costs and the importance of taking all related factors into account in deciding upon the type and size of apparatus. Similar considerations should be applied to the selection of generating units and to the determination of steam presssure and temperature.

Instrument equipment for mechanical apparatus such as boilers and condensers should be complete in so far as required as guides to efficient combustion and to the attainment of the highest degree of vacuum of which the condensing apparatus is capable; not that efficiency in the sense of low fuel rate is of special importance in this service, but that it is an essential to the attainment of maximum output from the major equipment installed which is the prime purpose of the station design.

It will usually be found advantageous to provide electric drive for one complete set of essential auxiliaries to permit starting these without waiting for steam. The main electrical features

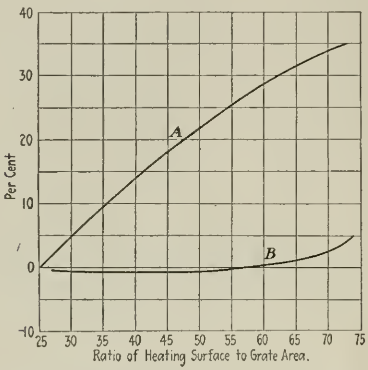

Fig. 4 Boiler-Plant Construction Cost and Capacity as Affected by Ratio of Boiler Heating Surface to Grate Area

A—Increase of steam capacity per sq. ft. of grate area
B—Difference in cost of boiler plant per unit of steam capacity
(Costs and capacities expressed as percentages based on ratio of boiler heating surface to grate area of 25:1 for a particular case.)

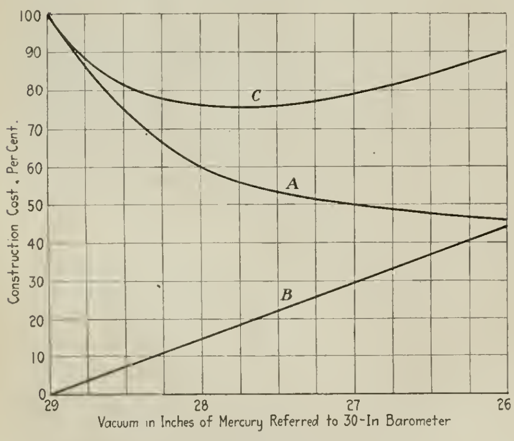

Fig. 5 Relay Station Construction Costs as Affected by Capacity of Condensing Equipment

A—Cost of condensing equipment
B—Increase in cost of boiler plant
C—Resultant effect upon total station cost
(All costs expressed as percentages based on cost of condensing equipment designed for 29 in. vacuum and 70 deg. cooling water for a particular case.)

of the relay station for the Class I conditions will be governed largely by the relation of the station to the rest of the system, provision being made to compensate for line or load characteristics wherever required.

Relay Station for Higher-Load-Factor Conditions

As the system load grows, if the period of relay-station operation is permanently lengthened, taking the development into the conditions of Class II for example, the higher load factor on which it may be possible to operate any new equipment may justify greater consideration of actual operating economy, condensing equipment may be of more liberal design, and boiler capacity may be added in greater ratio to steam demand, so permitting reduction of combustion rates.

Further growth of load and extension of the operating period for the relay station into the conditions of Class III will justify in new equipment still further consideration of operating economy; until, as the conditions of Class IV are reached, practically the same factors govern as in the usual independent type of central station.

As may be inferred from this outline of the progressive extension of the relay station to keep pace with the system's requirements, the relay station properly designed for low-load-factor conditions may be readily converted to a high-load-factor station, and so converted should operate as such with but a fraction higher total costs than the station specially designed for the higher load factor.

Fig. 6 shows the power costs from two types of station operating on the same conditions of load. Station A is designed initially for relay service under Class I conditions. Improvement in load factor is accompanied by the installation of such additional equipment and of such economic characteristics as may be warranted. Station B is designed for continuous operation at 50 per cent annual load factor. Its first cost is nearly 50 per cent higher than that of the initial step of station A and, while more economical at the load factor for which it is designed, on the lower range of load factors the higher efficiency of its equipment is insufficient to bal-

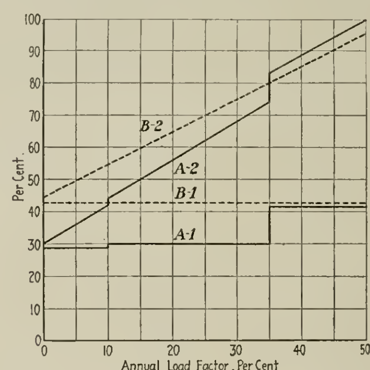

Fig. 6 Annual Power Costs of Steam Relay Station as Affected by Load Factor for Which Plant is Designed

A-1—Annual fixed charges } Class I Relay Station
A-2—Annual total power cost
B-1—Annual fixed charges } 50% Load Factor Station
B-2—Annual total power cost
(All costs expressed as percentages based on total power cost for Class I relay station developed for 50 per cent load factor and operated at 50 per cent load factor.)

ance the higher fixed charge. Accordingly, where there is doubt as to the actual load factor at which the relay station may be called upon to operate, it will in general be advisable to design for the minimum probable load factor rather than risk unnecessary expenditure in providing for load conditions that may require years to attain.

If the fundamental design is right, the initially high operating charges characteristic of the low-load-factor station are readily outgrown, whereas the fixed charges, essentially higher for the high-load-factor station, are inescapable and remain until amortized a permanent burden on the development.

Emergency Reserve Type of Relay

Turning now to the station which must also function as an emergency, or breakdown, reserve, the emergency service required of such a station may vary from floating capacity for instant availability to merely providing against interruptions of several hours or days. The requirements in any particular case will be governed in a large measure by the character and importance of the load served.

(Continued on page 674)

The Rising Importance of Oil-Injection Type of Internal-Combustion Engine

A Review of the Development of the Internal-Combustion Engine From the Early Gas-Burning Type to the Present-Day Injection Engine Capable of Operating on Any Form Of Liquid Fuel Without Explosive Shock

By CHARLES E. LUCKE,[1] NEW YORK, N. Y.

ALL engineers are interested in the internal-combustion engine, whether directly concerned with its development or not, because it does stand for the highest efficiency in the transformation of heat into work. It is the most efficient prime mover with heat as the source of energy. Its promise of high efficiency on fundamental grounds is very old, but it is only within the present generation that hope has become even an approach to reality. Commercial success has become real in more and more fields of use and application all the time, and today we are able to appraise the situation as never before.

During this period the steam turbine has gone through its own period of development, and at this time when its limit of efficiency is in sight, the internal-combustion engine is actually twice as efficient, with the promise of more to come, in engines of good design and as favorably operated. Even with poor design or unfavorable conditions of operation the internal-combustion engine as to efficiency is practically as good as the best steam turbine of very much larger size.

Recognizing these facts, it is not difficult to understand the real and continuing interest in this problem of commercializing the internal-combustion engine. At the same time it is not at all clear just why it has developed along certain lines and not along others. Development along gas-engine lines—engines burning gas—has been a disappointment, and, taking the world as a whole, the gas-burning engine has not been much of a financial success.

In spite of such a discouragement, however, the internal-combustion engine has gone ahead and is today becoming a dominant, if not the dominant, new factor in transportation. Where it has failed in stationary practice with gas as a fuel, the reason is to be found in its high first cost and maintenance charges as against the low first cost and maintenance charges of the steam-turbine plant, which factors do not equalize through fuel saving unless the fuel cost is very high per unit and the load factor also high, conditions which have not generally obtained. On the other hand, in the transportation field the liquid-fuel applications are the ones that have come into favor because of their peculiar adaptability and the impossibility of competition by the fixed steam and hydraulic central stations on land. Even on the sea we find the motorship making very substantial headway against the steamer equipped with our most modern turbines.

Rise of Importance of Liquid-Fuel Development in the Combustion-Engine Field

This phase of the problem—the rise of importance of the liquid-fuel development in the combustion-engine field—is worth while analyzing. It is important for all engineers to know something about the business and problems of others, and on this assumption there should be general interest in the story of the adaptation of the internal-combustion engine to the uses of liquid fuel, so as to aid in the adaptation of the engines thus developed to transportation by the motorcycle, the automobile, the motor truck, the tractor, the railroad car or locomotive on land, by aircraft, and on the water by the motor boat and the motorship—in addition to certain stationary uses.

The first successful commercial machines of the internal-combustion class were gas-burning engines. While they have now sunk into a condition of more or less commercial insignificance, they have left behind a useful influence in that they have taught certain lessons that are of value in solving the problems of liquid-fuel adaptation.

The first lesson taught by the gas-burning engine is, the higher the efficiency the higher must the compression be. That is as it should be on thermodynamic grounds, and experience has amply demonstrated the validity of the theory. The second lesson is, that in addition to high compression, high efficiency is obtainable only if combustion is carried out in a correct and proper manner as to timing and rate. The gas-burning engine has also demonstrated that to get the maximum results in both power and efficiency it is equally necessary that the fuel be intimately and homogeneously mixed with the air throughout its entire mass, and that the cylinder be fully charged with that kind of mixture.

In addition to these principles of combustion for transforming high percentages of heat into work, the building of gas-burning engines has established many basic principles in the structural problem. To make cylinders, pistons and heads that will not crack is not as easy as it would seem, but taking the experience of the world at large, it can be said that reliable means of avoiding cracks have been devised.

In the adaptation of liquid fuel there are certain special problems that have to be faced that did not exist with the gaseous-fuel internal-combustion engine. The two principal classes of problems are in the fuel itself and in the special type of service to be met. It very early appeared there could be no such thing as a universal liquid-fuel engine equally good for gasoline, kerosene or fuel oil, or equally good for boats or automobiles or aircraft. There might very well be an automobile engine or a motorship engine, or a tractor engine, or a railroad engine, or a stationary electric-lighting-set engine, but each must be different.

It is this adaptation that occupies most of the period of development. To study the fuel phase of liquid-fuel adaptation, fuels must be divided into the two classes that are now found commercially but which division originally was not so clear. The first class includes fuels that are sufficiently volatile to make a more or less homogeneous and gaseous mixture with air by passing through so simple a device as a carburetor, which is similar to the older air-gas mixing valve of all gas-burning engines. The second may be termed the non-volatile class, and it includes anything that cannot be used in such a carburetor with or without heat, but which requires a device that must be built into part of the engine structure rather than a device or attachment to what would otherwise be a gas engine, thus initiating the injection oil engine.

The really difficult problem of the gasoline engine appears only when it is realized that the fuel available is no longer volatile enough to make the desirable homogeneous mixture, but not yet bad enough to require an injection engine. Before getting down to the problem of the injection engine proper, however, it is desirable to analyze some of the difficulties encountered in adapting the gas-burning engine and its principles of good utilization to light, and then to heavier, gasoline.

Difficulties Encountered in Adapting the Gas-Burning Engine to Light and Then to Heavier Gasolines

The first principle of maximum compression cannot be carried as far as is desirable because the ignition temperature of these gasoline mixtures is lower than that of the gases forming the bulk of the fuels for the more efficient gas-burning engine. Furthermore, the temperature of the mixture before compression is no longer under the complete control it used to be with cold gas, and the temperature at the point of ignition or when compression ends

[1] Professor of Mechanical Engineering, Columbia University, and Mechanical Engineer, 117 Broadway. Mem. Am.Soc.M.E.

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is as much a function of the temperature before compression begins as it is of the amount of pressure rise.

The conclusions reached in gas-burning engine practice with regard to mixture quality, proportionality, homogeneity, intimacy, are all verified with gasoline. In proportion as that kind of mixture is attained with the volatile liquid fuel, so is it possible to attain some fair measure of the promise of efficiency, but the limit of attainment and the realization of it both fall off as the volatility falls off, and with the gasoline we are now using approximately only one half vaporizes in the intake passages.

The other half that will not vaporize is carried along in three different states: (*a*) as a film on the walls, such as rain will form on a window pane, (*b*) as a fog that floats, and (*c*) as a rain that is falling or driven by the air currents. A fog turns into rain, the

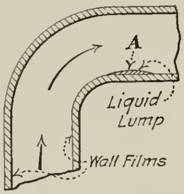


Fig. 1 Gasoline-Kerosene Carburetor Engine, Liquid on Manifold Walls

rain makes films and the action cannot go far before the fuel is all wall film. No amount of ingenuity with devices such as screens, baffles and paddles can prevail, because these cannot overcome the laws of liquid flow and vapor pressure that are operating. This is a problem of serious importance, because if the unvaporized liquid fuel gets into the cylinder and strikes a hot spot, such as the piston head, it will vaporize there locally, and will form on the piston head a "pancake" of vapor that will have displaced the air and not be mixed with it. This when combustion takes place above it, is simply heated to decomposition temperature, producing carbon, and though actually not burning itself, it fouls up the engine and interferes with its operation with a loss of fuel.

If the unvaporized fuel entering the cylinder strikes on a cold cylinder wall, it will run down past the piston into the lubricating oil. This unvaporized fuel is mainly kerosene and the lubricating oil is also a petroleum product. They are mutually soluble and as a consequence the viscosity disappears. The mixture is no longer a lubricant. It runs down into the crankcase and destroys the lubrication of the main bearings and the crankpins, as well as the piston pins. How can these things be prevented from happening? Unless they are prevented, the engine is no longer commercial.

Two courses of action are open. The first is to heat the mixture as it leaves the carburetor, and thereby raise the vapor pressure to a point where in a 15 to 1 proportion there will be a vaporized-fuel and air mixture at the minimum possible temperature and a pressure of one atmosphere. It may be said, therefore, that a moderate amount of heating is permissible, and possibly a sufficient amount to completely dry the mixture if the gasoline is not too heavy, but complete heating for a kerosene mixture is not. Gain will be realized, but also a loss, and the loss will overbalance the gain, and the practice must be abandoned.

The next mode of attack is to try to handle the mixture with some of the fuel as a liquid. To handle a wet mixture means really, in the modern multi-cylinder engine, to distribute the stream of liquid as it runs along on the inside of the pipes, to four, six, or more branches, giving to each the same amount of liquid in order that all cylinders may work the same, assuming the liquid will be vaporized or sprayed as it enters each cylinder. To accomplish this it is necessary to know how the liquid moves. Imagine the liquid coming up the side walls of the riser and approaching a bend as in Fig. 1. How would it turn? Observations in glass show that the liquid forms a very substantial lump at *A*, just beyond the turn, and on the inside of the bend. Films collect at the outside of the bend, but the velocity of the air-vapor mixture is so great at that point as to drive the liquid film around the bend to the point of least velocity. It is really the shape of the stream of air that the plug of liquid reveals.

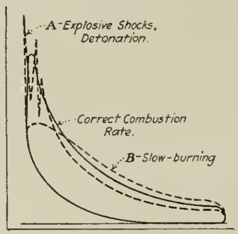
Therefore, if the gasoline is not very heavy, then a moderate heating of the mixture—not too much—with some form of hot spot is the right thing so as to avoid preignition, and with this moderate heating a manifold to take care of the distribution of the rest of the liquid.

Remedies Proposed

The net result of all this is that the gasoline carburetor engine is approaching a crisis in its history that is going to force the use of radical remedies. The remedies now being considered are as follows:

First, the elimination of the manifold entirely. This will take away the distribution problem and will permit the delivery of the liquid as a liquid with its air into the cylinder directly. No particular nozzle spraying is needed and not much vaporizing, because by properly forming the inlet valve and its passages a combustible foglike mixture will be formed as the charge enters the cylinder. This method has proved to be successful, and it is now the standard in use for all farm and most tractor engines, several hundred thousand of which are made every year, burning kerosene without any mixture heating whatever beyond what is incidental to suction.

Lubricating-oil contamination still is troublesome, and all such engines suffer from it to a greater or less extent. To minimize this the cylinder lubrication must be kept separate from that of the main bearings and crankpins. With admission of the mixture,



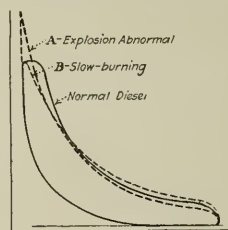


Fig. 2 Injection Oil Engine—Explosive Combustion
Fig. 3 Injection Oil Engine—Non-Explosive Combustion

however poorly vaporized, directly to the cylinder, good mixtures can be made without reduction of compression, but it is actually increased by adding water. This allows the water to enter the cylinder as a spray, just as the kerosene does, and by reason of its thermal, and to some extent its chemical, action, the compression can be raised so that some tractor engines and many farm engines have as high as 90 lb. compression.

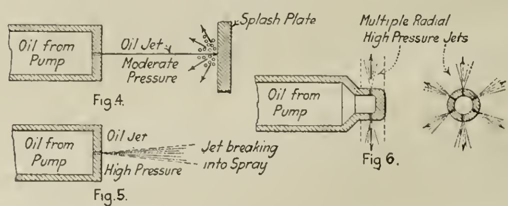


Fig. 4 Hornsby Jet-Splash Spraying Device
Fig. 5 High-Pressure Jet Breaking into Spray
Fig. 6 Multiple Radial High-Pressure Jets Breaking into Spray

The second remedy is to change the volatility of the gasoline by mixture with another and more volatile fuel. By properly selecting the things to be added to the gasoline, it is possible to not only improve the volatility, but at the same time raise the ignition point. Experiments with a benzol-alcohol-kerosene mixture at Columbia University have yielded truly wonderful results judged by the possibilities of the future. It is amazing to what extent compression can be raised on a charge of gasoline ready to preignite normally, with a minor amount of alcohol added. This is also true with benzol. Such mixtures carried the German aircraft through the war.

Abandonment of the Carburetor Engine as a Means of Solving the Present Motor-Fuel Problem

The third remedy—and this is the radical thing—is to abandon the mixture engine entirely and take up the injection engine. The abandonment of the carburetor engine, or the complete pre-mixture engine, is a thing that would solve the present fuel problem as we hear of it, and that fuel problem is a real problem. America is today facing a situation in its liquid-fuel supply that is one of the most serious things that has happened industrially. This country has reached the point where imports exceed exports. That means a real shortage. It is due to the motor-car and allied demand. Its direct effect is increased prices for those volatile constituents that are in greatest demand, but without a corresponding increase in price for such residuals as are not in demand. A switchover from the carburetor engine, which requires the light distillates, to an injection engine—independent of the distillate and of a kind which is independent of volatility, operating with anything having proper fluidity—would mean that the automobile industry would be revolutionized. Such a step cannot be taken suddenly. It is a difficult job, but it is possible to explain the difficulties and to state the progress that is being made in solving them. Not only is this a matter of interest to the engineer, but it is a matter of national importance.

In case of the successful development of a suitable injection engine the problem of gasoline shortage disappears, because the injection engine can handle any petroleum distillate, any coal-tar product, any alcohol or similar fuel, subject to the one condition that it shall be of proper fluidity to pass the pump valves and spray finely at the spray orifice. If a fuel is not naturally of high fluidity, there is not one that cannot be made of proper fluidity by adequate heating. The temperature of heating, however, must not be carried so far as to cause a decomposition with carbonization and cracking.

Injection and Carburetor Engines Compared

The injection engine, compared with the carburetor engine, not only makes engines independent of the grade of fuel (there is only one requirement besides its viscosity—cleanliness), but it presupposes that there will be under compression only air, and that only after compression shall the fuel be injected. This means that by properly choosing the time of injection the compression may be as high as pleases the designer. There is no longer any limit of temperature of ignition, because there is nothing to ignite. As a consequence the injection engine has higher possibilities of efficiency, and those possibilities are attainable, and attained.

Another difference found between the injection and the carburetor engine is that due to the difficulty in making the fuel reach all of the air. With the gas-burning engine and with the carburetor type of volatile-liquid-fuel engine, a mixture is made externally and every part is actively combustible, so that there will be the maximum possible work per cylinder charge for a given compression and shape of combustion line. With the injection engine there are certain real advantages, as pointed out, but if after compression of the air charge the fuel is quickly thrown in, it will be difficult to reach all of the air in an unfavorably shaped combustion chamber from a single point of injection.

There must be a means of spraying the oil into a charge of dense air—air of a density up to 30 or 40 atmospheres means of arranging to get the injected fuel in contact with as much of the air as possible, and means of preventing the delivery at any point of any considerable amount of fuel that cannot reach air, because in that case carbon will be formed and smoke produced which will choke up the engine in time.

The Two Classes of Injection Engines

The means of carrying out the operations that are peculiar to the injection engine are divisible functionally into two classes. The air must always be compressed. It may be compressed to ignition temperature and higher, so that the fuel as injected into it ignites immediately and burns as fast as it gets in, the rate of combustion being the rate of injection and controlled by mechanical means. On the other hand, it may be compressed not to ignition but to something less than ignition temperature, and then the fuel injected suddenly to form an explosive mixture which will burn as nearly instantaneously as may be. This gives us two classes of injection engines. The first, the correct operation of which is shown in the indicator card of Fig. 2 in full lines, is explosive in type, and if the combustion is imperfectly carried out there may result explosive shocks as shown at A, or slow burning as at B in dotted lines; the other, shown in Fig. 3, carries the air to a higher compression pressure, so as to have it not only as hot as the ignition temperature but somewhat hotter. This will give a non-explosive combustion at substantially constant pressure according to the full line, but if combustion be carried out imperfectly, or deranged as to timing of injection or combustion, it may produce explosive shocks as at A or slow burning as at B according to the dotted lines.

Each of these two classes is subject to certain derangements or diseases peculiar to a given mechanism, but comparing the two properly adjusted, how do they stand with reference to each other? Is there any great choice, any reason why the advocate of one should call the advocate of the other wrong? Not at all. Each is justifiable on the grounds of efficiency, power and practicability, so that the real problem boils down to one of mechanical questions of relative cost, reliability, foolproofness and adaptability to service conditions. The two are related in this simple manner as to efficiency. If the compression of the first with explosive-type combustion is about half the compression of the other burning the fuel at substantially constant pressure, their efficiencies are substantially the same. In the former case, if an explosive mixture is to be made, the compression must be kept X degrees below the ignition value in order to keep it under control, and in the other case Y degrees above ignition temperature to insure prompt ignition after injection.

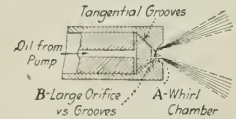


Fig. 7 Single-Orifice Whirl-Chamber Spray Nozzle

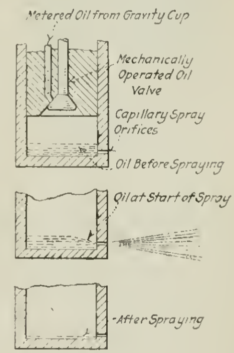


Fig. 8 Hvid Air-Spraying Cup

Assuming the exponent n in the equation $PV^n = C$ to have a value of 1.4, it appears that 150 lb. compression will produce the ignition temperature of kerosene (998 deg. fahr.) if the initial temperature is a little less than 250 deg. fahr., and if an explosive mixture is to be formed and not preignited, a margin of 100 deg. below ignition will be attained with an initial temperature of something under 200 deg. and a margin of 200 deg. with about 175 deg. fahr. initial. For fuel oil having an ignition temperature of 1070 deg. fahr. the same conditions will be brought about by the same compression when the initial temperatures are 300 deg. fahr., 250 deg. and 200 deg. respectively.

On the other hand, if the air is to have a safe margin of temperature over the ignition value before compression, higher compression or higher initial temperatures are necessary. For solid-injection sprays it is generally assumed that 200 deg. margin is safe and for air spraying 400 deg. margin. For the latter case a compression of 450 lb. is pretty generally adopted, and this will be secured with a little over 250 deg. initial with kerosene and a little less than 250 deg. with fuel oil. Solid-injection ignition may be produced with equal reliability with less compression, or with lower initial temperature, or both.

Methods of Spraying Fuel Employed in Injection Engines

The first mechanical problem in connection with this injection engine is that of making the spray, and one might say, in a way, that the building of the engine begins with the forming of a chamber around a spray. The simplest way of making a spray nozzle, introduced by the first successful commercial engine which was brought here from England—the Hornsby—consists in drilling a hole in a plate. Through this a jet is projected which strikes the wall, a spray being formed by splashing (Fig. 4). If the hole is

reduced in size, or if supplied with oil under much higher pressure, the oil will move proportionately more slowly on the sides as compared with the center, and finally the entire jet will expand into a fine mist (Fig. 5).

The essential characteristic of such a spray is strong penetration power. What is necessary, however, is some means of spreading. This can be secured by multiple holes (Fig. 6). It can also be secured by using slots which are normally closed but which are opened by the oil pressure deflecting the metal. Spread can be secured also from a single spray orifice by giving the oil back of the orifice a rotary motion just as in the mechanical atomizer oil burner as developed for the Navy (Fig. 7). Here the oil grooves are arranged to deliver tangentially into a small whirl chamber A, so that the oil in the chamber will have a rotary motion, as also will the oil issuing from the end of the orifice B at the outlet from the chamber. If the orifice B has an area many times greater than the area through these grooves, there will be no residual pressure in the chamber A, and in this case with sharp edges oil spray will issue in a hollow cone form, due to a pure centrifugal whirl. The spray will have a good uniform spread with little or no penetration. If, however, orifice B be narrowed down so that it is smaller than the grooves in area, there will be residual pressure in the whirl chamber A, producing axial velocity also, and the cone spray becomes narrower and solid. The spray will then have less spread and more penetration.

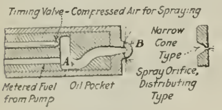


Fig. 9 Air-Spray Valve, Open Type

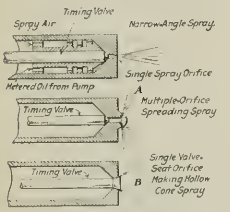


Fig. 10 Air-Spray Valve, Closed Type

In addition to this method of solid-injection spraying there is the air-spray system. This in its simplest form (Fig. 8) consists of a cup with liquid fuel in the bottom, compressed air above the fuel, and a small hole in the side at or below the oil level. As the air escapes through the hole there is first a depression of the liquid right at the point and the liquid is carried to the orifice by the air flow across its surface and blown out, being sprayed by the higher velocity of the air. Such a spray is fine and has good penetration, but not much spread.

A modification giving somewhat better control is shown in Fig. 9, which has a depression in the passageway at A, in which the fuel is deposited as a pool. A deflector over the oil directs the air down and across its surface. The air in motion will tear the liquid off from the surface and this may be delivered to the cylinder in a narrow cone spray through a contracted orifice A, or through multiple orifices as at B, to get an adequate spread. This form is the so-called "open air spray" of the Diesel engine.

Next there is the so-called "closed air-spray valve," in which a valve seats on the outlet of a passage as in Fig. 10, and which when lifted allows the air to flow. The oil is delivered by the pump into the passage and spreads out on plates usually provided with holes, grooves, or slots so as to offer a large amount of surface to be wetted by the oil, which can be blown off gradually and delivered as a spray through a single or multiple orifice A. Such a spray has a narrow angle, strong penetration, and little spread except as may result from impact and rebounding. This is the most common air spray of the Diesel engine. To secure more spread directly, the valve can be reversed in seating as in B.

For any give form of spray, air or solid, there must be a suitable combustion-chamber form, or for any given combustion-chamber form there must be selected a spray of suitable shape or energy to best reach distant air, with always the possibility of setting up turbulence or internal air currents as a corrective means.

Diesel Engines and Their Limitations

The first class of engines to be noted under the injection type is the one that is most successfully used commercially—the air-injection Diesel engine—and which normally has about 450 lb. compression—more than is sufficient to ignite an ordinary oil, enough more to be safely above ignition temperature all the time. Such engines are normally rated at 70 lb. brake mean effective pressure but are capable of producing over 100 lb. if the metal can stand the intense heating. A fuel consumption of from 0.4 to 0.45 lb. per b.hp. per hr. is standard. They are built in all except very small sizes with cylinders up to about 36 in. diameter, depending on speed and mean pressure. The maximum size is limited by the same internal heating conditions with tendency to crack the metal as obtain for large gas engines. The air-compression Diesel engine is in successful use, as is well known, for both stationary and marine purposes, and is the standard oil engine in use for large ships.

Certain limitations of the air-injection Diesel engine make it unsuitable as a substitute for the gasoline engine. It cannot be made to work with cylinders of too small a size without abnormally high compression, because of the cooling conditions that exist during compression, and in the smallest practical size it is too expensive and too complicated. The control of the air spray is peculiarly delicate. The air for it must be provided by an attached air compressor, and it requires a pressure of never less than 600 and often 1300 to 1500 lb. per sq. in. Such a compressor small enough for the purposes of an automobile is a mechanical absurdity. The particular field to which the air-injection Diesel is not at all adapted, therefore, is that of the small-cylinder high-speed engine, and that, in the internal-combustion market, is the biggest field of all.

Desirable Features of Semi-Diesel Engines

To approach the problem of the small injection engine, what is available as a starting point? The nearest thing is a type of engine that has been on the market for some time and which is commonly known as the semi-Diesel. These have a feature particularly attractive in the small-engine field—that of operating with so-called "solid-injection or airless spray" that eliminates the air compressor and the delicacy of adjustment of an air-spray valve system. They are simple, but do not operate nearly so well as the air-injection Diesel engine. One feature of this class is hot metal, which plays in these engines the function of more or less vaporizing the fuel and also and mainly that of ignition. This hot metal, when an external wall, is always a fire risk. On a ship it may be serious and in many buildings it is prohibitive. A hot-metal combustion chamber is practically an auxiliary pressure-enclosing wall and thereby constitutes an element of some danger of breakage. The temperature of the hot metal is difficult to control within proper limits, and sometimes impossible.

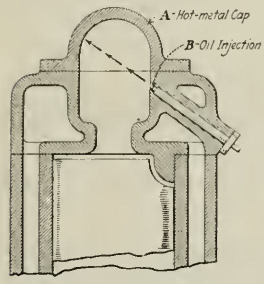
These semi-Diesel engines of hot-bulb, plate or tube pattern cannot be described in detail because of lack of space. They differ from each other mainly in the hot-metal form, or location, and the combustion-chamber shape with reference to oil injection. An unjacketed cap A (Fig. 11) more or less hemispherical, closing a water-jacketed chamber connected to the cylinder by a neck, with an oil-injection nozzle B arranged so the jet strikes the hot cap to produce ignition by contact, is typical of a group of engines that started with the Hornsby.

Cold-Wall Explosive-Combustion Solid-Injection Engines

As a result of a fairly general knowledge of the conditions surrounding these so-called solid-injection semi-Diesel engines, attention has been directed toward substitutes that would have some of the good qualities they had—simplicity, cheapness, foolproofness—as well as the good properties of the Diesel—cold walls, ignition by compression, and cleaner combustion with greater independence of fuel quality. Efforts to produce a cold-wall engine are directed along both lines. One is the explosive-combustion engine; the other, the non-explosive-combustion engine. Cold-wall explosive-combustion solid-injection engines are comparatively new. The British Crossley (Fig. 12) has a piston with a conical end and a cylindrical projection A. The cylinder head is completely water-jacketed. As the piston approaches the head, the projection A will pass the corner of the cylinder head, at which time the air in the annular space B is trapped. This projection is a loose fit but not too loose, so that during the time it is passing into the head bore there is a violent annular stream of hot compressed air cylindrically distributed down the sides of the combustion

chamber and back along the center. Into that stream of air is injected a fine spray of oil that is instantaneously ignited, burning as fast as oil and air come together. The combustion is explosive in type but not in fact.

An American representative of the same class of engine is found in the Price construction (Fig. 13), which works differently and in which the combustion is normally explosive in fact. Here a fine spray is injected into a conical combustion chamber A on each side of a central cylindrical chamber B, up which a gentle air current rises during compression. This serves to help mix the fine spray with the air during the last of the compression stroke. Compression is adjusted so that the ignition temperature is reached just before the end, and as the air charge before compression is cooler at no load than at full load, the misfires that would happen, due to failure to reach ignition temperature, are prevented by an air throttle having the effect of retaining enough hot burnt products to avoid misfires. Should the air charge get too hot from any cause, the whole charge might be ignited everywhere at the same time before compression was complete, producing a detonating combustion with explosive shock. Later injection would correct this if the charge were hot enough or compression high



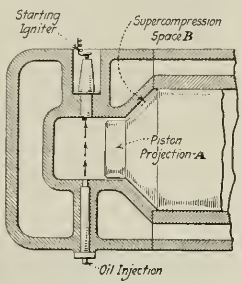
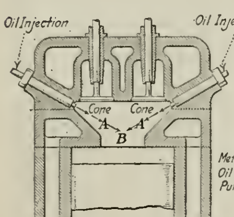


Fig. 11 Hornsby Type of Combustion Chamber
Fig. 12 Crossley Cold Combustion Chamber



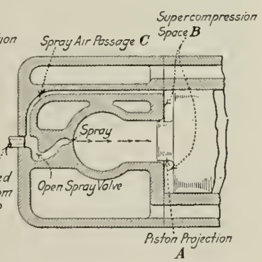


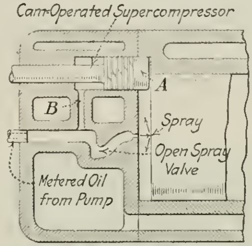
Fig. 13 Price-Ingersoll-Rand-De La Vergne Cold Combustion Chamber
Fig. 14 Haselwander Cold Combustion Chamber

enough and make the action like that of the Crossley engine, where timing of injection is depended upon to prevent detonating shocks, as is spark timing in mixture engines burning gas or gasoline.

These engines are real modern improvements. They can, with a comparatively moderate compression—200 to 250 lb.—give a fuel consumption that is substantiallly equal to the Diesel with its 450 lb. compression, but they must deal with a real difficulty. The combustion is essentially explosive combustion in fact or in type, and with explosive combustion not correctly timed—a little too early or too fast—detonations, either regularly or intermittently, are almost sure to occur. The shocks due to these detonations constitute one of the objections, and this has led other designers and investigators to devote their attention to a new class of solid-injection Diesel engines with non-explosive combustion in cold walls, the attractive features of which are less or no tendency to detonate, greater ease of maintaining correct combustion, and equally good fuel consumption.

Solid-Injection Diesel Engines with Non-Explosive Combustion in Cold Walls

An early attempt to eliminate the air compressor from Diesel engines was made by the German Haselwander, as shown in Fig. 14, which is practically a Diesel engine with air injection but without a compressor. An open type of air spray is combined with a piston construction embodying a cylindrical projection A that traps air in the space B. A passage C leads this air around to the spray nozzle. The end of the piston supercompresses part of the charge of air, driving it over the fuel and causing it to deliver a spray into the cylinder. The difficulty is that there is no control of timing. Any change in the leakage between the piston



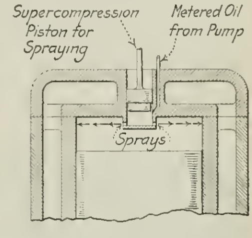
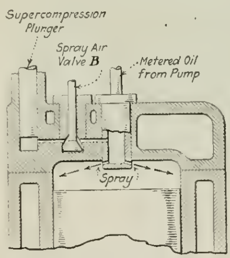


Fig. 15 Trinkler-Korting Cold Combustion Chamber
Fig. 16 Hoflinger Cold Combustion Chamber



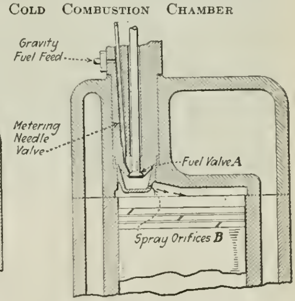


Fig. 17 Gernandt Cold Combustion Chamber
Fig. 18 Hvid-Brons Cold Combustion Chamber

projection and the walls changes the timing, while carbon causes a binding action. There is also a tendency toward reverse flow on the outstroke.

A modification of this engine designed by Trinkler and built by the German firm of Körting is shown in Fig. 15. Trinkler added a small piston A in a cylinder connected with the main cylinder at both ends. Just at the right time the piston A was moved out by a cam control so as to force air from the back end through the passage B to the spray nozzle. This little auxiliary piston A furnished the charge of supercompressed air for spraying the fuel, and it was timed like the old make-and-break ignition of the gas engine. The objection to it was that it tended to stick and stop the engine.

In Höflinger's proposed engine, Fig. 16, a small cuplike cylinder with a piston projects into the working cylinder. A passage for oil is connected below the piston and before the fuel is wanted it is deposited by the pump in that cup or bottom end of the small cylinder. Just when it is wanted a timing cam drives the piston down, compressing air on top of the fuel charge and expelling both through holes A in the side as an air spray. So far as is known, this engine has not been built, but it is very suggestive, especially when considered along with the very modern one reported from Detroit by Gernandt, Fig. 17, with special reference to use for automobiles. This has the Höflinger cup and fuel feed, but with a connection to a timing valve and to an auxiliary cylinder with a piston. The piston of Höflinger's cup is replaced by an independent piston A and separate timing valve B. Then at the right time the piston descends, the valve opens by a cam movement and the charge of air is supplied to the cup, spraying the oil into the cylinder.

Finally, the simplest of all in this class and the one form that has come into almost universal use for small stationary engines, and has practically no competition in its own field—farm units—is the Hvid, shown in Fig. 18. The Hvid retains the same fuel cup as the last two engines but with entirely different connections for fuel and provisions for supplying and timing the spraying air. The fuel is delivered into the cup by gravity through a mechanical valve *A*, so that after it is in the cup the latter is a closed chamber. The fuel is delivered into the cup long before injection, in fact, before compression begins. During compression air flows into the cup through three holes, *B*, which prevent the outflow of oil prematurely, provided the holes are small enough so as to be capillary. After compression is complete, the air in the cup has a lower pressure than the air in the cylinder, which differential is quickly equalized on the expansion stroke. As soon as the cup pressure exceeds the cylinder pressure, the cup air will spray the

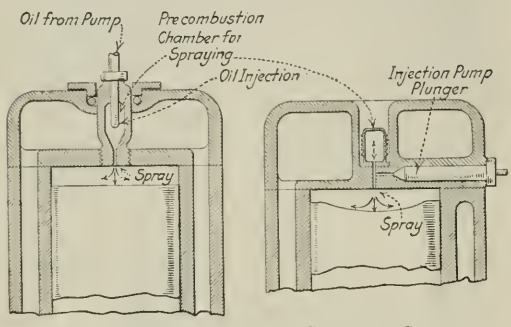


Fig. 19 First Steinbecker Cold Combustion Chamber
Fig. 20 Present Steinbecker Cold Combustion Chamber

oil into the cylinder. If the holes are too large, fuel will leak into the cylinder while the cup is being charged. If they are too many, the air escaping into the cylinder will come out of some without spraying oil out of the others. There is a limit to both the number and size of the holes and the net result is that the Hvid cup seems to be limited to small cylinders, but in a small cylinder where a small number of capillary holes will pass the right amount of oil it is thus far supreme. It is the simplest possible, automatic in timing because cylinder pressures control the timing of the spray, and the only objection is that the combustion is a little late or slow. This little engine may be said to represent the limit of commercial success for small engines with solid injection supplied by air without an air compressor.

Steinbecker has devised another spraying scheme which has been worked out experimentally. In the form shown in Fig. 19 a very small bulb-like chamber with a narrow neck is connected to the cylinder head. Through the top of this chamber a spray nozzle projects and delivers a jet or a coarse spray into the neck. At this time the air has already been compressed to and above the ignition temperature, so that as the oil escapes it immediately ignites, but not much can burn because not much of it can reach air in the narrow passage. What burns on the back face of the spray, according to Steinbecker, will raise the pressure in the bulb so as to produce an outflow of gases to respray finely what oil has been delivered to the neck and deposited on its walls. By the rise of pressure in the bulb, Steinbecker expected to really spray the main charge of oil.

Steinbecker has a recent engine, Fig. 20, in which the bulb chamber is retained, the neck passage is made extremely narrow so as to get a very high velocity through it, and injection pump delivery is led into the middle of the neck. It is timed so that oil enters near the end of the compression stroke while there is still some upward flow of air from the cylinder to carry it into the bulb chamber, which is unjacketed and hot, so as to produce ignition and combustion by explosion. The hot gases produced cause a reverse flow to the cylinder and spray the oil delivered later directly into the cylinder. This is Steinbecker's engine as it now stands, and as operated experimentally even in automobiles. The timing is directly by the pump, and should that pump force the oil in too soon, there would be an explosive shock. If the timing were wrong, the correct amount of oil would not enter the bulb and the spraying would fail also. It is probably quite sensitive to pump timing, as is not the case with some others, including the Hvid.

The Divided Combustion Chamber as a Means of Preventing Detonating Shocks

One of the great difficulties with injection is to prevent the development of explosive shocks by too early, and loss of efficiency by too late, timing. Rapidly recurring detonations will wreck any machine in time. To direct the oil stream into the combustion chamber by a pump, without any other means of control of time and rate of combustion, is a method employed by Vickers in England, using a central pressure supply of oil admitted to spray valves by cam-timed oil valves. The equivalent was worked out by Junkers in Germany, using direct pump injection without timed oil valves, who succeeded in making it work in an aircraft engine, and to him is due the credit of first making a solid-injection heavy-oil engine that would fly in the air. In both cases, however—the German and the British—the fuel went directly into the cylinder and the production of detonating shocks was entirely a question of avoiding too early an injection—and earliness and lateness are a matter of a few degrees of crank angle. They must be extremely sensitive.

Here a different principle, intended to prevent detonating shocks and relieve the engine of the necessity for accurate timing, claims attention. In accordance with it the main combustion chamber is divided into two parts, one in the cylinder and the other removed—a divided combustion chamber. The air is compressed partly in the cylinder and partly in a connecting pocket, the major part in the former.

The first construction embodying this principle to be noted

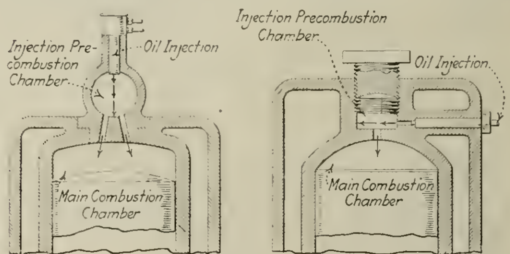


Fig. 21 Nydahl Divided Cold Combustion Chamber
Fig. 22 Nielsen Divided Cold Combustion Chamber

here is a Scandinavian one by Nydahl, shown in Fig. 21. He provided a spherical chamber connected to a cylinder by a series of holes and with an oil spray at the top. The piston stops at a point that leaves considerable air in the cylinder. There is a body of air in the cylinder and another body in the injection chamber at dead center. If the quantity of air in the injection chamber is small enough in comparison with that in the cylinder, then when the fuel is injected—the whole charge of fuel into the small amount of air—it cannot produce any explosive shock because so small an amount can burn. What, then, will happen to the rest of the fuel? It will change as it would in a gas producer where fuel reacts with less air than is required for combustion. Some of it will burn; the rest will gasify; possibly some will merely vaporize. In this divided-combustion-chamber construction the piston becomes the principal element of combustion timing, somewhat as in the Hvid engine because the main combustion is produced by the flow from injection chamber to cylinder. The divided combustion chamber is the principal element in preventing the explosive shocks, the piston movement controls the completion of combustion, and if the compression is high enough the whole structure can be jacketed.

Such a water-jacketed injection chamber, but of more or less cylindrical form, and embodying the divided combustion chamber and side injection of fuel, is shown in Fig. 22. This is a Danish

(Continued on page 686)

Design and Construction of the 16-in. Disappearing Carriage from an Engineer's Standpoint

By MAJOR G. M. BARNES,[1] U.S.A., WASHINGTON, D. C.

I HAVE been asked to give you some of the details of the design and construction of the new 16-in. disappearing carriage for harbor defence. It was suggested that this Society would be interested in the construction of this large gun carriage from an engineering standpoint. I will therefore try to avoid any consideration of the carriage as a piece of ordnance and will describe it as a large machine, hoping that some of the problems which have been solved in the development of this large mount may be of interest and possibly may have some direct application to other engineering problems in which you are more directly interested.

This weapon is a 16-in. high-power gun, mounted on a disappearing carriage, especially designed for seacoast-defence purposes. The gun weighs 170 tons, while the carriage upon which it is mounted weighs an additional 670 tons. When emplaced in the seacoast fortification the gun and carriage will be in the rear of an embankment of sand and concrete of such thickness that the highest-power naval guns can not penetrate it.

As this embankment will reach nearly to the height of the gun when the latter is in the firing position, only the muzzle will be seen from the ocean side. When firing, the shock of discharge, which is equivalent to a force of over eight million pounds acting along the axis of the bore, drives the gun from the firing position into the loading position (Fig. 2), which is approximately 12 ft. below the position of the gun as shown in Fig. 1.

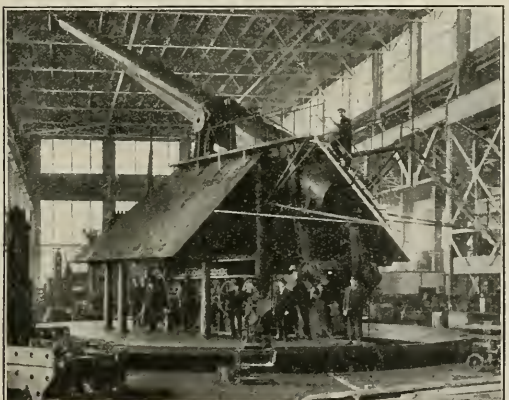


Fig. 1 16-in. Disappearing Carriage, Model of 1917

The gas pressure acts during the time the projectile is in the bore and for a short time thereafter. The force of explosion of the gun must be absorbed in the carriage so gradually and to such a nicety that there will be no shock or vibration to the carriage parts when the gun moves from one position to another. The gun pointer, who is stationed only 7 ft. to the left of the gun, must be able to keep his eye at the telescopic sight during firing and continue to direct the gun upon the target.

Although the gun and the carriage weigh approximately 840 tons, they can be easily turned in direction by the power of one man applied at the traversing handwheel. The armor-plate shed shown in the illustration protects the carriage and the gun crew from small shell fragments, concrete and débris which might fall about the gun if enemy shells should strike the parapet.

[1] Chief of Railway and Seacoast Carriage Section, Ordnance Department.

Lecture delivered at a meeting of the Washington, D. C., Section of The American Society of Mechanical Engineers, March 31, 1921.

Principal Parts of the Carriage

Fig. 3 shows diagrammatically the principal parts of the carriage. The gun is attached to the upper end of the gun lever by means of its trunnions. The gun levers are trunnioned near their centers to the top carriage, which is constrained to move up a plane inclined 1 deg. to the horizontal. The lower ends of the gun levers are connected to a crosshead, which is constrained to move vertically in guides.

A very heavy counterweight (315 tons) is attached to the crosshead. The function of this counterweight is to raise the gun from the loading or the recoiled position to the in-battery or firing position. The elevating arm, which is attached to the gun near

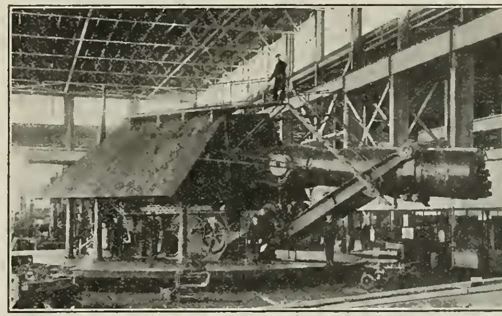


Fig. 2 16-in. Disappearing Carriage, Loading Position

its breech end, controls the elevation of the piece. The lower end of the elevation arm can be moved up or down. The slide, to which this end of the elevating arm is attached, is constrained by the rear bracket casting to move in the arc of a circle, the center of which is the position of the elevating trunnions in the loading position. The breech of the gun will therefore always return to the same position for loading, regardless of the angle of elevation at which the gun is fired.

When the gun is fired the shock of discharge is absorbed mainly in the following ways:

1. In raising the counterweight
2. In throttling oil through the varying orifices in the recoil cylinders, which are built into the top carriage
3. In moving the gun, gun lever and top carriage from the in-battery to the recoiled position.

Forces Acting on the Members of the Carriage

In designing the carriage it is necessary to make a complete solution of the forces acting on the various members and to proportion the parts accordingly. The method used in determining these forces is given in detail in the book Stresses in Wire-Wound Guns and in Gun Carriages, by Col. L'H. Ruggles, Ordnance Department, published by John Wiley and Sons, Inc. Any one particularly interested in the mathematical solution of the forces acting on a carriage of this type will find a very complete solution in this book.

The maximum stresses occur in different members at different angles of elevation. It is therefore necessary to make calculations at various angles of elevation to determine the maximum stress which occurs in each member. Fig. 3 indicates the maximum stresses in the principal members of the 16-in. disappearing carriage when the gun is fired. The accelerations of the principal moving parts along the x and y axes are also given.

It will be noted that the force of the powder gases amounts to 8,700,000 lb. This force is reduced at the trunnions to P =

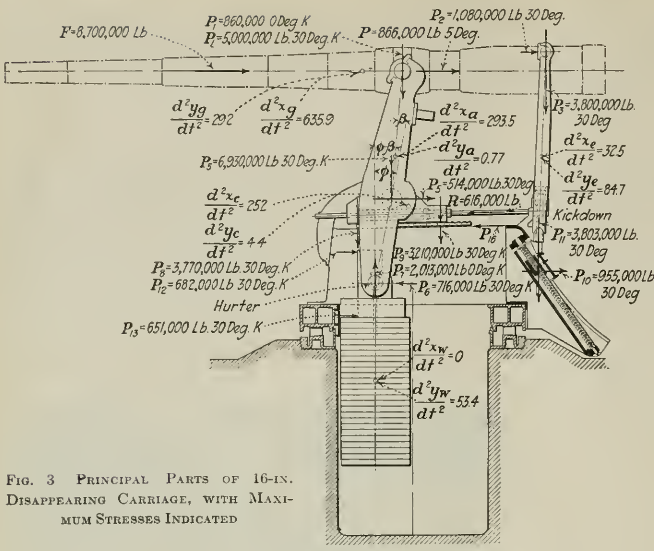


Fig. 3 Principal Parts of 16-in. Disappearing Carriage, with Maximum Stresses Indicated

866,000 and P_1 = 860,000 at 0 deg. elevation. At maximum elevation P_1, however, becomes 5,000,000 and the carriage parts must be designed to withstand this force. It is interesting to note that P_7 exceeds 2,000,000 lb. The value of the counterweight in absorbing the energy of fire is therefore apparent. The piston-rod pull is 616,000 lb., and is assumed to be constant throughout the length of recoil.

It will be seen that the forces P_2 and P_3 acting on the upper end of elevating arm are very large. These forces have been computed on the assumption that this arm is rigid. In order to reduce the force on the elevating arm, it has been made elastic; that is, a second recoil mechanism has been introduced. This recoil mechanism allows the arm to shorten when a large stress is brought upon it. As soon as the stress is relieved, the arm returns to its original length. The introduction of the elastic arm slightly increases the stresses in the gun levers and other members, which must be computed on this basis. The arm still fulfills its function of keeping the gun at the proper elevation.

The Recoil Mechanism

A part of the energy of fire is absorbed in the recoil mechanism. This mechanism is simple and consists of two cylinders located in the top carriage. The piston heads and pistons are stationary, while the recoil cylinders move back and forth. The cylinders are formed by two forged-steel liners slipped into the longitudinal holes in the top carriage. Two bars, called throttling bars, are bolted to the interior of each cylinder. Two corresponding notches are cut in the piston head. The upper surface of the throttling bars is a curved surface and so proportioned that the pressure in the cylinder is constant over the length of recoil.

The arrows indicate the direction of the flow of oil during recoil. The piston rod and head remain stationary while the top carriage moves to the rear. The length of recoil can be controlled by means of the throttling valve, which when open allows the oil in the recoil cylinder to pass to the low-pressure side without throttling past the throttling bars. When the gun goes from the out-of-battery to the in-battery position, the top carriage moves forward and the direction of the flow of oil is reversed. Just before the gun reaches the in-battery position the counter-recoil buffer acts. As the male buffer, which is part of the piston head, enters the rear end of the cylinder, the oil is gradually forced out. The remaining energy in the gun and counter weight is thus gradually absorbed and the gun comes to rest without shock. This action can also be controlled by means of the buffer valve, which when open allows the oil to escape to the recoil cylinder.

There is also another device used to help absorb the final energy at the end of recoil and counter recoil. This system, called the "hurter" system, is shown below the cylinders (Fig. 4). Just before the counterweight reaches its upper position it strikes the lower end of the hurter cylinders. The pistons of the hurter cylinders are rigidly attached to the carriage and are stationary while the cylinders are movable. Oil in the lower part of these cylinders, which is the high-pressure side, throttles past the recoil stem, up through its center and out into the low-pressure side. Also before the counterweight reaches its lower position the hurter cylinders are forced down by the expeller cam and the reverse action takes place. The recoil stems are

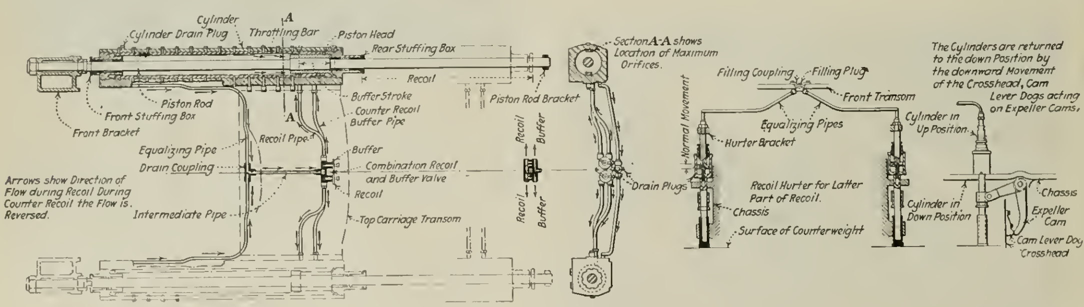


Fig. 4 Recoil Mechanism

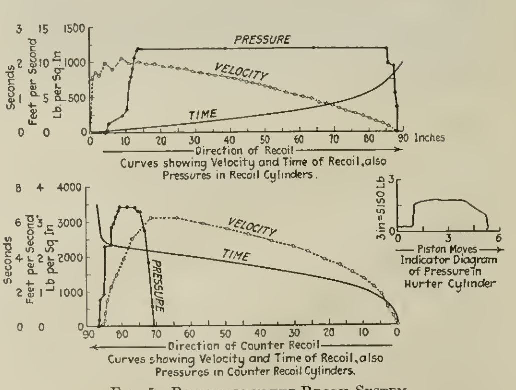


Fig. 5 Pressures in the Recoil System

(Continued on page 674)

Control of Corrosion in Iron and Steel Pipe

Corrosion of Iron or Steel in General—Protection of Pipe Against Exterior Corrosion—Internal Corrosion of Water Pipe and Its Prevention

By F. N. Speller,[1] Pittsburgh, Pa.

While there is a vast difference in the amount of corrosion of iron and steel under different conditons, and it has been proved that the relative corrosion of these metals also varies decidedly with surrounding conditions, there are certain fundamental causes which underly all cases of corrosion which should be understood by all who are interested in this problem in any of its phases.[2]

Every metal when placed in water is subjected to a fixed tendency to go into solution. This is wholly a matter of electrochemical activity and varies to a definite extent with each metal. Thus the initial reaction in the process of corrosion is analogous to solution in acid, pure water being in effect a very weak acid. The acidity of the water depends on the concentration of the hydrogen ions, which determines the initial speed of attack. As in all electrochemical reactions, however, the initial speed of solution soon slows down as the numerous little electrochemical couples which form over the surface of the metal become "polarized" due to the accumulation of hydrogen on their cathodic surfaces, ultimately stopping the solution of the metal. In the case of iron a small amount of the metal (less than 10 p.p.m.) is dissolved as ferrous hydrate, which also has a decided retarding action on the solution of the metal. This, the first stage of the corrosion of iron, while essential, is not a serious matter if the reaction between water and iron can be stopped at this point. As a matter of fact this reaction cannot proceed unless in some way or other the hydrogen film protecting the metal is removed. This is usually brought about by means of something in the nature of a depolarizer, generally free oxygen, which also combines with ferrous hydrate forming insoluble ferric hydrate, commonly known as rust.

This, the second stage of corrosion, is thus caused by the oxidation of hydrogen and ferrous hydrate in solution by the free oxygen of the atmosphere. Oxygen is soluble in water at normal temperature to the extent of about ten parts by weight per million (7 cc. per liter), and as water readily absorbs more oxygen when this element is used up, as in rusting under atmospheric conditions, it will be seen that under such conditions the reaction will continue until the metal has been destroyed; or the reaction may be brought to a stop at any time through exhaustion of the supply of available oxygen.

Water and oil lines suffer mainly from outside corrosion due to soil conditions, which resembles more nearly corrosion under water than atmospheric corrosion. Underground corrosion may be accelerated by the presence of certain salts or acids in the soil, and by the more ready access of free oxygen either by direct circulation of air or by means of underground waters which have become charged with oxygen and carbonic acid. The corrosive action is greatly increased by a rise in temperature and velocity of water within certain limits and by contact of the metal with any materials which tend to intensify galvanic action, such as cinder or certain kinds of mixed trench fill, or even the heavy mill scale formed in hot finishing of the pipe, which has a strong tendency where firmly attached to localize corrosion and cause pitting. Rust once formed on the surface also acts as an accelerator to a somewhat lesser extent.

From this brief outline of the main factors which tend to influence corrosion it will be seen how important it is to keep all parts of the pipe from contact with wet soil or water through the use of protective coatings of substantial thickness properly applied.

The influence of composition of the metal under most conditions does not seem to have much effect in itself, all other things being equal. Wrought-iron, bessemer-steel, and basic open-hearth steel pipe have been in service thirty years or more, the records of such lines showing failures in some places and practically no corrosion in other places, depending on soil conditions, drainage, and other external factors. So far as the metal itself is concerned the factor of prime importance as affecting initial corrosion seems to be the surface finish, particularly the mill scale, which is decidedly electronegative to iron and therefore is a more or less powerful accelerator of corrosion.

Protection Against Exterior Corrosion

From the foregoing it will be understood that the main object of protective coatings is to exclude water from contact with the metal. Such coatings as are available at present are by their very nature easily damaged and thus rendered practically useless if subject to abrasion after being applied. No coating has yet been found which has any chance of protecting such a material as oil-well casing. Most of what follows is therefore applicable mainly to line pipe or water pipe subjected to underground corrosion.

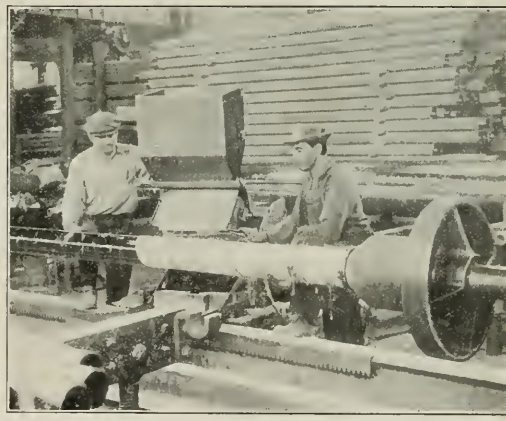


Fig. 1 Machine for Wrapping Pipe Spirally with Fabric after Application of Hot Bituminous Coating

Before any coating is applied in the field all loose rust or scale should be removed and a thin priming coat applied to the clean dry surface after the line is put together and ready to be ditched. When a priming coat is applied at the place of manufacture, it is important that the surface should be cleaned and freshened up before any further protective coating is applied in the field. The subsequent protection needed depends on conditions which should be determined by a careful survey of the nature of the soil and drainage of the territory in which the line is to be laid. In well-drained sand or clay soils a second coat of some reputable pipe compound may be all that is necessary or perhaps one coat may be sufficient, but in wet marshy places, especially where the ground water is corrosive, a much more substantial waterproofing will be necessary. Wherever the ditch can be drained economically, it will of course be of considerable advantage to do so.

The function of the priming coat is principally to afford a strong bond between the thicker protective coating and the metal, and is essential where the subsequent coat is applied hot to the relatively cold metal. The priming coat may consist of coal tar or a pure asphalt dissolved in naphtha or benzol to a thin cosistency. It is of little protective value in itself as is true of paints in general underground. To be of any practical value where underground corrosion is known to occur, a non-porous coating of substantial thickness

[1] Metallurgical Engineer, National Tube Company. Mem. Am.Soc.M.E. Presented at a meeting of the Ontario Section of The American Society of Mechanical Engineers, Toronto, February 2, 1921. Slightly abridged.

[2] Those who want to go into further details of the mechanism of corrosion may consult a paper on Preservation of Hot-Water Pipe, by Speller and Knowland, Trans. A. S. H. & V. Engrs., vol. 24 (1918), p. 217.

is required. The coatings which have given the best service may be classified as follows:

1 Melted bituminous mixtures which can be safely heated to 350–400 deg. fahr. with a melting point of about 150 deg. fahr. may be applied in the field with suitable brushes operated by hand or mechanically. Sometimes a coating of this class is poured over the pipe, the surplus being caught in a strip of canvas about 30 in. wide held by two men, by which means the coating can be worked evenly over the underside of the pipe. In this way with some care and practice a coating of from $^1/_{16}$ to $^1/_4$ in. thick may be applied without much variation in thickness.

The well-known dips applied at the works by manufacturers come under this heading. Most pipe has to stand a wide range of temperature fluctuation enroute to destination, often as much as 100 deg. fahr. If the temperature drops below the brittle point the coating is liable to crack off, and if the solar heat absorbed raises the temperature of the coating above the melting point the mixture runs, in addition to which there is always a certain amount of damage due to abrasion in handling, all of which necessitates careful inspection and attention to repairs. Coal-tar pitch when properly refined makes one of the best preservative coatings, but unfortunately the range between the brittle and melting points of this material rarely exceeds 45 deg. fahr., so that an asphalt blend must be used in most cases where the pipe has to be shipped any distance after coating. The absorption of solar heat may be limited considerably by dusting the surface of the pipe with portland cement or fine white sand. A coating of whitewash applied over the sanded surface has been tried and was found to keep the temperature of the coating down to atmospheric temperature under the July sun.

2 Under some conditions the coating above described may be reinforced with advantage by a strip of fabric 6 or 8 in. wide wound spirally around the pipe while the coating is hot. This is easily done at the mill after the pipe has received the dip coat, by means of a machine designed for the purpose (Fig. 1). The fabric should be dried in vacuum and saturated by passing through a small tank of the asphaltic mixture as it passes on to the pipe. With pipe 12 in. and smaller a saturated fabric in rolls of suitable size would be convenient for this purpose in the field, such as a large-size electric tape, or the fabric may be saturated after application by a final coat of thin consistency. This method of protection has been used for some years and has become standard with one American manufacturer for bell-and-spigot steel water pipe, having been found to give good service.

3 Where the ditch is wet most of the time, especially where stray electric currents are likely to occur in the vicinity of the pipe, provision should be made to keep these stray currents off the pipe by the use of insulated joints or other means.[1] The pipe should then be boxed in as indicated in Fig. 2 after being cleaned and having received the usual priming coat. The pipe is supported underneath every 10 ft. or so on some non-porous insulating material such as a piece of hard-burned sewer pipe or heavy glass about $^3/_4$ in. thick. An asphaltic compound such as Parolite or some similar mixture with a melting point of about 150 deg. fahr. which has been heated so as to run readily is poured in between the pipe and the box on one side. Particular care should be taken that the asphalt passes underneath the pipe without leaving air pockets, which would of course leave an opening for water to penetrate the coating. This coating has been found to be very effective both against corrosion and electrolysis when applied uniformly and not less than $^3/_4$ in. thick.

4 Where corrosive conditions are severe as in marshy places where the water is brackish or acid, a covering of concrete has proved to give the best protection. A mortar of 3 parts sand to 1 of portland cement thoroughly mixed together should be poured between the pipe and the box as in the case of the bituminous coating (see Fig. 2). The pipe should be centered in the box and supported on non-porous material at suitable intervals so that the coating will not be less than 2 in. in thickness for 8- or 12-in. line pipe. The same precautions should be taken as under (3) to avoid air pockets, with careful inspection to avoid leaving any uncoated places. The sideboards may be removed and reused. If this is done a coating of asphalt should be applied to the sides of the concrete before filling in the ditch.

[1] For practical and up-to-date information on this subject, see forthcoming report of the American Committee on Electrolysis which will soon appear under the auspices of the American Institute of Electrical Engineers.

Oil lines protected in this way in brackish water have been free from corrosion for 25 years near the New Jersey coast. Precautions must be taken to guard against or repair cracking from expansion or contraction, or settlement.

Concrete coatings are not proof against electrolysis.

Internal Corrosion of Water Pipe

The corrosion to which iron or steel pipes are subjected from contact with the water on the inside is not so serious as external corrosion; on the other hand, it is somewhat more difficult to protect against.

The principal factors which determine the rate and character of internal corrosion and pitting are:

1 Composition and finish of the metal

2 Composition, temperature and rate of flow of the water.

In the case of corrosion under water, the composition of the metal does not seem to have any marked influence on the character or amount of corrosion. Internal corrosion of cold-water pipes is usually so slow as to be negligible, although in some localities this is not the case. However, the rate of corrosion is usually so slow as to be difficult to determine with cold water, but when the water is heated under pressure the corrosive action is so much accelerated as to make it practicable to compare different materials in the same line and get trustworthy results in a year or two.

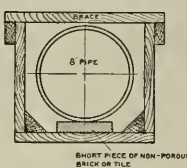


Fig. 2 Section of Wooden Form Used for Application of Asphalt or Concrete Coating

It has often been noticed that internal pitting is much deeper near mill scale where the scale is thick and firmly attached. The reason for this is undoubtedly due to the electronegative character of the scale with respect to iron. Old rust acts somewhat in the same way, but is much less harmful. When the mill scale and rust are removed the tendency to pitting is greatly reduced provided the metal itself is fairly homogeneous and free from strains. It has been clearly demonstrated experimentally that surface finish is much more of a controlling factor in corrosion than any variation in composition of the metal in itself, which is likely to occur, the explanation of this fact being that the external difference of potential due to mill scale and other extraneous matter is much greater than that due to segregation or other irregularities in the metal.

There is a wide difference in the rate of corrosion with different domestic waters at normal temperature. Take, for example, Great Lakes water in comparison with the water supply of most of the New England cities and New York City. An interesting and useful example of corrosion greatly accelerated due to the magnesium salts in the water, is that of the 30-in. steel main to the Coolgardie mining district, Western Australia.[1] A few years after this pipe line was put into use serious corrosion was found both inside and outside. The deepest inside pitting was within a few inches of the lockbar seam where the mill scale had not been broken off in bending the plate. The engineers who investigated this case are of the opinion that had this scale been removed before coating, pitting would not have occurred or would have been greatly limited. The cause of corrosion and means of prevention were investigated by Sir Alexander Binnie, Sons & Deacon, Sir William Ramsay, and Mr. Otto Hehner, who in their joint report, Sept. 30, 1909, recommended that three grains of lime per gallon be added to the water and that the water be deaerated and that precautions be taken to prevent reabsorption of air. The lime treatment was tried first but resulted in a considerable increase in thickness of scale on the interior walls of the pipe. Before the lime treatment was tried a heavy coating of rust and scale had formed in places. The effect of the lime treatment on corrosion of this pipe according to the above report was rather inconclusive and disappointing. Deaerating was then tried. The reports after two years' service

(Continued on page 697)

[1] O'Brien and Parr, Proc.Inst.C.E., vol. ccv. part 1, 1917–1918.

Steam Superheaters: Their Design, Construction, Application and Use

Fundamentals of Design and Materials Used—Characteristics and Details of Locomotive, Marine and Stationary Superheaters—Operating Conditions Where Reciprocating or Rotating Prime Movers Use Superheated Steam—Results Obtained by Using Superheated Steam

By H. B. Oatley,[1] New York, N. Y.

SINCE 1700, when the noted French physicist, Denis Papin, inserted a heated mass of iron in a piston, so that the steam moving the piston might be kept freer from moisture, the advantages of superheated steam, the difficulties of properly designing apparatus for generating it, and the necessity for having prime movers so fitted as to use it effectively, have been known and, as time passed, have been more keenly appreciated by engineers throughout the world.

The present paper will be confined to four phases of the question, namely:

a Fundamentals of design and materials used
b Characteristics and details of locomotive, marine and stationary superheaters
c Operating conditions where reciprocating or rotating prime movers use superheated steam
d Results obtained by using superheated steam.

Design and Materials

Only the tubular form of superheater, and its use as an integrally-built live-gas or waste-gas superheater will be herein discussed.

Important factors in superheater design may be considered under the headings of efficiency, durability, accessibility and safety. A design to be of merit should have a high rating in these four fundamentals.

Efficiency may have three interpretations: efficiency in design, efficiency in operation, and efficiency in return on the investment.

Efficiency in design may be measured in terms of superheater bulk and weight, and by the draft retardation produced by its inter-

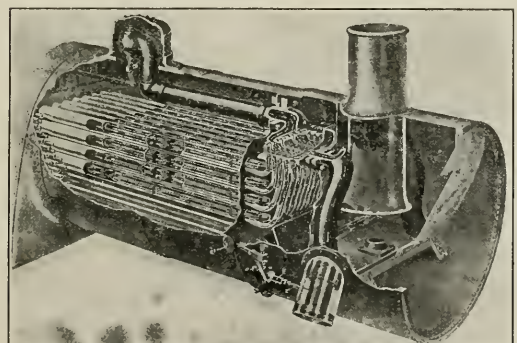


Fig. 1 American Standard Locomotive Superheater, Type "A" Equipment

position in the path of the products of combustion. It is generally true that a superheater of minimum bulk will have a minimum weight and naturally offer a minimum retardation to gases. It also follows that superheaters located in relatively high gas-temperature zones have greater heat-transmitting efficiency; hence, are smaller and more advantageously used. In many cases waste-gas superheaters of not over 50 deg. fahr. capacity have double the weight and bulk of 200-deg. fahr. superheaters of the live-gas type. In the foregoing consideration of elements of design, equal capacities of the superheater should be made the basis of comparison.

Efficiency in operation is affected by the sustained cleanliness of both the gas-touched and steam-touched surfaces, by accessibility for inspection, tightening and repair of the superheater itself, or by the ease with which conditions existing in the vicinity and affecting the performance of the superheater may be corrected.

The character of the outer surface of the superheater pipes, whether smooth or corrugated, controls the ease and thoroughness with which it may be cleaned. It also limits the ability of the soot blower to thoroughly cleanse the superheater from soot and dirt. The predominant use of the smooth surface indicates a general acknowledgment by superheater designers and users of the heavy

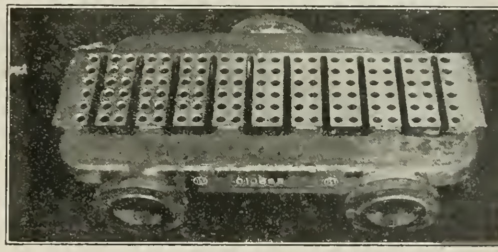


Fig. 2 Preferred Form of Top Header

heat losses resulting from soot-coated superheaters, and the difficulties in cleaning rough surfaces. The importance of the heat losses possible due to soot will be better appreciated when it is realized that it requires five inches of fine asbestos to equal the heat-insulating capacity of one inch of soot.[1] The time required to blow soot from the superheating surface should be as brief as possible, in order to conserve steam.

Efficiency in return on the investment is affected by first cost of the superheater, installation expense and maintenance charges compared with the financial gain obtained. Generally speaking, fuel economy is first considered among the advantages of superheating, although in many cases, particularly in railway and marine service, the results of large water economy aggregate a considerable item. Reduced boiler maintenance, because of the smaller quantity of fuel burned, and water evaporated, per horsepower-hour frequently appears as a credit due the superheater.

Durability is measured by the life of the superheater parts, and by the period elapsing between repair periods. This feature is affected by service conditions, and by the position of the superheater with respect to the path of the gases. In superheaters located where soot accumulation is rapid and where moisture may reach it, the soot will produce greater deterioration than where the superheater elements are subjected to live gases. This to some extent may explain the attempt to protect, by cast or malleable iron, steel unit pipes of waste-gas superheaters. The deposit of soot is naturally less where gas velocities are high, and explains the preference of the majority of designers for live-gas superheaters, and for the high gas velocities that are obtainable with such designs.

Accessibility should embrace "getatability," not only of the superheater but of adjacent parts of the boiler and other details. A minimum number of steam joints in the superheater, and their location at a point where inspection may be made without shutting

[1] Chief Engineer, Locomotive Superheater Co. Mem. Am.Soc.M.E

Condensed from a paper presented at a meeting of the Eastern New York Section of The American Society of Mechanical Engineers, Schenectady, N. Y., January 13, 1921.

[1] *Paper Industry*, November 1920, p. 1187.

down the boiler, or involving excessive labor and trouble in making such inspection, are to be considered under this head.

Safety rarely becomes a problem in superheater design, inasmuch as the size of superheater parts is small in comparison with boiler drums and also because the stored energy in the entire superheater is relatively small. Furthermore, the factor of safety in both units and headers, due to the consideration of durability, and the small sizes of parts, is relatively high. In case of failure of a unit, damage to property is negligible and injury to the operating personnel practically unknown. A representative of one of the largest insurance companies recently made the statement before a board of boiler inspectors that his company, and he believed that other

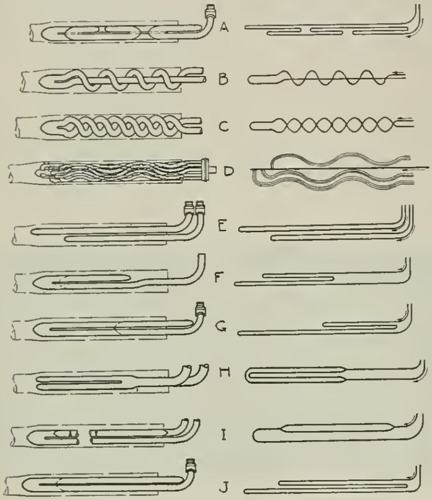


FIG. 3 TYPES OF SUPERHEATER UNITS

companies, had not received a single claim in connection with a superheater failure.

CHARACTERISTICS AND DETAILS

It may not be realized that the locomotive superheaters in use in this country alone have an aggregate horse power of over 60,000,000. All of these superheaters have tubular structure, and are of

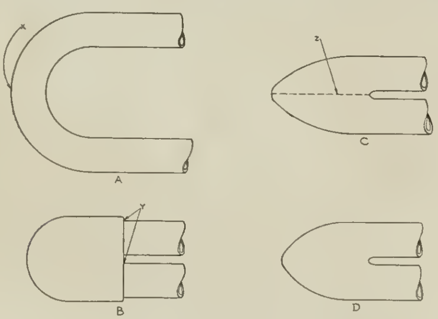


FIG. 4 METHODS OF CONNECTING TWO PARALLEL PORTIONS OF A SUPERHEATER UNIT

the bare fire-tube live-gas type. What is true in the United States as to type and structure of superheater, is true in other countries of the world where steam locomotives are in use.

The limitations imposed in the design of a superheater for a locomotive boiler are, in the author's opinion, more severe than for any other use. Space is restricted, weight conditions important and the requirements for high degrees of superheat very pronounced. The compactness of the boiler provides severe operating conditions for the superheater, because of the quality of the steam delivered to it. Steam velocities existing within the superheater units, gas velocities passing over the outer surface of the units and the necessity for strong and rugged structure to withstand the severe vibratory conditions encountered while the locomotive is running, require great care in the design and construction of the equipment.

The superheaters installed in more than half of the steam locomotives in this country weigh from 3.0 to 4.0 lb. per maximum cylinder horsepower of the engine. These figures are interesting, particularly in comparison with the running-order weight of engine per maximum cylinder horsepower, which, on the modern locomotive, ranges between 115 lb. and 160 lb. The figures in Table 1 show these ratios for the United States Railway Administration standard engines built during the war.

TABLE 1 WEIGHTS OF SUPERHEATER AND ENGINE PER MAXIMUM CYLINDER HORSEPOWER OF U.S.R.A. STANDARD ENGINES BUILT DURING THE WAR

Type of engine	*A* Weight of superheater, lb.	*B* Max. cyl. hp.	$\frac{A}{B}$	*C* Weight of engine only, lb.	$\frac{C}{B}$
060-A	4326	1397	3.10	165000	118.2
080-A	6475	1822	3.56	214000	117.5
282-A Light	8432	2252	3.75	290800	129.2
282-B Heavy	9451	2308	4.09	325000	141.0
2102-A Light	10016	2428	4.13	352000	145.2
2102-B Heavy	11023	2850	3.87	380000	133.4
462-A Light	7669	2082	3.68	277000	133.0
462-B Heavy	8432	2428	3.47	306000	126.0
482-A Light	8931	2428	3.68	327000	134.8
482-B Heavy	10016	2610	3.84	352000	135.0
2662-B	11386	2810	4.05	448000	159.7
2882-B	13554	3720	3.64	531000	142.8
		Average =	3.74		134.6

The steam velocity in units of locomotive superheaters frequently is in excess of 12,000 ft. per min. This may be startling to many power-plant engineers who consider 6000 to 8000 ft. per minute as the upper limit of steam velocities in pipe lines.

Gas velocities through the flues of locomotive boilers, as in stationary power plants, vary through a wide range, and it is not unusual to find velocities of 8500 ft. per min., or more than 90 m.p.h., when locomotives are working to their capacity.

Fig. 1 shows the American standard locomotive superheater termed the type "A" equipment. Its general characteristics are believed to be well known and the description will be centered on the question of headers and units.

Fig. 2 shows the preferred form of top header, termed the "modified through-bolt" design, which is fitted in nearly one-half of the superheater locomotives in this country. This header is made of high-grade cast iron, is rather intricate in coring and good foundry

FIG. 5 STEPS IN THE FORGING OF SUPERHEATER RETURN BENDS

practice is required in order that a satisfactory header may be obtained. Alternate cross-passages carry saturated steam and superheated steam. Expansion is provided, as well be noted from the coring which separates adjacent fingers, without setting up excessive stress in the header. This construction at the same time reduces to a practical minimum the amount of wall surface subjected to different qualities of steam.

There have been numerous forms of header, in which cast-steel

and steel-plate construction have been used. Experience has demonstrated, however, that there is no necessity for using cast steel.

Units in locomotive superheaters are universally of cold-drawn seamless steel tubing and range from $1^3/_8$ in. to $1^5/_8$ in. outside diameter, with the $1^1/_2$-in. size as the most generally used size.

Units designed for use in fire tubes have undergone a most interesting development. Fig. 3 illustrates a few forms, all applicable to a fire-tube superheater, and some possessing features applying equally to a water-tube boiler installation.

In summing up the question of superheater unit, it is considered that unit J, which is really a world-standard form, represents the highest average of any thus far developed, particularly when considered on the basis of—

a Efficiency in the abstraction of heat from the gases
b Thorough mixing and *uniform* superheating of the steam
c Better equalization in the area of gas passage and more constant gas velocity
d Maximum superheating surface
e Minimum resistance to flow of gases when (*c*) and (*d*) are considered
f Less opportunity for deposit of soot and cinders by maintaining relatively high gas velocity through length of flue
g Cost.

Units H and I are forms not thus far used, but experiment has demonstrated that they will meet, from an efficiency standpoint, all of the advantageous features of the standard unit J and from a practical operating standpoint would not differ appreciably from the standard unit. They would be more expensive to manufacture, and under present conditions are, therefore, not generally preferred.

In the design and installation of units two important features are (*a*) return bends and (*b*) the jointing of units to the headers. Fig. 4 represents the development in connecting two parallel portions of a superheater unit.

Sketch A is the simplest form and is merely a pipe bent into a "U," or hairpin, form. Diameter of tube and distance between the two pipes have naturally minimum limits if distortion in the bent portion of the pipe at X is to be avoided. For fire-tube superheaters, where a close spacing is essential, bending of the pipe in this way is obviously prevented.

Form B shows two pipes fitted to a return bend. The return bend as used is almost always of cast steel, and the pipes are threaded into it. In designs where expansion stresses are excessive, it is necessary to acetylene or electric weld the joint Y between the return bend and the pipe, in order to insure permanent steam-tightness.

Increasing demands in capacity, particularly for locomotive and marine installations, require a minimum of obstruction in the flue and, for a number of years, pipes have been joined by forming their ends, and welding the two pipes together as shown at C, Fig. 4, the welded joint being at the point Z. The extremely severe service conditions of a superheater have demonstrated that the durability of electric or acetylene welds is not sufficient to insure requisite life and freedom from possible steam leakage. Long experiment and persistent efforts to develop practically a perfect bend resulted in the form now in world-wide use, and termed the "forged" return bend. In appearance it is as shown in sketch D. Particular points of advantage are uniformity in the character of the metal, freedom from any roughness or obstruction, either within or without the return bend, and a strength which is never less than that of the pipes of the unit from which the return bend is made.

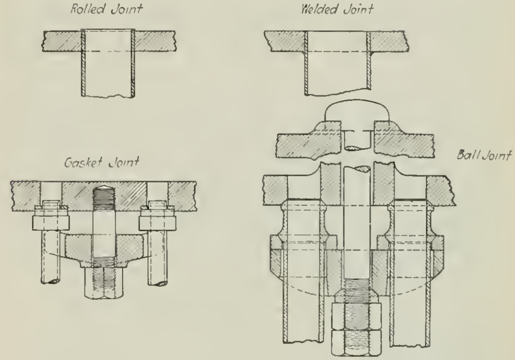


Fig. 6 Methods of Connecting Superheater Units to the Headers

Fig. 5 shows the steps in the process of forging this return bend. It is proper to emphasize that it is made *from the pipe* without the addition of any other material. The finished unit therefore becomes practically a continuous pipe without other than forged welds.

The jointing, or connection, of superheater units to the headers, or collector castings, is another detail which has passed through numerous stages of development. Methods of connecting these two superheater parts may be classified as permanent and detachable, and are shown in Fig. 6. The term "permanent" as here used covers joints which are welded, or are made by rolling the pipe in the header, either method requiring considerable work and time for removal.

Where pipes are welded to the header, actual breaking of metal

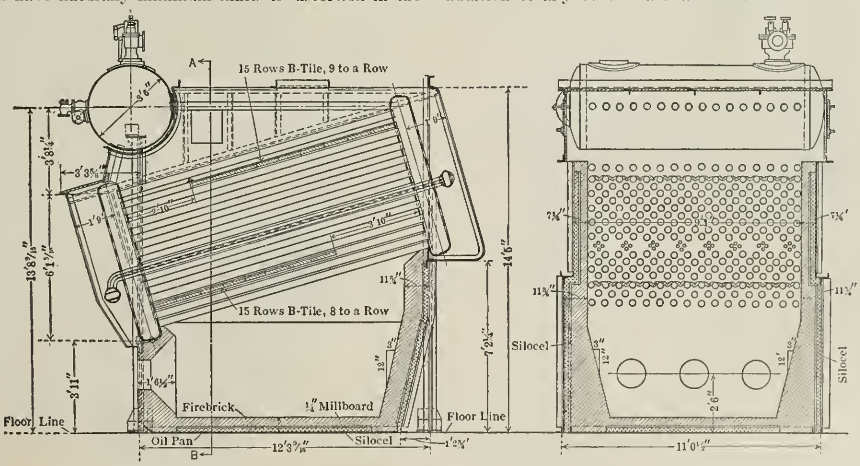


Fig. 7 Setting for Heine Boiler Built for the Emergency Fleet Corporation

is necessary in order to remove a unit. Where pipes are rolled into a header, in a manner similar to the setting of a tube in a boiler, it is necessary to remove a handhole plate, or a plug, and then to crimp the expanded end of the unit pipe and drive it out of the header. It is, of course, possible to cut off the unit outside of the header, and to remove the cut-off portion separately. This is perhaps better practice, as it makes available, for later attaching the unit to the header, material which has not been stressed and fatigued by previous rolling and expanding. Obviously, to cut

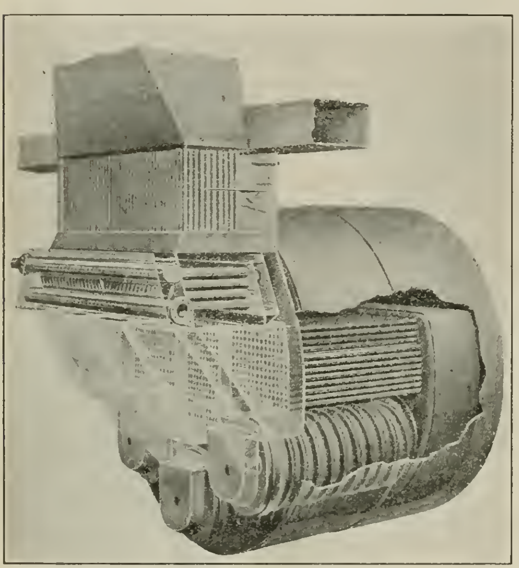


Fig. 8 Foster Superheater in Scotch Marine Boiler Utilizing Waste Heat

off the end of a unit, applicable to fire-tube boilers, makes necessary welding on a short piece of pipe, or rebending the unit, in order that it may reach the header, and at the same time occupy its proper position in the boiler tube. Either method involves considerable time and expense.

Disconnectable, or detachable, unit ends have been in almost universal use for locomotive and marine superheaters, and to a considerable extent in stationary practice. The advantages of disconnectable units are obvious and recognized fully in all lines of superheater use.

Fig. 6 shows both the gasket joint and the ball joint, and quite well illustrates the forms used throughout the world.

The gasket joint is to be preferred where the smaller diameter and more flexible superheater pipes are used. With small pipes the joint is easily drawn up normal to the seat and, because of the flexibility of the pipe, expansion and vibration cannot produce leakage.

In the locomotive field where unit pipes are of larger diameter and consequently more rigid, it has been found of decided practical advantage to use a metal-to-metal spherical joint. This form has been developed in the United States and its adoption has followed in a number of other countries.

Some Considerations in Marine Practice

In marine practice fire- and water-tube boilers are met with. The former have, for years, been used almost exclusively in merchant ships, while the latter, for a decade or more, have been practically a standard in naval construction. During, and since, the war, water-tube boilers have had greater application to passenger and cargo vessels.

Fig. 7 shows a Heine boiler as fitted in a number of war-built American vessels. The unit pipes are parallel to the water tubes, running through both water legs, and being attached, front and back, to the headers by rolled joints. The use of this type of equipment has thus far been confined to American vessels built within the past four years.

Fig. 8 illustrates the Power Specialty Company's waste-gas superheater, which was applied to both Scotch fire-tube and water-tube boilers fitted in some vessels built by the Emergency Fleet Corporation. The units in this design are of the covered type with extended surface. The covering is of cast or malleable iron slipped over the steel superheating tube. The units are attached to the header, as well as to the return bend, by rolled joints with handholes and covering plates opposite the pipe opening.

Fig. 9 shows the Locomotive Superheater Company's type M apparatus, the units being of the bare-tube type with forged return bends, and are connected to the headers by the recess gasket joint previously referred to. With this method of joining no handholes or handhole covers are required.

Fig. 10 is a picture of a complete superheater withdrawn from a Scotch boiler. The headers, to which the units are attached, are made of either high-grade cast iron, cast steel or forged steel, as may be desired, and as may be deemed acceptable by the classification societies in the countries in which the ship is to be built. Attention is invited to the chief difference between the type M marine superheater, and the type A-locomotive superheater. In the marine design, pipes of from $^5/_8$ in. to 1 in. outside diameter are used, and only one loop of the unit occupies a flue. In the locomotive type two loops of a unit occupy the same flue. In the marine type there may be from two to six loops in as many flues, depending on the proportions of the boiler and the degree of superheat specified.

In type M installations no change is usually made in the diameter

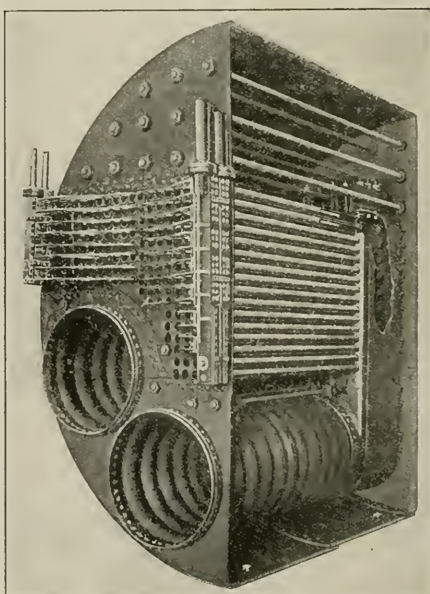


Fig. 9 Locomotive Superheater Co.'s Type "M" Superheater

of the tubes in the boiler from what would be fitted for saturated-steam operation. It is possible to do this because—

a The tubes in Scotch marine boilers have a relatively low ratio of length divided by internal area, and

b The gas area may be made more favorable, because of the flexibility permitted by the superheater design.

The question is many times asked how it is possible to insert superheater units in the tubes of Scotch boilers without retarding the draft. The explanation is not difficult to understand, when it

is realized that a reduction in fuel per hour of from 10 to 18 per cent is made possible through utilizing highly superheated steam. This means that the quantity of gas passing through the tubes is reduced in the same proportion as the quantity of fuel burned per hour, and that therefore a smaller area is sufficient if the same gas velocities are obtained. The obstruction caused by reduction in gas area, resulting from the insertion of the superheater units, is calculated in the design and in determining the diameter of the superheater pipe. The number of boiler tubes receiving the units, as well as the length of the unit, are varied to meet the conditions. It is also interesting to point out that the resistance of the gases passing the unit has, by careful test, been shown to be not more than the resistance encountered in passing a retarder having one turn. The use of retarders in marine practice is quite general, and they are frequently given from one and one-half to three turns. If a boiler fitted with retarders of two turns should be considered, it will be quite possible to remove the retarders, apply superheaters, obtain the fuel economies consistent with the type of prime mover used and, without increasing the air pressure from the fan, to burn, if occasion requires, a larger amount of fuel per hour and, assuming that the prime movers in the ship are suited, to obtain a very much greater indicated- or shaft-horsepower output.

The superheater installation in the S. S. *Cuba*, the first passenger vessel under the American flag to receive turbo-electric propelling equipment and to use high degrees of superheat, may illustrate more fully the points referred to. There were originally four Scotch boilers supplying saturated steam to triple-expansion engines of 2400 i.hp. These boilers were, if anything, small for the power to be developed. The space available in this vessel for the boiler room could not be increased without prohibitive expense and cutting down on the space usable for other purposes. It was desired to provide 3000 shaft hp. in the new installation of propelling equipment, and the question immediately arose as to whether the boilers would be adequate. The substitution of turbines for reciprocating engines naturally effected an economy in steam, but without increasing boiler efficiency. The installation of fire-tube superheaters has not only increased the boiler efficiency, but has provided a more efficient working medium. The net result being that 3000 shaft hp. is being supplied from the original boilers.

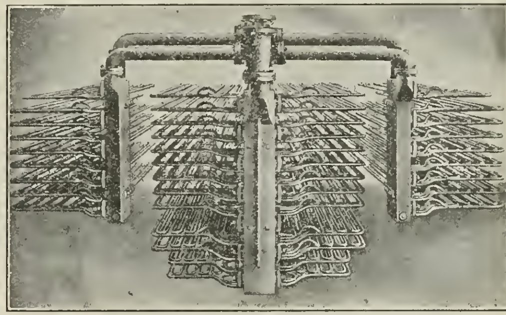


Fig. 10 Complete Superheater Withdrawn from a Scotch Boiler and Power Co. of New York

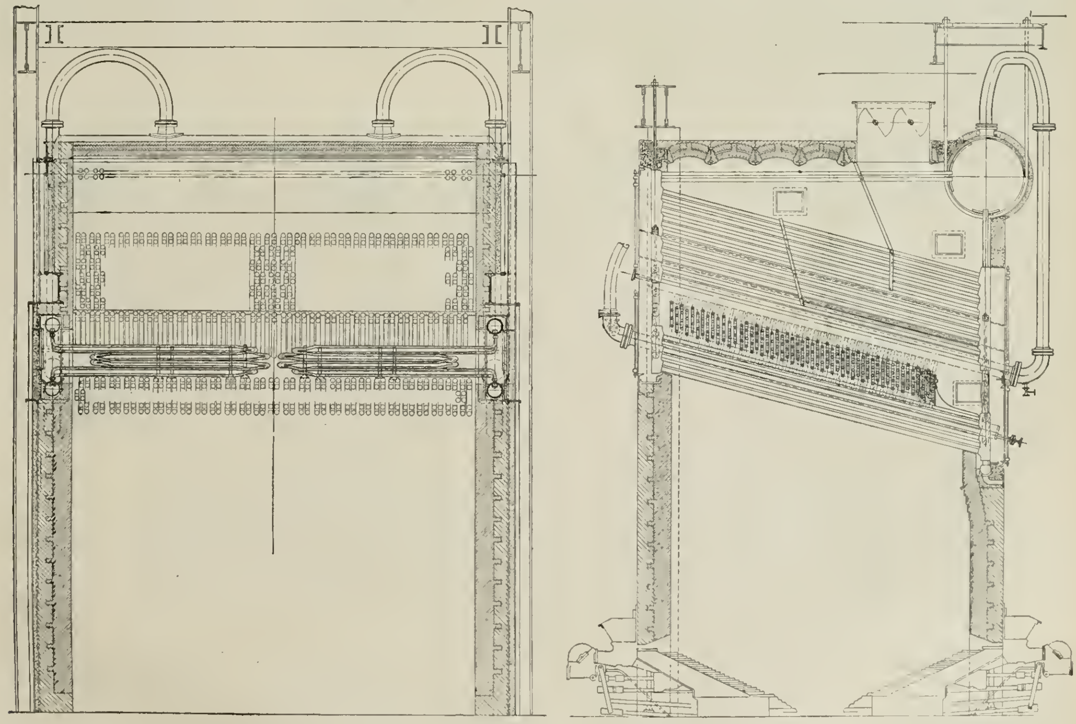


Fig. 11 Superheater for One of Twelve 1090-Hp. Water-Tube Boilers for the New Hell Gate Plant of the United Electric Light and Power Co. of New York

In the marine field, the adoption of superheaters has gone forward more slowly due to a number of causes which, previous to the world war, made the question of relatively less importance. American ships were not to any extent then in competition with vessels under foreign flags and fuel costs were comparatively insignificant. Today this condition does not exist. Our war-built merchant fleet, which will be the nucleus of a greater American merchant marine, is now in competition on all seven seas against vessels flying other flags, and this competition necessitates the most careful study of operating costs. More than 75 per cent of the steam-driven merchant ships built abroad since the war have been fitted with super-

heaters, and fuel economies of from 12 to 18 per cent, depending on the type of propelling equipment, are being obtained by foreign operators. Fuel costs where they now are, or where they may be in the future, are compelling reasons why American marine engineers must adopt superheated steam, and other means of reducing fuel costs, or face handicaps which will militate against American success.

Many of those opposed to such betterment in operating conditions have contended that the personnel on American ships is unable to handle superheaters and equipment using superheated steam. To make such contention is a slander on American ability to do aboard ship what is being done in our power plants, and on locomotives.

It is doubtful whether our war-built vessels can be made quite as effective in the use of fuel as prewar construction. This statement is made without the intention of criticizing the colossal task which the Emergency Fleet Corporation and Shipping Board performed from the date of its organization up to the armistice. For failure, however, to change their viewpoint subsequent to November 11, 1918, and for failure to make the changes which were possible and necessary in order that post-war construction should have high operating efficiency, considerable criticism may be given fairly to the officials in charge. It is only within the past nine or twelve months that a few ships have been so revised as to produce operating economies which will give them a more nearly even chance with foreign-operated vessels. The S.S. *Eclipse* may be cited as one instance of this character.

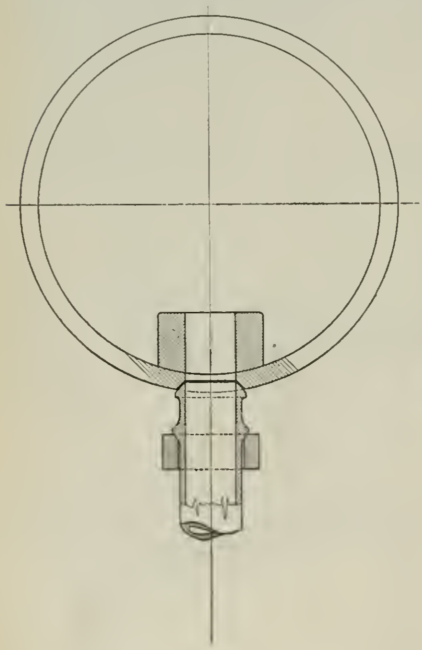
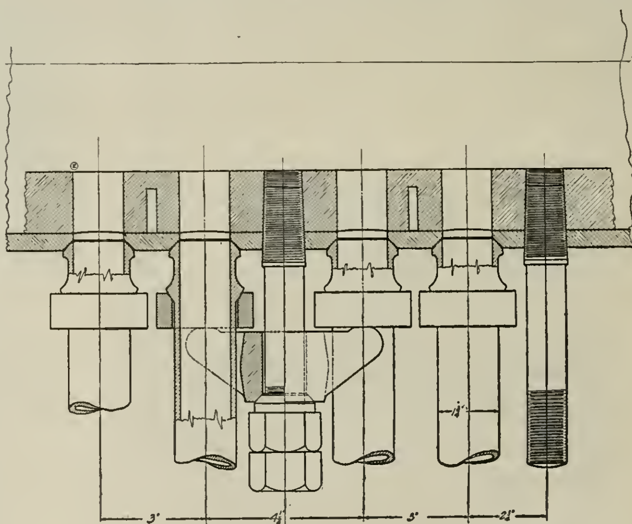


Fig. 12 Inside Bar Circular-Section Header



The original decision of the Emergency Fleet Corporation at the beginning of their program called for low-capacity superheaters giving not over 50 or 75 deg. of superheat. It was believed that this would be adequate to provide protection for turbines. Had the specified amount of superheat been obtainable under the severe conditions existing at sea, such a program would have been correct and justified. The many instances of turbine blades cut by water, after but a few thousand miles of operation, demonstrated that low-capacity superheaters, under the conditions stated, failed to provide the protection which was necessary. It is difficult to understand why the known successful means of fuel economy, all the data for which were in the possession of the Emergency Fleet Corporation in 1917, have not been utilized in the post-armistice program. Not only would the protection to turbines have been assured, but economy in fuel and increased cargo space, vital as they are, would have been assured. The tonnage of iron and steel, critical as it is, would have been reduced 50 per cent, so far as the metal entering into the construction of superheaters was concerned.

A Late Example in the Stationary Field

The boiler shown in Fig. 11 is now being built by the Springfield Boiler Company for the new Hell Gate plant of the United Electric Light and Power Company of New York. The first installation will consist of twelve boilers. Space is provided for twelve more. When this plant is finished it will probably be the largest power plant in the world. The boilers are equipped with stokers on both ends and an adequate amount of combustion space is provided to make them capable to work at very high rating. The leading feature of this installation is the location of the superheater. Up to date all superheaters installed in this type of boiler have been arranged with the headers inside of the boiler, and with units located between the first and second pass, extending parallel to the boiler tubes. This new superheater arrangement is different from any other design in this country. The superheater is located in the first pass between the sixth and seventh row of tubes. The space is thus selected to protect the elements from too high temperature and at the same time to secure the high superheat specified with a minimum amount of tubing, and as little obstruction to the flow of the gases as possible.

The superheater is designed to deliver about 200 deg. of superheat at approximately 200 per cent rating, with maximum pressure drop of 10 lb. at 300 per cent rating. The design provides for two sets of elements and two sets of headers located in the side wall on each side of the boiler. The headers are supported on steelwork. They are free to expand and contract in all directions, and all joints between header and units can be inspected from the outside of the boiler by merely removing the access doors in front of them.

The elements are fastened to the headers by means of a detachable ball joint. They are equipped with forged return bends. Every unit can be removed from the boiler should necessity occur, without entering the boiler setting, and without disturbing any other portion of the boiler, other than the opening of an access door. Another feature of this superheater is the number of joints in the headers. There are only two joints for every 60 ft. of tubing, and there are only 204 steamtight joints in the entire superheater, as compared with other superheater designs which would have at least four times as many joints, including handholes.

Superheater headers are, in stationary and marine service, sometimes cylindrical in section, sometimes flattened on opposite sides, and in some designs are rectangular or square in section. The material is open-hearth steel.

Fig. 12 illustrates an "inside bar" circular-section header, and shows units connected to the header in a manner similar to the practice in use on all American locomotive superheaters. The units in stationary practice are of either the bare- or covered-tube type, the former predominating, although not to the extent found in railway and marine installations

Fig. 13 shows, in correct relation, sections and side elevations of various styles of units found in stationary superheaters. Relative bulk and weight may be easily compared.

The use of cores in superheater units is decreasing, for the reason that the practical disadvantages offset the theoretical advantages, particularly under bad water conditions. The second and third units of Fig. 13 have frequently been fitted with cores.

TABLE 2 TESTS MADE UNDER ACTUAL OPERATING CONDITIONS

(Machine shop only under constant load conditions at night. Tests made about two weeks apart with flues and approximately the same condition.)

	Duration of Test—4 hours each			
	Saturated steam	Superheated steam	Increase per cent	Decrease per cent
Total coal consumed, lb	9316	6827	...	26.7
Steam consumption, lb. of water	57500	46000	...	20.0
Avg. steam pressure of boilers, lb	118.0	115.0	...	2.5
Avg. load on Corliss engine, i.hp	43.0	43.6	1.4	..
Avg. load on Woodmill engine, i.hp	43.2	42.8	...	0.9
Avg. load on electric generator, kw	56.7	56.8	0.2	..
Revolutions of air compressor, total	26590	26630	0.1	..
Boiler hp. developed	386	336	...	12.9
Per cent rated capacity developed	107.0	93.3	...	..
Temp. of feedwater, deg. fahr	212	207	...	2.4
Heat value of 1 lb. coal, B.t.u	13510	13190	...	2.4
Degrees superheat, main header	...	163	...	..

Operating Conditions

To go into the details of operating conditions would require more space than is available, and only a few of the more important factors will be referred to.

Increased steam temperature makes necessary provision for greater expansion of pipe lines, expansion joints, etc., than where saturated steam is used. In installing superheaters in existing plants, it is therefore necessary to determine what expansion is

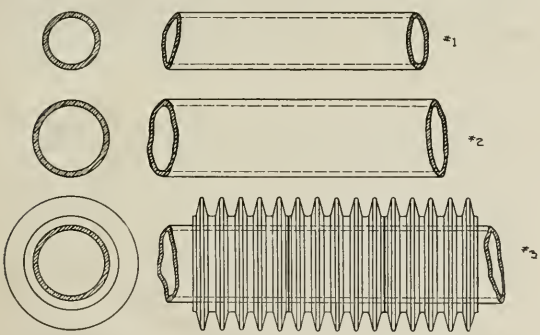


Fig. 13 Styles of Units Found in Stationary Superheaters

provided for, and if not adequate, provision must be made, or pipe-line difficulties will ensue.

Where reciprocating engines are using superheated steam, the valves must be of proper design and material, and suitable lubricating conditions must be provided by using oil of proper quality.

When turbines are to change from saturated to superheated steam, it is necessary to know that the turbine design is suitable, and what degree of superheat may be used without distress.

Results Obtained

In locomotives, upward of 20 per cent in fuel economy is believed conservative as applying to the 33,000 locomotives, with high-degree superheaters now operating on the United States railroads. Road tests of locomotives are more difficult to carry out with the accuracy obtainable from stationary plants, but comparative results, on which conclusions may be reached, have fortunately been available through testing plants of the Pennsylvania R. R., Purdue University and University of Illinois.

Fig. 14 shows indicator cards obtained from the Pennsylvania test results, which indicate the steam economy for equal horsepower, and Fig. 15 shows the increased horsepower for comparable rates of evaporation. The steam economy shown is $30^1/_4$ per cent, and the increase in horsepower for a given evaporation is 45.1 per cent.

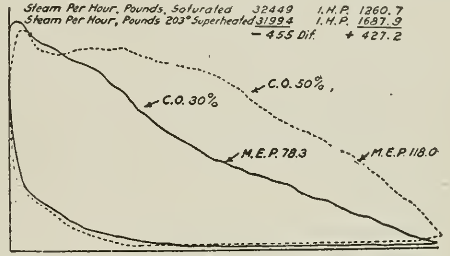


Fig. 14 Indicator Cards Obtained in Pennsylvania Railroad Tests, Showing Steam Economy for Equal Horsepower

In marine service interesting data have been collected, generally from the owners, for over fifty vessels ranging from 2800 to 16,000 deadweight tons cargo capacity, some driven with reciprocating engines, some with geared turbines, and some having turbo-electric drive. Thirty-eight of these ships provided with superheaters averaged a coal consumption of 3.3 lb. per 100 dead-

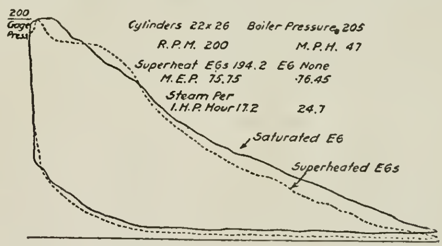


Fig. 15 Indicator Cards Obtained in Pennsylvania Railroad Tests, Showing Increased Horsepower for Comparable Rates of Evaporation

weight ton-miles, while for fifteen not so equipped the fuel consumption averaged 5.28 lb. per 100 deadweight ton-miles. Comment on these figures would be superfluous.

The results obtained by using superheated steam in stationary power plants are more numerous, and very complete accounts of carefully conducted tests have filled the pages of the technical papers for a number of years.

Table 2 is believed to be of more than ordinary interest as it indicates the savings obtained by superheater installation in a railway power plant. As might be expected, fuel economies are high due to the fact that the character of work performed by the steam in plants of this kind is varied, and, of necessity, inefficient at best. It is well known that economies obtainable from superheated steam are more pronounced when the steam is originally used less effectively, and fuel savings for a given degree of superheat are greater for simple and compound engines and less for turbines and triple-expansion condensing engines.

In the railway field, where its adoption and extension has been most rapid and complete, there is a strong desire to go to even higher degrees of superheat than formerly, and hundreds of our locomotives are operating with steam at temperatures beyond any ordinarily found in either stationary or marine service.

The belief of many engineers, strengthened by considerable study of the problem, is that steam of 800 deg. fahr. temperature is adaptable for general use, and that the results will be entirely justified and will prove gratifying to owners and operators of such plants.

The Possibility of Improved Methods of Rolling Sheet Steel

By SUMNER B. ELY,[1] PITTSBURGH, PA.

PROBABLY the first iron plates were made by hammering and must indeed have been a crude production. About 1725–1730, however, rolls seem to have come into use, although it was a number of years later before anything resembling a thin sheet was made. Yet from that day to the present time the same general type of machinery has been used for rolling sheet steel. To be sure, our sheet mills of today compared with the early ones would appear giants in size and strength, yet after all what real difference is there except this increase of size and strength? We have no continuous sheet mills, we do not even use roller-driven tables, automatic guides, etc., and practically everything is done by hand.

This statement may need a little qualification. Occasionally we do come across some small devices in use. Such, for instance, as a hinged or pivoted table to assist the catcher returning the pack over the top of the rolls to the roller. This particular device does not save any labor, in the sense of fewer men being employed; it is merely a help to the catcher. Some devices, such as shifting tables, and auxiliary attachments to cold rolls, may have a tendency to cut down the labor force; but after all such small helps as these are not real changes in the machinery of sheet rolling, and furthermore are far from being universally used.

It would seem, however, as if some device might be gotten up to cut down the number of men needed about a sheet mill. A mechanical catcher, for example, which would automatically catch the pack of sheets as it came through the rolls, lift it up and return it to the roller again. Such a device would seem to be a mechanical possibility and probably could be made to work successfully, but the amount of saving it would effect has apparently not been sufficient to act as a real incentive.

Importance of Proper Heating in Sheet-Steel Rolling

In the manufacture of heavier steel products the temperatures to which they are heated are high, comparatively, and there is some latitude; but with sheet steel the heat must be just right. Even starting with the bar, say, as it comes from the furnace for the first pass in the mill, if it is too cold the scale will not be lifted and this scale rolls into the sheets, making rough surfaces and causing them to stick together when later they are rolled in packs. If the sheet mill could receive only bars that were perfectly clean, no harm might be done even if the heat was a little too cold; but all commercial bars carry scale and this, of course, must be taken into account.

However, if instead of the bar coming too cold from the pair furnace, it is a little too hot, then there is still worse trouble; for the large sheet rolls will get hotter than the roller anticipated, will expand and the line of contact between them will not be correct; and in addition, as the bar is too hot it will be softer than it should be, and will not spring the rolls the desired amount. The consequence of this is that the bar when worked down on the chill rolls will produce a sheet round on the back end, that is, thinner in the center than at the sides; whereas, probably the bar that preceded it had the proper temperature and produced a sheet that was not long in the center, but long on each side, having what the roller calls "horns." A round-end sheet indicates that the rolls are "full" in the middle and horns show that the rolls are "hollow." Now when a circular-end sheet is placed on top of a horned sheet and the two are reheated and put into the rolls together, the pack will either pinch or run off at the back end, that is, the sheets will spread one from another on the back end of the pack, due to the uneven drawing.

And even if the roller by great care and judgment in adjusting the draft screw is able to prevent a pinch, the scale which is produced by excessive heating will only lift in spots, sinking into the sheets and causing the pack to stick together in patches, so that the sheets cannot be pried apart without tearing.

Every one familiar with sheet rolling realizes that the rolls must be kept at the proper heat so that they will maintain the proper shape to successfully roll such a thin product. A roller may (probably unconsciously) count on a certain spring to a stand of rolls and by trial find the proper heat to go with it, so as to keep the shape of his rolls right; and he will watch carefully the size of the horns on each sheet as this is an indication of the shape of the mill. He knows that if he rolls too fast—does not allow time enough between passes—his rolls will lose their shape. Neither must he roll too slow. Again, sheets always entered at the same place on the roll may cause trouble. He must constantly watch and guard against such things as cold drafts of air blowing on the rolls, in fact, anything that will in any way effect the temperature of the roll.

Of late years some of these difficulties have been helped by burning gas against the rolls to expand them when not in operation or by blowing steam on working rolls in order to keep down the expansion.

Roll-Neck Friction an Important Factor

Another most important factor is the roll-neck friction and it is not always appreciated how much this amounts to. For example, when finishing a pack if one neck of a roll be greased (with hot neck grease) without greasing the other, the pack will always draw a long horn next to the neck that is dry. The reason is that the friction on the ungreased neck is greater and consequently heats and expands the roll on that side. The author has reason to think that anywhere from 60 to 90 per cent of the power required is used in overcoming roll-neck friction, although there are no definite figures to go on. This is one of the most important things in roll design and yet there is no scientific information available on the subject; if there were it might lead to some radical changes.

Prof. W. Trinks of the Carnegie Institute of Technology has plans for building an experimental rolling mill which is arranged so that each factor entering into the problem of rolling can be controlled; and it is hoped that such a mill will be installed, for there is great need of definite figures in connection with all steel rolling generally. The apparatus devised for the purpose of determining roll pressures and spreading forces in this mill was described at length in Mechanical Engineering of January 1920 (pp. 11–13), by W. B. Skinkle, at that time Director of the Bureau of Rolling Mill Research of the Carnegie Institute of Technology.

On hot-roll sheet mills at work a blue or indigo color is often observable and this will correspond to a temperature of about 550 deg. fahr. This temperature will often run higher, although when reaching 750 deg., showing a gray, the roll is liable to break shortly afterward. In a totally dark room probably 900 deg. fahr. would give the roll a perceptible red color. Naturally the roll is hotter in the center than at the ends and the necks are still cooler; for although grease is often seen burning on the neck, yet the temperature at which it burns is generally lower than the temperature of the roll as indicated by its color.

In the history of sheet rolling there has been a tendency to continually increase the diameter of the rolls, until today sheet rolls of 30 in. are seen, and the author understands rolls as large as 32 in. have been used. The larger the roll the more tonnage can be turned out, as the large roll does not change its temperature as readily as a small one. There is evidently a limit to the size however (aside from practical considerations of handling such heavy rolls), for the larger the roll the more the radiating surface to cause cooling. The fact that the volume varies as the cube and the

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[1] Professor of Commercial Engineering, Carnegie Institute of Technology; formerly Chief Engineer, American Sheet and Tin Plate Co. Mem. Am.Soc.M.E.

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surface only as the square of the diameter, has only an indirect relation to this problem of cooling. It is also to be borne in mind that the larger curvature will not draw the steel as much for the same total pressure.

As far as the breakage of rolls is concerned, this is apparently due to unequal expansion, and not to the stress of rolling—as evidenced by the fact that rolls sometimes break when the roll is standing still, the roll train perhaps having been stopped for a few moments during the working period.

The Possibility of a Continuous Sheet Mill

Considering now the possibility of a continuous sheet mill, it will be remembered that about fourteen years ago the U. S. Steel Corporation spent a very large sum of money at South Sharon, Pa., and installed a continuous sheet mill which consisted of a series of stands of ordinary two-high rolls in tandem; the sheet passing through one stand after another, never being in two stands at the same time; and the sheets were automatically doubled and matched together in special devices at certain points in the train. After a most thorough trial, however, the mill was dismantled and the ordinary method of sheet rolling installed.

This is a convincing and definite proof of the great difficulties of sheet manufacture by using our present roll stands in a continuous train. Aside from any other question, the difficulty of keeping so many different rolls in a like expanded condition and shape seems insurmountable. The present method of using gas and steam on rolls which was not known at that time, might have aided a little; but something much more certain than this must be devised if light gages are to be rolled in this manner. Possibly the heavier gages, 10 and 12, say, could be made in this way; but we already have satisfactory mills of a different type for this purpose and we would be no further along toward automatically rolling light-gage steel.

Some method of absolutely heating the steel to a definite temperature, possibly some form of electric furnace, and some way of keeping the shape of the roll, must be devised. Rolls have been cast with holes through the centers and steam introduced or gas burned inside them; but they have been found inadequate to hold their shape and stand up to the service. The practice already mentioned of using gas and steam on the surface of the rolls is more satisfactory. Perhaps some day rolls will be placed inside a constant-temperature furnace; but what would be done about the bearings and other details is a question which as yet has not been answered.

A Successful Austrian Continuous Sheet Mill

Some twelve or more years ago the author visited a continuous sheet mill in the town of Teplitz in Northern Austria. This is an extremely interesting mill and the only one of its kind he ever heard of. There are five stands of two-high continuous rolls, all being alike, having a diameter of 23 $^5/_8$ in. and a length of 59 in. In front of this is a small set of three-high rolls, and to the right a larger set of three-high rolls. An 8-in. slab is delivered to the large three-high mill and broken down to 3 or 4 in. thick. This slab is then cut in half and put into a reheating furnace. One of the halves then goes to the small three-high mill and is reduced to $^9/_{32}$ in. (7 mm.) thick and then without reheating is put into the continuous stands. This thickness ($^9/_{32}$ in.) is always the same and the reduction is varied on the continuous mill to give the required final thickness.

The sheet is finished about 60 ft. long and is of course in all the stands at the same time. Sheets are always rolled singly and never in packs or doubled, and are from 40 to 50 in. wide. The stands are about 9 ft. from center to center and no idle rolls or automatic tables of any kind are used, simply stationary guides 6 or 8 in. high and a cast-iron plate between the stands on which the sheet slides. The gear train gives the first stand rolls 30 r.p.m., the next $37^1/_2$, then 45, $52^1/_2$, and finally 60 for the last stand. When the author saw the mill it was rolling a final product of 12 gage, making a total reduction in the five stands of some 58 per cent (from 7 mm. to 3 mm.).

Several points of great interest present themselves in connection with this mill. The first is the fact that such a thin piece of steel could be in all the five stands of rolls at the same time and not either tear or be crumpled between them. There is a great deal of confusion as to the pull exerted by rolls generally on steel, but as a matter of fact there is little if any pulling action, assuming of course the steel to be free and not held by any outside force. The resultant of the various forces acting on the steel must be vertical; for if it were inclined there would be an unbalanced horizontal component which would cause acceleration, making the bar go faster and faster. As such an action does not occur, this resultant force must be vertical. And therefore if the speeds and drafts are correct among the various stands of rolls, the sheet will not "pull" itself to pieces going into the rolls, assuming of course that the shape of the rolls is also right.

This continuous mill has demonstrated the fact that not only can the shape of the rolls be controlled but the speeds and drafts among the various stands can be properly adjusted, at least for single sheets as thin as 14 gage.

Another point of great interest is the fact that the back end of the sheet comes out thicker than the front end, due to the rapid loss of heat while in the continuous rolls. The finished sheets are respectively 2.5 mm. and 2 mm. thick at the edges at the back and front ends and 60 ft. long. To operate this mill economically it must work these long lengths and it is their practice to cut the 60-ft. sheets into short pieces, and afterward sort together the corresponding thicknesses from the different long lengths of finished sheets so that the variation of thickness will not be noticeable to customers.

The author was told that the mill was not a great financial success as there was not demand enough to keep running steadily on these particular gages. Further, the engine running the continuous mill was of about 1000 hp. normal rating and totally inadequate to run the mill satisfactorily.

Little experimenting had been done in trying to roll two sheets in a pack, for the furnace layout made it almost impossible to do so. However, the little that had been done seemed to show, as one would expect, that the thinner the sheet the greater the non-uniformity of thickness. It would seem that a reversing two-high mill, receiving alternately the hot and cold ends of the steel, might equalize this thickness and possibly be more satisfactory than the five continuous stands. So the question would naturally arise as to the best method to employ in rolling 12- and 14-gage sheets.

Then, too, it would be impossible to take this 12- or 14-gage material rolled on a special mill and finish it on the ordinary two-high sheet mill. Shapes of sheets and rolls will not fit, and while one of two packs might be rolled with care, the scrap loss would be enormous and this has been tried commercially and failed. It has also been suggested and thought possible to reduce the cost of sheet rolling by starting with the product from a universal plate mill instead of a sheet bar mill. If a universal plate of 7 or 8 gage and of accurate width were cut to proper size it would be equivalent to doing away with some of the present roughing-down process. However, when the price of universal plate is taken into account there is little or no gain; and in addition the difficulty of doing good work has been very greatly increased.

At first thought it would seem that sheets might be successfully rolled in packs on a two-high reversing mill. The condition of the same two rolls in the same relation to each other and the same pack of steel is what we have in the commercial mill now; and certainly with reversing roller tables, etc., a large saving in labor would result, even if the tonnage per set of rolls was not increased. However, it must be remembered that in a reversing mill first one end of the pack and then the other would be entered; and that this thin pack of sheets would have to be first drawn in one direction and then in the opposite direction; and that the two ends of a pack are not alike. So that we really have a very different condition from the ordinary two-high stand.

This sheet-machinery problem is a real problem, but as the author sees it, the only logical way of approach is from the scientific experimental side. It has been pretty well demonstrated that practice cannot furnish enough information. We need more knowledge of what actually occurs in rolling, what are the pressures, heat distribution, radiation, friction, etc., and when enough data and information are at hand, new ways and means, as always happens, will be indicated.

Relative Efficiency of Various Types of Condensing Apparatus

Results of Comparative Tests Carried Out on Double-Pipe Coils, Submerged Coils With and Without Manifolds, and Cooling Towers, and of Value as a Guide in the Selection And Design of the Most Efficient Type of Condenser

By ALLEN F. BREWER[1] and FRANK A. STIVERS,[2] PORT ARTHUR, TEX.

Among the many problems confronting engineers today there is none of more vital importance than that of improving the efficiency of condensing apparatus used in connection with the distillation of various liquids. However modern may be the process of distillation in practice, it will continue to fall short of its ultimate purpose—increased production—if the condensers in use are unable to stand forcing or are inadequate in their ability to perform the heat transfer and cooling required. The subject of heat transfer or conduction through metal with oil or oil vapor as one of the mediums has been mentioned by Dean P. F. Walker, of the University of Kansas in his paper, The Need of Research in the Industrial Field,[3] as a problem of frequent discussion among refining engineers; the latter without a doubt having had the condenser in mind throughout.

In order to arrive at conclusions concerning this problem which would ultimately be of value as a guide in the selection and design of the most efficient type of condenser, certain experiments have been carried out by the authors on a number of the most general designs of such apparatus for the purpose of obtaining data indicative of the relative efficiency of each. On account of the difficulties in construction that would have arisen, as well as the variation in operation, had any vapor other than steam been used as a medium to be condensed, it was considered best to carry out all tests with low-pressure steam. It is quite evident that the relative ability of each type of condenser as far as heat transfer is concerned is the same whatever the vapor passing through it; therefore the authors have felt justified in having conducted their experiments using the most uniform vapor available, i.e., steam.

Types of Apparatus Tested

Four types of apparatus were tested, namely:

Double-Pipe Coil
Submerged Coil, Not Manifolded
Submerged Coil, Manifolded
Cooling Tower.

Descriptions of these immediately follow.

Double-Pipe Coil. Built of 2-in. pipe within 3-in. pipe. Length of 3-in. pipe between fittings, 18 ft. 2 in.; effective length of 2-in. pipe, 19 ft. 2 in.; overall length of coil, 20 ft. 2 in.; height, 6 ft. 3 in.; area of cooling surface, 146 sq. ft. Coil supported vertically between two sets of 3-in. pipe driven into the ground with holes drilled at proper intervals to support bolts for the coil pipes. Solid-end fittings manufactured by the York Manufacturing Company for refrigeration purposes were used. Eleven sets of fittings in all with extra inlet and outlet fittings. Low-pressure steam used in all runs on this apparatus. Steam inlet at top of coil to pass between 2-in. and 3-in. pipes. Condensate outlet to bottom of coil and therefrom to tank and scale for weighing. Cooling-water inlet at bottom of coil within the 2-in. pipe. Outlet at top of coil, thence to ditch. All cooling water taken from hydrant line and metered.

Submerged Coil, Not Manifolded. Built of 30 lengths of 2-in. pipe, 8 ft. long, joined together with standard return bends. Arranged in a coil five pipes high and six pipes wide. Total area of cooling surface, approximately 162 sq. ft. No manifold fitted, therefore same steam particles entered at top and passed back and forth through all the pipes to leave the outlet at the bottom and flow to a tank and scale for weighing. Coil set in a steel tank 2 ft. 4 in. high, 3 ft. 9 in. wide and 10 ft. long. Seams of tank doped to prevent leakage. Cooling water taken from hydrant line via meter and 2-in. pipe to the bottom of the above-mentioned tank. Water overflow at top of tank via 3-in. pipe to ditch. As close to counterflow as possible in such an apparatus was thus obtained. Size of coil overall, 20 in. high by 24 in. wide

Submerged Coil, Manifold Type. Built of 30 lengths of 2-in. pipe, 8 ft. long, manifolded at inlet and outlet into five sections of six pipes each. Intermediate connections of all piping was made with standard return bends. Total area of cooling surface was approximately 162 sq. ft. Live steam used due to lack of available exhaust steam. Steam inlet at top of coil via manifold. Controlled by a valve and gaged. Condensate outlet via bottom manifold and thence to a tank and scale for weighing. Coil set in a steel tank 3 ft. 2 in. high, 2 ft. 1 in. wide and 10 ft. long. Seams calked with asbestos packing to prevent leakage Cooling water taken via hydrant line and meter and 2-in. pipe to the bottom of the tank. Water overflow at top of tank via 3-in. pipe to ditch. As close to counterflow as possible in such as apparatus was thus obtained. Overall size of coil, 23 by 23 in.

Cooling Tower. Built of 2-in. malleable iron pipe and standard fittings, three pipes wide, nine pipes high (i.e., three nine-pipe sections) with manifolded inlet and outlet. Overall lengths of pipes, 8 ft.[1] Distance center to center horizontally 19 in., vertically, 8 in. Approximate area of cooling surface, 146 sq. ft. (including horizontal pipes, vertical nipples, standard fittings and manifold fittings, etc.) Overall height of coil, 5 ft. 3 in., length 8 ft. 5 in., width 3 ft. 9 in.

Cooling-water distribution over the tops of the coils was carried out by means of a 2-in. inlet pipe, taking water from hydrant line via a meter and thence to a tin distributor box at the opposite end of the coil from where the steam entered. Flow of both steam and cooling water was parallel; i.e.. from top to bottom. From the distributor box the cooling water was fed to the top pipes of the coil by means of wooden troughs, having a canvas strip in the apex of each. These troughs were easy to adjust to obtain equal and uniform flow over the coil, the water flowing over the top of each trough and dripping down the canvas strip on the top pipe and thence in sequence to the lower runs of pipe. It was attempted to obtain a certain amount of counterflow by installing a series of six garden-hose nozzles attached vertically to $^3/_4$-in. piping fed by the main cooling-water supply and controlled by a valve. This proved, however, to have no material advantage and to be beyond proper control.

Wood baffling 4 in. on centers constructed to uprights at each corner of the coil was installed around the entire apparatus to do away with splash and still provide free access for the air. Exhaust steam of 5 in. pressure was used, being led to the coil via a top manifold and controlled by a valve. Condensate outlet was via a bottom manifold and thence to a barrel and scale for weighing. Steam was trapped and pipes covered to obtain as dry steam as possible. All cooling water used was taken from the hydrant and metered.

Method of Conducting Tests

Inasmuch as the ultimate purpose in view throughout the experiments in question was to obtain a knowledge applicable to the design of practical condensing apparatus of maximum efficiency for condensing oil, vapor and cooling the resultant condensate to final temperatures in the neighborhood of 100 deg. fahr., all data were taken with this point constantly in mind. Low-pressure steam of an average quality of 98 per cent was used throughout as the condensing medium. In every case four variable factors presented themselves for consideration, namely:

Temperature of cooling water entering condenser
Quantity of cooling water
Temperature of condensate
Quantity of condensate.

There was as well a certain variation occurring in the heat content and temperature of the steam, but not of sufficient amount to materially influence the results obtained. Throughout the experiments the temperature of the inlet cooling water was held as constant as possible, thus eliminating this variable from further consideration. Three separate series of tests were therefore carried out on each type of condenser, maintaining one of the three remaining variable constants in each case, namely:

1 Volume of condensate constant; temperature of condensate and volume of cooling water varied

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[1] Mechanical Engineer, The Texas Company. Assoc-Mem. Am. Soc.M.E.

[2] Mechanical Engineer, The Texas Company.

[3] Mechanical Engineering, September 1920, p. 487.

Presented at a meeting of the Houston Section of The American Society of Mechanical Engineers, Houston, Tex., March 25, 1921. Slightly abridged.

[1] See Bureau of Mines Bulletin No. 176, page 36: "It is well when possible to place pipes in a continuous coil so that an air space not less than twice the diameter of the pipe will be left vertically between pipes of the same coil, and a space 8 to 10 times the diameter of the pipe will be left open horizontally between sets of coils."

2 Temperature of condensate constant; volume of cooling water and volume of steam varied

3 Volume of cooling water constant; temperature of condensate and volume of condensate varied.

Results Obtained in the Tests

The results of the tests are given in Table. In every series the order of efficiency was practically the same, namely:

1 Double-Pipe Coil
2 Submerged Coil, Not Manifolded
3 Submerged Coil, Manifolded
4 Cooling Tower.

The results cannot be assumed as indicative of the capacity of various condensers under practical conditions, inasmuch as in some cases it required as high as 40 lb. pressure to force the steam through the coils. The data are intended purely to show a comparison of efficiency and relative heat transfer.

A comparison of the manifolded and non-manifolded submerged coils indicates the same limitations. In fact, even through the efficiency of a non-manifolded coil is the higher, yet it may be necessary in practical operation to manifold the coil in order to provide adequate area for flow; although this must be done at the expense of a decrease in heat transfer.

The double-pipe coil gives the nearest perfect counterflow of the mediums as is indicated by the high outlet-water temperature and low condensate temperature. In the submerged coil perfect counterflow cannot be gained, but a partial effect is obtained by putting the inlet water entrance at the bottom and at the opposite end of the coil from the steam inlet which is located at the top of the coil. The data show a cooler outlet water and warmer condensate than for the double-pipe coil. The handicapping feature of the cooling tower is that an unavoidable parallel flow of the mediums exists; and a high outlet temperature of condensate prevails.

The possibility of spraying the outside of the double-pipe coil is worthy of mention and consideration in the construction of a practical condenser. No actual data were taken to support this contention in the experiments in question, but it was noticed that a marked heat transfer by evaporation was clearly evident on several occasions when the apparatus was operating and showers occurred.

There is one advantage held by the cooling water which must not be overlooked, namely, the fact that evaporation is used for carrying away the major part of the heat, only a small amount being transferred as sensible heat to the cooling water. This is a practical advantage if the cooling water is to be spray-cooled and reused. The effect that weather conditions have on the coils is marked. When humidity is high, when there is rain or little breeze, evaporation will be decreased and vapor clouds hang heavily around the coils. Most efficient operation was found to occur when a light breeze prevailed and the air was dry.

TABLE 1 DATA OBTAINED IN TESTS OF VARIOUS TYPES OF CONDENSERS

Length of test, min.	Temp. of inlet water, deg. fahr.	Temp. of outlet water, deg. fahr.	Steam pressure, lb. per sq. in.	Temp. of steam, deg. fahr.	Temp. of condensate, deg. fahr.	Cooling water per min. gal.	Condensate per min. lb.
Constant Flow of Condensate							
Double-Pipe Coil:							
60	86	210	5	228	95	5.0	8.3
60	86	209	5	228	91	6.1	8.5
60	90	207	5	227	89	6.5	8.2
60	90	206	5	226	88	7.9	8.5
60	87	202	5	228	88	9.5	8.4
60	86	193	5	223	87	10.8	8.6
60	86	178	5	225	86	12.8	8.4
Avg.	87.3	200.7	5	226.4	..	....	8.4
Submerged Coil, Not Manifolded:							
40	92	139	4	226	96	29.4	8.4
40	94	146	4	226	96	23.8	8.3
40	94	141	5	227	97	20.7	9.3
40	94	158	5	227	98	16.3	8.9
40	95	168	5	227	99	13.2	8.5
40	94	172	5	227	102	8.9	8.3
40	94	181	5	227	106	5.0	8.7
Avg.	94	158	4.7	226.7	...	....	8.6
Submerged Coil, Manifolded:							
60	90	192	5	227	120	4.8	8.2
60	90	194	5	227	113	10.4	8.4
60	90	177	5	227	106	15.6	8.4
60	90	153	5	227	103	19.6	8.9
60	91	141	5	227	102	22.9	8.4
60	91	135	4	226	102	29.8	8.5
Avg.	90.3	165.3	4.8	226.8	...	....	8.5
Cooling Tower:							
60	92	110	5	223	108	23.7	8.8
60	92	111	5	222	110.5	21.9	8.0
60	92	112	5	224	111	20.9	8.2
60	92	113	5	224	112	18.8	8.3
60	92	115	5	224	113	16.8	8.5
60	92	120	5	219	118	12.9	8.7
60	92	127	5	220	119	11.9	8.8
Avg.	92	115.4	5	222.3	...	....	8.5
Temperature of Condensate Constant							
Double-Pipe Coil:							
40	90	211	4	225	96	5.1	5.0
40	90	211	12	244	96	7.9	10.1
40	91	214	20	259	96	11.3	13.7
40	91	213	24	265	96	16.3	16.4
40	91	210	30	274	96	24.8	19.9
40	91	195	40	287	96	36.3	28.0
Avg.	90.6	...	..	...	96	....	....
Submerged Coil, Not Manifolded:							
60	95	148	5	228	97.5	10.5	2.9
90	90	172	5	229	92.0	9.7	4.3
60	93	142	5	227	95.5	13.3	5.3
60	94	149	5	228	94.5	17.3	7.9
90	91	161	5	229	94.0	19.5	8.9
60	94	148	5	229	95.5	24.0	10.0
90	92	155	5	224	98.0	28.8	12.4
90	95	139	5	222	103.0	47.0	13.1
Avg.	93	...	.	...	96.3	....	....
Submerged Coil, Manifolded:							
60	88	153	2	219	96	11.9	5.8
60	90	160	2	219	94	11.5	6.5
60	90	162	3	222	96	12.9	7.7
60	90	159	4	225	96	16.3	8.5
60	90	149	5	228	96	23.2	9.1
60	91	145	7	233	99	29.5	9.2
60	90	132	6	230	102	34.8	9.8
60	92	134	8	235	102	37.5	10.0
Avg.	90.1	...	.	...	97.6	....	....
Cooling Tower:							
60	92	106	5	228	110	13.2	4.1
60	92	106	5	228	110	13.9	5.9
60	92	116	5	228	110	16.8	7.0
90	92	100	5	225	100	18.8	8.0
40	92	104	4	225	105	25.8	8.4
40	92	106	4	225	105	33.3	8.7
40	92	106	4	225	105	4.72	8.9
Avg.	92	...	.	...	106.4	....	....
Cooling-Water Flow Constant							
Double-Pipe Coil:							
30	92	230	50	298	115	23.8	31.5
30	92	221	40	287	105	21.6	24.1
30	92	212	30	274	98	21.7	20.3
30	92	190	20	259	95	21.6	16.3
30	92	188	15	250	94	21.4	13.4
30	92	160	8	235	94	21.5	10.5
Avg.	92	...	..	...	....	21.9	....
Submerged Coil, Not Manifolded:							
60	96	120	5	224	96	21.2	2.4
60	96	141	5	224	97	21.1	5.6
60	94	156	5	227	98	21.6	8.8
60	93.5	166	5	224	99.5	20.9	10.8
60	92	172	5	224	100.5	20.7	12.6
60	92	172	5	223	105.0	21.7	14.1
40	91	192	18	255	110.0	20.0	14.8
40	92	192	20	259	122.0	20.2	16.2
40	91	200	22	262	137.0	21.4	19.3
Avg.	93	...	..	...	....	21.0	....
Submerged Coil, Manifolded:							
60	88	122	1/4	213	93	20.0	3.7
60	88	125	1	216	95	20.3	4.5
60	90	130	2	219	97	20.3	5.3
60	90	142	4	225	101	20.0	6.8
60	92	161	7	233	108	20.3	10.1
60	89	171	8	235	111	20.2	11.0
60	89	160	9	237	117	21.1	11.9
60	92	151	10	240	146	20.5	13.0
Avg.	89.8	...	....	...	....	20.3	....
Cooling Tower:							
90	94	94	5	225	86.7	17.7	1.7
90	93	99	5	226	94.8	19.3	3.6
60	93	94	5	226	90.0	19.0	3.0
90	88	98	5	227	96.0	14.2	5.7
90	89	100	5	227	108.0	14.4	8.2
60	92	122	5	224	120.0	18.3	10.5
60	92	125	5	225	125.0	20.4	12.1
90	93	118	5	218	131.5	18.1	15.6
Avg.	91.8	...	...	...	....	17.7	....

In conclusion, the following points may be emphasized as being brought out by the data obtained in the tests:

1 On a basis of heat transfer the double-pipe coil is far superior to any of the other types of condensers tested; the degree of superiority and the comparative efficiencies of the others being shown clearly by the resultant curves.

2 Considering the submerged coils, the non-manifolded type of apparatus shows a better heat transfer than the manifolded coil under like operating conditions.

3 On a basis of low outlet temperature of the cooling water, the cooling tower is much superior to other coils, as the data indicate. This characteristic is of value if the cooling water is to be cooled and reused.

DESIGN OF STEAM POWER STATIONS FOR HYDRAULIC RELAY

(*Continued from page 652*)

Miscellaneous power service and lighting should, in general, be completely relayed against more than momentary interruption; for some classes of power, frequently that applied to electrolytic processes, for example, longer interruption of service is not of so serious moment, not sufficiently serious to warrant the expense of full relay; on the other hand, an extensive d.c. network, such as that in large metropolitan cities, must be absolutely safeguarded against interruption, however brief.

When the steam relay station is to serve as an instantaneously available reserve, the necessary excess capacity in generating units must be maintained on the line and actually under steam at all times. Station design to provide most economically for such service must afford, for minimum investment, a maximum of flexibility in capacity with minimum stand-by charges. Characteristics in equipment peculiarly favoring these requirements are:

1 Combination electric-steam drive on the larger auxiliaries, such as circulating pumps and mechanical-draft fans, for the units operated as floating stand-by
2 Turbo-generating units with direct-driven exciter, and with overspeed-controlled steam bypass for turbine-blade cooling independent of normal governing valves
3 High ratio of turbo-generator capacity in comparison with point of lowest water rate
4 Wide flexibility with quick response in control of boiler output and rate of combustion
5 High ratio in capacity of combustion equipment vs. area of boiler heating surface.

Where commercially available, fuel oil with mechanical atomization is particularly advantageous on this class of service, and its use permits the fulfilment of these boiler-plant requirements to an almost ideal degree. With proper design the response to control is practically instantaneous; capacity attainable is the highest of any commercial fuel. Oil fuel has the added advantage, particularly important in stand-by service, of minimum banking loss.

Pulverized coal, bituminous or sub-bituminous, for the larger plants, is only second to oil in flexibility of control and low banking loss. In general the underfeed type of mechanical stoker, given proper ratio of grate area to heating surface, will also fully meet the requirements in both flexibility and capacity, but banking losses are necessarily higher than for either oil or pulverized coal.

The class of fuel to be adopted in any particular case should be governed by the local conditions of fuel market, load and relay-station load factor, present and prospective, station location and capacity. However, it is usually true that fitness of equipment, and of its arrangement, for the requirements of the fuel determined upon, are more important than selection of type of fuel.

Emergency relay service on loads for which absolute continuity is of less vital importance will normally involve actual readiness to serve only during periods of anticipated power deficiency such as between seasons when stream flow is precariously near the actual load requirements and any slight diminution of flow will necessitate calling upon the relay station, or when there is possibility of sudden ice accumulation, or threatening floods.

For relay service of this character it will usually be sufficient to maintain a few boilers under fire and the larger of the essential auxiliaries turning over. The general characteristics of equipment outlined for conditions requiring instantaneous availability of the reserve apparatus will be advantageous in this case also. The combination electric-steam drive for auxiliaries may be omitted in the interest of first cost as the relay is not necessarily intended to meet full failure of hydraulic power, but the provision of electric drives for one complete set of essential auxiliaries, as recommended for the normal deficiency make-up of relay station to permit prompt starting of such equipment without waiting for steam, will usually be found particularly advantageous under the service conditions now considered. It may also under some conditions be advantageous to make use of electrical heaters in maintaining hot-water circulation in certain of the boilers, instead of actually holding them under fire. Oil is again the ideal fuel, but it is questionable if in the average case pulverized fuel will possess any advantage over the forced-draft underfeed stoker. New developments may, of course, readily change the relative status of these two methods of burning coal. In general the features of design which are specially advantageous for this type of relay are common to the instantaneous type of relay and are readily embodied in the station designed for the simpler type of make-up service.

Considering again the general characteristics and requirements of the steam relay station, the feature which should be regarded as secondary only to low construction cost and adequate dependability is that of low attendance requirements, and not merely for the non-operating period but for actual operation as well. With this object in view the design should tend to large units and, as far as compatible with thorough simplicity, to automatic control. Where feasible, combining the functions of distributing station with those of the hydraulic relay; assists materially in holding down both construction costs and attendance for the relay station. It should be borne in mind, however, that maximum returns on the investment in any type of steam power station can only be had through skilled and well-trained operators. Such men cannot be picked up on a moment's notice. It is true that it is often possible during periods of plentiful water supply to distribute men from the steam stations through other departments, but the number of men that may actually be employed in this way is limited. Where men are held over long periods without really effective employment, there is invariably loss of efficiency and of morale.

DESIGN AND CONSTRUCTION OF 16-IN. DISAPPEARING CARRIAGE

(*Continued from page 660*)

machined to varying diameters so as to give a uniform pressure throughout the stroke. By means of these various hydraulic systems, the enormous weights move from one position to another without the least shock or perceptible vibration.

How closely the pressure in the recoil cylinders can be kept constant, the assumption made in the calculation, is illustrated by indicator-card records taken from the 16-in. disappearing carriage, model of 1912 (Fig. 5). The first diagram shows the operation of the recoil system during recoil. For the first five inches of recoil there is no pressure on account of the void left in the cylinder to take care of the expansion of the oil. The pressure quickly builds up to a maximum of about 1200 lb. per sq. in. and remains constant over the remainder of the length of recoil. The velocity curve shows that the maximum velocity of the top carriage of about 10 ft. per sec. is quickly reached and that this velocity is reduced almost on a straight line over the length of recoil. The time curve shows that the gun moved from the in-battery to the recoiled position in about two seconds. The velocity and time curves were obtained by means of velocimeters.

The second diagram shows the operation of the same system as the gun goes from the loading or recoiled position to the in-battery or firing position. There is no appreciable pressure in the recoil cylinder until the buffer mechanism, previously described, comes into play. This buffer acts for the last 16 in. of counter recoil. The pressure quickly builds up to about 3500 lb. per sq. in. and the velocity which has reached over 3.5 ft. per sec. is quickly reduced to zero. The time for the gun to move into battery is shown to be about seven seconds.

The third diagram shows the pressure in the hurter cylinders at the end of recoil. The orifices are proportional so that the pressures will remain nearly constant throughout the stroke.

The construction of the elevating arm may be of interest because by making this arm elastic the force which it must carry is reduced from about 4,000,000 lb. to less than 1,000,000 lb. When a suddenly applied load is brought upon this gun, the oil in the cylinder of its recoil mechanism is throttled past the piston head through two grooves of varying cross-section cut in the cylinder wall parallel to the longitudinal axis. The cross-sectional area of these grooves is such that a constant pressure is maintained in the cylinder throughout the stroke. The piston remains stationary while the cylinder moves. As soon as this heavy load is relieved, the springs force the arm to return to its original length, and the recoil mechanism again acts to prevent the sudden action of the springs.

The Various Determinations of the Specific Heat of Steam and Their Technical Significance

By H. SCHMOLKE

IN THE past few years several attempts have been made to determine the specific heat c_p of superheated steam at constant pressure for a wide range of temperatures and pressures. This is of great practical importance since c_p is one of the most valuable physical magnitudes, and in so far as its relation to pressure and temperature is known, it makes possible the determination of all the other thermodynamic properties of steam, as has been shown by Planck. Thus, if u denotes the internal energy of steam, v its specific volume, p its specific pressure and A the heat equivalent, then the heat content of steam is found to be $i = u + Apv$, this being obtained by means of the equation—

$$c_p = \left(\frac{\partial i}{\partial T}\right)_p$$

in which T denotes temperature, and i can be determined provided c_p has been found by measurement. Further, the entropy s can be determined from the equation—

$$c_p = T\left(\frac{\partial s}{\partial T}\right)_p$$

if the specific heat of the steam is known for all values of p and T. This makes it possible to determine from experimental data the function—

$$\varphi = s - \frac{i}{T}$$

and from this can be determined all the magnitudes defining the state of steam, since if the above value for i is introduced into the function for φ, the following equation is obtained:

$$d\varphi = ds - \frac{du + Apdv + Avdp}{T} + \frac{u + Apv}{T^2}\,dT \;\ldots\ldots [1]$$

Also since

$$ds = \frac{du + Apdv}{T}$$

another expression for the same function is obtained, namely:

$$d\varphi = -A\,\frac{v}{T}\,dp + \frac{u + Apv}{T^2}\,dT \;\ldots\ldots [2]$$

but in accordance with general rules of mathematics the total differential must be—

$$d\varphi = \left(\frac{\partial\varphi}{\partial p}\right)_T dp + \left(\frac{\partial\varphi}{\partial T}\right)_p dT \;\ldots\ldots [3]$$

and likewise

$$\left(\frac{\partial\varphi}{\partial p}\right)_T = -A\,\frac{v}{T}, \text{ and } \left(\frac{\partial\varphi}{\partial T}\right)_p = \frac{u + Apv}{T^2} = \frac{i}{T^2} \;\ldots [4]$$

From this it follows that

$$Av = -T\left(\frac{\partial\varphi}{\partial p}\right)_T;\; i = T^2\left(\frac{\partial\varphi}{\partial T}\right)_p;\; s = \varphi + T\left(\frac{\partial\varphi}{\partial T}\right)_p \;\ldots [5]$$

and

$$u = T\left[T\left(\frac{\partial\varphi}{\partial T}\right)_p + p\left(\frac{\partial\varphi}{\partial p}\right)_T\right] \;\ldots\ldots [6]$$

By partial differentiation of φ with respect to either p or T all the fundamental magnitudes of steam can be found, and because of this φ is called the characteristic function of steam.

This is of importance not only for the superheat range of steam, but has a certain significance for the range of saturation, as it may be shown that at the limit of saturation the characteristic function has the same value for both steam and water. If superheated steam and water are brought into contact under conditions where all outside influences are excluded, then at each change of state the volume V, the internal energy U, and the mass M of the entire system must remain constant, and hence $\delta M = 0$, $\delta V = 0$, and $\delta U = 0$. The notation δ indicates a virtual, infinitely small variation of state, while d corresponds to an actual process. Since $M = M_1 + M_2$ (where subscript 1 refers to steam and subscript 2 to water), and similarly one may write $V = M_1v_1 + M_2v_2$ and $U = M_1u_1 + M_2u_2$, it is advisable to express the above equations of condition in the form—

$$\Sigma\delta M_n = 0,\; \Sigma M_n\delta v_n + \Sigma v_n\delta M_n = 0, \text{ and } \Sigma M_n\delta u_n + \Sigma u_n\delta M_n = 0 \;\ldots [7]$$

Here Σ denotes the summation of the magnitudes indicated by subscript 1 and subscript 2. If, in the system under consideration, equilibrium prevails, the entropy is a maximum and therefore its variable $\delta S = \Sigma M_n\delta s_n + \Sigma s_n\delta M_n$ is zero. Since, further, as has been shown above, one may write—

$$\delta s = \frac{\delta u + Apdv}{T}$$

it follows that

$$\delta S = \Sigma\,\frac{M_n\delta u_n}{T_n} + A\Sigma\,\frac{M_np_n\delta v_n}{T_n} + \Sigma s_n\delta M_n = 0 \;\ldots\ldots [8]$$

From the three equations of condition of state, expressions may be found for δM_2, δv_2 and δu_2. These expressions are introduced into Equation [8] for δS, which gives

$$\delta S = \left(\frac{1}{T_1} - \frac{1}{T_2}\right)M_1\delta u_1 + A\left(\frac{p_1}{T_1} - \frac{p_2}{T_2}\right)M_1\delta v_1 + \left(s_1 - s_2 - \frac{u_1 - u_2}{T_2} - \frac{Ap_2(v_1 - v_2)}{T_2}\right)\delta M_1 = 0 \;\ldots\ldots [9]$$

The three variables δu_1, δv_1 and δM_1 appearing here are entirely independent of each other and therefore in order that δS shall become zero for all changes of state, it becomes necessary that each of the three coefficients become zero; for this to take place it is necessary that $T_1 = T_2 = T$, and $p_1 = p_2 = p$, and—

$$s_1 - s_2 = \frac{u_1 - u_2 + Ap(v_1 - v_2)}{T}, \text{ or } s_1 - \frac{u_1 + Ap_1v_1}{T_1} = s_2 - \frac{u_2 + Ap_2v_2}{T_2} \;\ldots\ldots [10]$$

This proves that in the state of equilibrium the characteristic functions of steam and water are equal to each other. But the former, as has been shown above, may be expressed as a function of p and T providing c_p has been determined by measurement.

For example, Dieterici found that the specific heat of water is $c_{fl} = a - bT + cT^2$, where a, b and c are constants. From this it would appear that the entropy of the liquid is

$$s' = \int \frac{c_{fl}\,dT}{T}$$

and its heat content at the limit of saturation is

$$i' = \int c_{fl}\,dT + Apv_0.$$

Since v_0, the specific volume of water at 0 deg, cent., is known, the characteristic function $\varphi' = s' - i'$ may be computed and set down as being equal to the corresponding characteristic function of pure steam. This in its turn makes it possible to determine the saturation pressure and the heat of evaporation, provided, however, the specific heat of the steam has been correctly determined by measurement, which once more proves the great thermodynamic value of a correct knowledge of the specific heats of steam.

Prior to 1906 only very meager information was available as to the numerical relation between the specific heat of steam and pressure and temperature variations. Regnault was one of the first investigators to take the trouble to determine experimentally the specific heat of steam at atmospheric pressure and a temperature of about 175 deg. cent. (347 deg. fahr.), and he found that at these conditions $c_p = 0.48$. For a while this value was accepted not only as the average value within the temperature range of 128 to 221 deg. cent. (262.4 to 429.8 deg. fahr.), but a further step was taken and an erroneous conclusion drawn from Regnault's observations to the effect that c_p is generally independent of T.

R. Mollier accepted this assumption as a basis in working out his J-S diagram for steam, first published in 1904, and which had since become of great practical importance. He did this notwithstanding the fact that experiments carried out considerably earlier than the publication of his papers by Mallard and LeChatelier have given sufficient information to indicate the incorrectness of the above assumption. Although these two investigators clearly established that the numerical value of c_p increases in the higher ranges of temperature, nevertheless the belief in the invariability of the specific heat of steam continued to prevail and variations were admitted only within the highest ranges of temperature. As to the dependence of c_p on pressure, no information whatsoever appears to have been available at that time (1904). An important step in advance was made with the publication of the investigations of R. Linde and H. Lorenz in 1905. The former numerically calculated the specific heat c_p from the experimentally determined value of specific volume v and found that this decreased with increase of temperature and increased with increase of pressure. Lorenz came to the same conclusion from an investigation of specific heat by direct measurement, and at about the same time Callendar arrived at similar conclusions which compelled Mollier to revise his recently published diagram.

While the above investigations brought about a change of view as to the functional relation, if any, between the specific heat of steam on one hand, and temperature and pressure on the other, they did not solve the problem of the quantitative character of this relationship, and it was the work carried out at the Laboratory of Engineering Physics in the Munich High School by O. Knoblauch and M. Jakob that gave the first reliable figures (1906).

In the original experimental installation as used in Munich, the steam from the boiler went first into a water separator where dewatering was accomplished by mechanical means and thence passed into an electric superheater, in which latter the steam, after thorough drying, was raised to a temperature of t_1 deg. cent. Then in a second superheater the temperature was raised to t_2 deg. cent. by supplying the steam with a precisely measured amount of electrical heat energy equal to W cal. per hr. Thereupon the steam was condensed in two condensers and its weight G kg. per hr. was determined.

In order to compute the average specific heat within the temperature range of t_1 to t_2 from the data of measurement, employment was made of the formula—

$$c_p = \frac{W - V}{G\,(t_2 - t_1)}$$

where V is the unavoidable heat loss determined by separate tests.

The experiments were carried out over a pressure range of 2 to 8 atmos. and with temperatures ranging from around saturation to 350 deg. cent. (662 deg. fahr.). On the whole they led to the following conclusions: c_p, with temperature T constant, increases within increase of pressure, especially in the region near saturation; with the pressure constant c_p decreases with increase of temperature, reaches a certain minimum value, and then with increase of superheat begins to increase. The specific heat at 0 atmos. pressure is not constant, but rises with increase of temperature.

It would appear from this that the general conclusions arrived at at Munich, notwithstanding the presence of quantitative differences, are in the main in accord with former observations. These observations were further extended by the publication in 1911 of the investigations by Knoblauch and Hilde Mollier bearing on the specific heat of steam at pressures from 2 to 8 atmos. and temperatures of 350 to 550 deg. cent. (662 to 1022 deg. fahr.).

In these tests, also carried out in Munich, the boiler steam was dried in a gas-heated preheater and after it attained a temperature of t_1 deg. it was led into an electric superheater which constituted the real experimental unit. Here its temperature was raised to t_2 deg. cent. by the addition of an amount of heat energy W, and the steam was then condensed in a condenser. After weighing the condensate and determining the heat losses by a separate test, it became possible to compute the specific heat by the formula above referred to. The new tests have confirmed the increase in c_p with increasing pressure, likewise its initial falling off with rising temperature and the existence of a minimum. It was also found that within the limits of temperature of 350 to 550 deg. cent. (662 to 1022 deg. fahr.) the increase in specific heat with increase in pressure became constantly smaller, so that ultimately the difference of values of c_p at equal temperatures and various pressures could barely be determined. The increase in specific heat with increase in superheat was observable also in the above range.

The minimum value attained by c_p with increase in temperature and determined by the Munich experimenters was confirmed later by the important investigations of L. Holborn and F. Henning, who worked with atmospheric pressure and temperatures up to 1350 deg. cent. (2462 deg. fahr.).

Investigations at such high temperatures appear, however, to have a theoretical rather than a practical interest. Of greater engineering importance are the determinations published in 1917 from work carried on again in Munich by O. Knoblauch and A. Winkhaus concerning the specific heat at pressures of from 8 to 20 atmos. and temperatures from the limit of saturation to 380 deg. cent. (716 deg. fahr.). In these tests the experimental installation already described was used, and c_p was computed in the same manner as before. It was found that there is also an increase of specific heat with increase in pressure in the new range of high pressures. As compared with the data of tests made in 1911 there were found slight variations in the region near saturation. There the numerical values of c_p were shown by the new investigation to be somewhat lower than the previous investigation would indicate, the new values being closer in accordance with the values of Holborn and Henning. Although the tests at Munich were carried on to pressures up to 30 atmos., it may be said that dating from the appearance of the investigation by Knoblauch and Winkhaus c_p may be considered as definitely known within the ranges used in ordinary engineering. It is also claimed that the theory for making use of the experimental observations has also been carried to a full practical conclusion, and that such a conclusion was reached when it became possible to derive by calculation all the magnitudes of the state of steam from data obtained by measurement.

At the same time, however, the analytical work of deriving one of the magnitudes defining the state of steam from another is by no means easy. This was found when an attempt was made to derive the specific heat c_p from an equation found experimentally by R. Linde for the specific volume of steam, namely,

$$v = \frac{RT}{p} - (1 + ap) \times \left[C\left(\frac{373}{T}\right)^3 - D \right] \ldots\ldots [11]$$

in which R is the gas constant (47.1), and a, C and D are constants. Notwithstanding the fact that the above equation expressed with the greatest possible precision experimentally observed data, and the further fact that there is available for determining c_p from v the relation—

$$\left(\frac{\partial c_p}{\partial p}\right)_T = -AT\left(\frac{\partial^2 v}{\partial T^2}\right)_p \ldots\ldots\ldots\ldots\ldots [12]$$

derived by Clausius, the computation led to results which quantitatively could not be brought into accord with data found by actual measurement. The same happens when use is made of

the modified equation for specific volume proposed by Callendar, or the modification of the Linde formula given by Goodenough.

The reason for this was indicated in 1912 by Jakob. From the Clausius equation it follows directly that—

$$c_p = c_p{}^0 - AT \int_0^p \left(\frac{\partial^2 v}{\partial T^2}\right)_p dp \qquad [13]$$

when $c_p{}^0$ is the value of specific heat in the ideal gaseous state. Because of this, in order to obtain c_p from v, it becomes necessary to carry through a double differentiation of the equation for the specific volume. This latter, written in a simplified manner, has the form

$$v = \frac{RT}{p} - \Delta v$$

where Δv is a correction term expressing a deviation from the law of gases. Hence

$$\left(\frac{\partial^2 v}{\partial T^2}\right)_p = -\left(\frac{\partial^2 \Delta v}{\partial T^2}\right)_p \text{ or } c_p = c_p{}^0 + AT \int_0^p \left(\frac{\partial^2 \Delta v}{\partial T^2}\right)_p dp \qquad [14]$$

From this it would appear that the determination of c_p depends primarily on the uncertain correction term in the equation of state and the double differentiation of the latter may easily lead to error. It is easy to understand why the failure of previous attempts created an impression that it would be generally impossible to establish a satisfactory connection between v and c_p on the basis of the Clausius equation. Jakob disproved this view by deriving from specific heats specific volumes by means of a system of c_p isobars in the c_p-t diagram. He did this graphically by using the relation—

$$v = \frac{RT}{p} - \frac{1}{A}\int_{T_0}^T \int_{T_0}^T \frac{1}{T}\left(\frac{\partial c_p}{\partial p}\right)_T dT^2 \qquad [15]$$

which is derived from the Clausius equation and in which T_0 is the temperature of the ideal state of gas.

Jakob, however, also considered as hopeless all exclusively analytical attempts at solving this problem, and it was only in 1916 that R. Planck succeeded in deriving an expression for the shape of the c_p isobars, which, on one hand reproduces with sufficient precision the experimental data, and on the other hand, permits that double integration which is necessary in order to determine v from c_p, as would appear from the above equation. In this he was successful, which means that the values of specific volume analytically found by him were in sufficient accord with the volumes determined by actual measurement. Unfortunately, however, his work is of greater value from the point of view of mathematics than of practical engineering, because his equation of state is of such a complicated form as to make its use in engineering impossible. Complete success in this field was attained only in 1920 by G. Eichelberg, who gave to the c_p isobars an expression of very high precision:

$$c_p = c_p{}^0 + \frac{C_1 p}{T^4} + \frac{C_2(p + 2 \times 10^4)^{3.2} - C_3}{T^{15}} \qquad [16]$$

where C_1, C_2 and C_3 are constants. From this it follows that—

$$\left(\frac{\partial c_p}{\partial p}\right)_T = \frac{C_1}{T^4} + \frac{3.2C_2(p + 2 \times 10^4)^{2.2}}{T^{16}} \qquad [17]$$

If this is inserted in the Clausius equation we obtain—

$$A\left(\frac{\partial^2 v}{\partial T^2}\right)_p = -\frac{C_1}{T^5} - \frac{3.2C_2 \times (p + 2 \times 10^4)^{2.2}}{T^{16}} \qquad [18]$$

and by double integration with respect to T we have—

$$Av = \psi(p) + T\varphi(p) - \frac{C_1}{3 \times 4\, T^3} - \frac{3.2C_2(p + 2 \times 10^4)^{2.2}}{14 \times 15 \times T^{14}} \qquad [19]$$

The undetermined functions $\psi(p)$ and $\varphi(p)$ necessary for the solution of the partial differential equation can be taken care of by the assumption that when temperature T rises, the values of specific volumes approach asymptotically those of the ideal gas. If this be so, then

$$T = \infty,\ v = \frac{RT}{p}, \text{ and } \left(\frac{\partial v}{\partial T}\right)_p = \frac{R}{p}.$$

Hence $\partial(\varphi) = \dfrac{AR}{p}$ and $\psi(p) = 0$.

By inserting these values in Equation [19], an equation of state is found giving values of specific volumes in every respect in accord with those derived experimentally. The correction member of this equation has the form $f(p, T,)$ while that of the equations of Linde, Callendar and Goodenough has the form $f(p)g(T)$, and it is this latter form that has been cited by Jakob as the main reason for previous failures to derive analytically c_p from v. Jakob's objections do not hold against Eichelberg's formula and its comparatively simple structure appears to make it suitable for practical purposes. Thus by this means one can compute without much trouble the entropy s and the heat content i from the generally known thermodynamic equations—

$$di = c_p dT - A\left[T\left(\frac{\partial v}{\partial T}\right)_p - v\right]dp \qquad [20]$$

and

$$ds = \frac{c_p}{T}dT - A\left(\frac{\partial v}{\partial p}\right)_T dp \qquad [21]$$

Then again with expressions for i and s available, the preparation of entropy tables becomes very much simplified through the elimination of the time-consuming planimetering of c_p- and c_p/T-curves. Furthermore, the Eichelberg equation makes it possible to determine analytically the exponents of the adiabatics of superheated steam, so that on the whole this equation may be considered as the keystone of a notable series of important investigations in a field of scientific and engineering importance. (*Zeitschrift f. Dampfkessel und Maschinenbetrieb*, vol. 44, nos. 1 and 2, Jan. 7 and 14, 1921, pp. 3–4 and 12–13, *pA*)

Improved Methods of Fatigue Testing

By H. J. GOUGH

REPORT submitted in April of this year by the author, member of the Engineering Department of the National Physical Laboratory, to the Materials and Chemistry Committee of the Aeronautical Research Committee, and published in advance of its official appearance.

The machine used in these tests is shown in Fig. 1 with some slight changes dealing chiefly with the lubrication arrangements and method of drive.

SccS is the central crankshaft with a heavy flywheel *F*. It is driven by a direct-coupled electric motor—not shown. The throw, or double radius, of each crank is 1 in. Two connecting rods *KK* join the rotating cranks *cc* to the balanced rocking arms *CC*, whose radii are 4 in. The shafts of the rocking arms end in clutches *QQ*, and the spindles of the two oscillating masses *WW* have similar clutches into which the ends of the test pieces *TT* can be secured. The oscillating masses *WW* are built up of a number of circular disks, the polar moments of inertia of which are known.

The original article shows the method of calculating stresses in specimens under test and the forms of test pieces—hollow and solid. It is obvious from the description of the machine that the fatigue on the material was induce by the action of the unbalanced flywheels.

Several methods of determining the torsional fatigue limit were considered, namely: (1) The rate of increase of strain with stress; (2) the rate of increase of width of the hysteresis loop with stress; and (3) the rate of increase of temperature due to internal work with stress. Methods 1 and 3 were those chiefly used. The specimen was placed in the holders and the machine run at low speed. The speed of the machine was hand-controlled throughout the test. When the galvanometer reading had become steady, it and the

strain-scale reading were taken. The speed was then increased by increments of 10 r.p.m., both scales being read at each speed. At a certain speed dependent upon the material, the amplitude of the motion of the spot suddenly increased. In most cases this increase was quite sudden and definite, the band of light opening out at both ends. In some cases the galvanometer mirror also swung across at the same time. Sometimes, however, this effect happened at a slightly higher speed and the yield point was seldom shown as clearly by the thermocouple as by the strain scale.

The material chiefly experimented on was 0.65 per cent carbon steel. The scale readings for both the thermocouple and strain

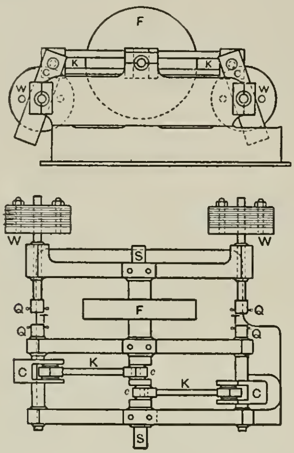


Fig. 1 Stromeyer's Machine for Measuring Alternating Torsion

scale are plotted against speed of machine in Figs. 2 and 3. The very definite nature of the yields is shown clearly by the curves. The "yield" point incurred at stresses of ±10.2 and ±10.5 tons per sq. in. for the solid and hollow test pieces, respectively. The difference may safely be ascribed to slight differences between the actual specimens tested. The thermocouple curve for the hollow specimen indicates the same "yield" point as the strain or deflection curve. With the solid specimen, however, the thermocouple curve gives the breakdown as occurring at a slightly higher speed than that given by the deflection curve. This difference is highly important as affecting the calculated stress at which breakdown occurs.

Reference to the formula from which the stress is calculated—

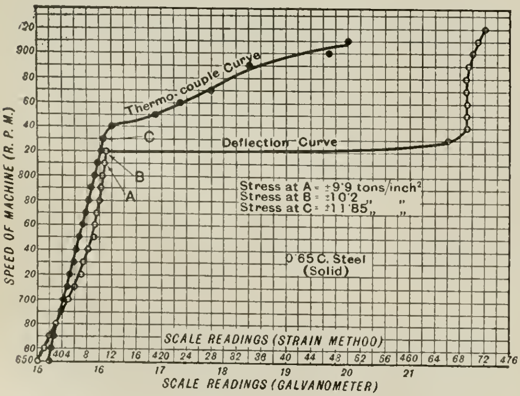
$$f_s = \pm KM\theta n^2/I$$

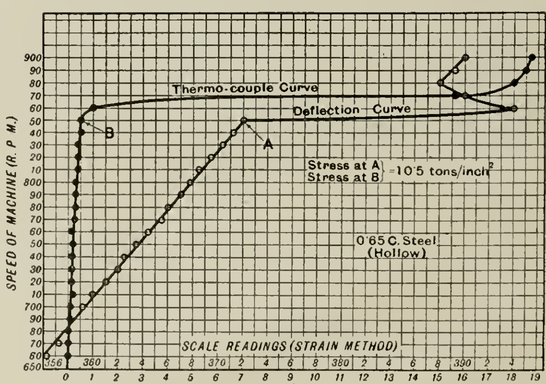
shows that the stress is proportional to the amplitude of the oscillating mass. In Fig. 2 the calculated stresses at the points A, B and C are as follows: Stress at A = ±9.9 tons per sq. in.; stress at B = ±10.2 tons per sq. in.; stress at C = ± 11.85 tons per sq. in.

Considerable error is involved if the yield point is assumed to be (from the thermocouple curve) at C instead of at B (from the strain curve). In several other tests a similar "lag" was noted on the thermocouple curve.

To show this point more clearly, Figs. 2 and 3 have been replotted to "stress" ordinates—see Figs. 4 and 5. That the fatigue limit is masked by the thermocouple in the case of the solid specimen may have been due to the following causes: (1) The galvanometer used may not have been sufficiently sensitive; (2) owing to the larger heat capacity of the solid specimen, the lag of the thermocouple may be a time effect. In some further experiments now being carried out, a galvanometer of much greater sensitiveness is being employed. Also a longer time interval is allowed before the galvanometer is read. With these precautions the thermocouple indicates the fatigue range at a stress in agreement with that given by the yield method. The change of slope of the stress-temperature curve is, however, nearly always less than that of the stress-strain curve. This fact would lead to the inference that if the calorimetric method of determining fatigue limits were used in a machine in which the stress applied was independent of the strain—the usual type of testing machine—it would be extremely difficult to estimate the stress at which the slope of the stress-temperature curve changed.

There is no doubt that the success of the yield and calorimetric methods described in this paper are due to the state of instability of the specimen under test, owing to the character of the machine employed. Directly a yield in the specimen occurs, the stress is automatically increased, producing a greater yield, and this multiplying effect continues until a second state of equilibrium of partial stability occurs. Careful deflection readings must obviously be taken in order to calculate the fatigue limit as shown by the thermocouple curve. Three observers are necessary for a calorimetric determination, whereas only two are required for the strain method. These facts lead to the conclusion that the strain method is more accurate and practical, although the calorimetric method is useful as a check.





Figs. 2 and 3 Thermocouple and Deflection Curves for Solid and Hollow Specimens of 0.65 per cent Carbon Steel

From these tests on 0.65 per cent carbon steel, the following conclusions were drawn: (1) That the fatigue limit under reversed shear stresses is marked by a "breakdown" or "yield" point in the material, as in Smith's experiments with direct stresses; (2) that this breakdown point is independent of the form of the section, solid or hollow; (3) that Guest's law applies to fatigue stresses. It can then be seen that these results and conclusions confirm those obtained by Dr. J. H. Smith for alternating direct stresses.

A curious phenomena was observed in the case of nickel, Fig. 6.

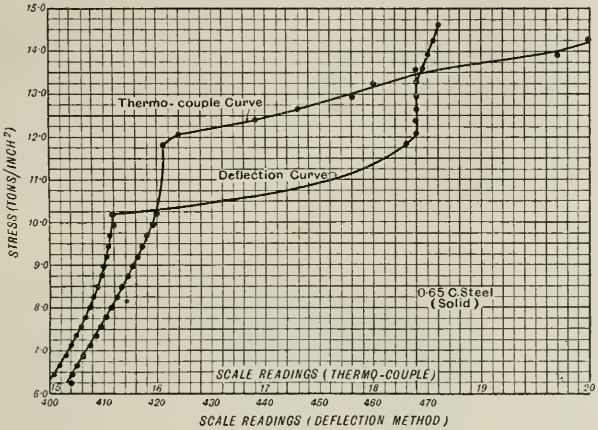
The material definitely yielded and again recovered. This is the only material which has, so far, behaved in this way.

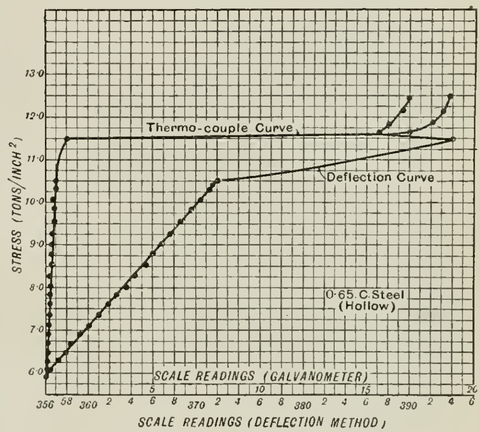
Fig. 7 shows the results of the test on Swedish iron. The material was apparently very unstable up to a certain speed (500 r.p.m.). For the next two increments of speed the strains increased regularly, followed by a definite yield. Subsequently the strains again increased in a regular manner. This result was so unexpected that a second specimen of the same material was prepared. The mass of oscillating weight was reduced so that the breakdown would occur at a higher speed. The curve obtained was very similar to the first. Whether the peculiar shape of the first part of the curve is due to a change in the modulus of rigidity as the stress increases, it is as yet impossible to say.

The following possible, quick method suggested itself for determining the fatigue limit. If the load were increased by increments and the deflection of the end of the cantilever observed, then a deflection-load diagram would probably indicate a "breakdown" point at the fatigue limit. Owing to the fact that the maximum stress occurs only at the one section, the "breakdown" would probably be visible as an "elastic limit" effect rather than as a "yield" effect as in torsion.

A plane mirror was affixed to the non-rotating ball cage and the deflection magnified optically. At each load the image of the filament on the scale was read. It was necessary, owing to the weights employed, to remove the load altogether at four points, with the result that the ball cage fell slightly. The curve at these points was consequently discontinuous, but for the specimen used, the 0.65 per cent carbon steel (as used in the torsion experiments), a departure from the straight-line law was clearly indicated at a point corresponding to a stress of ± 20.74 tons per sq. in. The endurance tests, it will be recalled, had given the fatigue limiting stress as ± 21.0 tons per sq. in.

The experiment seemed to indicate that the method would prove an extremely quick and reliable one for determining the fatigue limit under reversed bending stresses. The apparatus was accordingly modified so that the load could be applied continuously. The mirror was mounted on the specimen and allowed to rotate with it. Fig. 8 shows the new arrangement. A 150-lb. capacity single-lever weighing machine was mounted on top of the Wöhler machine and the load applied by means of an adjustable rod and a stirrup on the outer ball race. Details of the mirror attachment are indicated in the illustration.





Figs. 4 and 5 Curves of Figs. 2 and 3 Replotted to Stress Ordinates

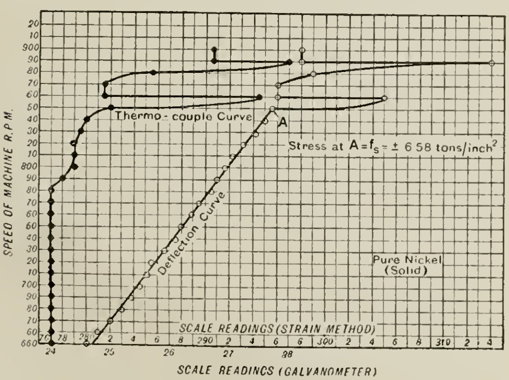


Fig. 6 Thermocouple and Deflection Curve for Solid Specimen of Pure Nickel

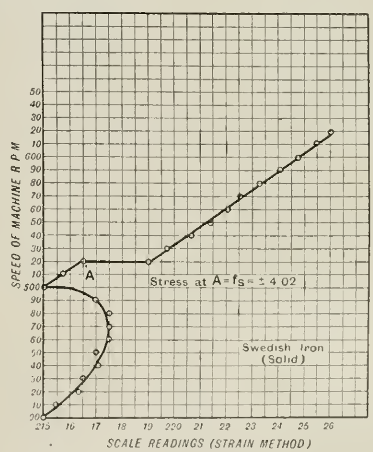


Fig. 7 Deflection Curve for Solid Specimen of Swedish Iron

Four materials have been experimented on using the modified apparatus: 0.65 per cent carbon steel (as used in the torsion tests); pure nickel (as used in the torsion test); a phosphor bronze (ultimate stress 36 tons per sq. in.); and a case-hardening steel. The observations taken from the 0.65 per cent carbon steel are shown plotted in Fig. 9. The other materials gave curves of the same type. The scale readings increase directly with the load until

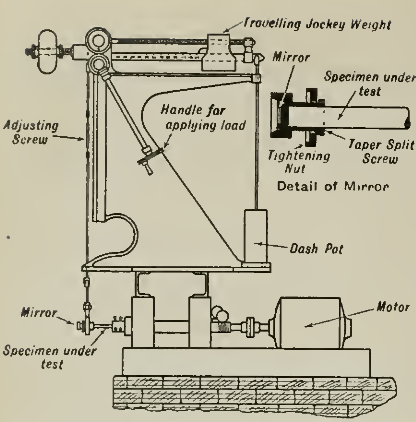


Fig. 8 Modification of Machine Shown in Fig. 1 Adapted for Quick Determination of Fatigue Limit Under Reversed Bending Stresses

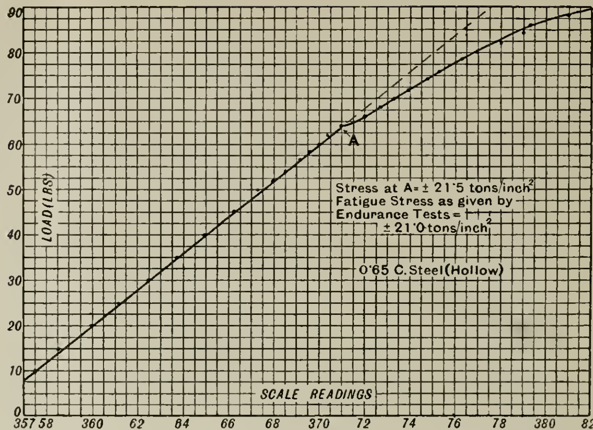


Fig. 9 Deflection Curve for Hollow Specimens of 0.65 per cent Carbon Steel Under Reversed Bending Stress

a certain stress is reached. Here a slight yield occurs. Subsequently the scale readings increase at an increasingly quicker rate than the load.

The stress at which the yield occurs coincides approximately with the limiting fatigue stress as found by the endurance tests.

The fatigue limiting stresses of nickel and the case-hardening steel as found by this new method on a solid specimen agree with the limiting stresses as found by endurance tests on hollow specimens. This fact indicates that the results obtained by this method are independent of the form of specimen used, a very important point, as the cost and difficulty of machining hollow specimens are rendered unnecessary. Table 1 compares the results obtained on the single specimens with those obtained by endurance tests.

TABLE 1 RESULTS OBTAINED ON VARIOUS METALS IN MEASURING FATIGUE LIMIT UNDER REVERSED BENDING STRESSES

Material	Fatigue limiting stress under reversed bending stresses: By deflection method on a single specimen, tons per sq. in.	By endurance tests on six specimens, tons per sq. in.
0.65 per cent carbon steel	±21.5	±21.0
Pure nickel	±13.26	±13.2
Phosphor bronze	±17.2	±17.8
Case-hardening steel	±33.6	±32 to ±35

Six specimens of each material are usually used in the endurance tests. (*The Engineer*, vol. 132, no. 3424, Aug. 12, 1921, pp. 159–162, 13 figs. and 4 tables, *eA*)

Short Abstracts of the Month

CORROSION (See Power-Plant Engineering)

ENGINEERING MATERIALS

Investigation of Physical Properties of Metals at High Temperatures Preceding Their Interval of Plasticity. Data of an investigation carried out under the direction of Professor Cantone in the Laboratory of Experimental Physics of the University of Naples. The investigation carried out by Dr. Mary Kahanoviez has been published in the Proceedings of the Accademia dei Lincei and deals mainly with the question of the transformations which occur in metals as a result of various heat processes. These were deduced from the emission of radiant energy from the metal. It was found that metals follow a simple law of emission which may be expressed by an equation of the type $E = kT^n$, where E is the energy emitted at the given absolute temperature T, and k and n are characteristic constants of the given body. The law of emissivity for oxides of metals is expressed by a more complicated function.

As regards the transformations found, it appears that they differ from oxidations in that they take place with absorption of heat, are reversible and tend in general to make the metal more specular. With nickel, the transformation takes place at between 350 and 370 deg. cent. (662 and 698 deg. fahr), while with iron the point is found around 739 deg. cent. (1346 deg. fahr.). Of particular interest is the case of silver, where the transformation takes place around 770 deg. cent. (1418 deg. fahr.) and has not been discovered by any other method.

The investigation by Dr. Washington Del Regno deals with residual variations in electrical resistance produced as result of heat processes in nickel steels. (*Il Forno Elettrico*, vol. 3, no. 5, May 15, 1921, pp. 71–73, *g*)

Mechanical Properties of Steel at High Temperatures

Universal Steel Classification Code. Horace C. Knerr and Arthur L. Collins. The present system of steel classification known as the S.A.E. system, is believed to be limited in scope and arbitrary rather than scientific.

Nine years ago when the system was inaugurated, alloys were few and the system did not provide for an indefinite expansion in that direction to meet present and future need.

The system was based on the use of numerals, which does not easily permit of expansion. Because of these and some other considerations, a new system was proposed in which letters in addition to numerals were employed, the letter system having the advantage that (omitting O and I) there are 24 available units as compared to nine with numbers. A letter is therefore chosen to represent, or at least suggest, the name of the material in question and numerals are used solely to indicate the quantities. In this way the alloy is expressed in a form somewhat similar to a chemical formula. The only question is whether such a system can be made sufficiently simple to meet practical requirements. The authors claim that it does.

To show how such a system works as compared with the present S.A.E. system the following examples may be cited:

Nickel Steels ("N" Steels)

Proposed	Present
20N1	2120 (1 per cent nickel, 0.20 per cent carbon)
20N2	2220 (2 per cent nickel, 0.20 per cent carbon)
35N3	2335 (3.50 per cent nickel, 0.35 per cent carbon)

Nickel-Chrome Steels ("NK" Steels)

Proposed	Present
20N1K	3120 (1.25 per cent Ni, 0.60 per cent Cr)
30N2K1	3230 (1.75 per cent Ni, 1.10 per cent Cr)
40N3K2	3340 (3.50 per cent Ni, 1.50 per cent Cr)
35N3KX	X3335 (3.00 per cent Ni, 0.80 per cent Cr)

(*The Iron Age*, vol. 108, no. 9, Sept. 1, 1921, pp. 515–517, *p*)

Experimental Investigation of the Mechanical Properties of Steel at High Temperatures, Eugene Dupuy. After a brief historical introduction the author comes to the conclusion that what previous work has shown is that steel at around 300 to 400 deg. cent. (572 to 752 deg. fahr.) exhibits a "blue brittleness," the characteristic of which is that the breaking load is higher and the reduction of area is at a minimum, above which temperature the breaking load gradually falls off and a greater reduction of area is observed reaching its maximum at around 1000 to 1300 deg. cent. (1832 to 2372 deg. fahr.)

An investigation by Rosenhain and Humphrey in 1913 appears to show that the curve indicating the relation between the temperature of the metal and the breaking load has two points of discontinuity which are perfectly well established and a third one which is doubtful.

The present author carried out a series of tests on plain carbon steel with the carbon content varying from 0.15 to 1.23 per cent both in its original state and heat-treated. From these it would appear that as the temperature increases, the breaking load begins to fall off. It is at a maximum of 300 deg. cent. (572 deg. fahr.), or in the region of "blue heat," and from then on it begins to fall

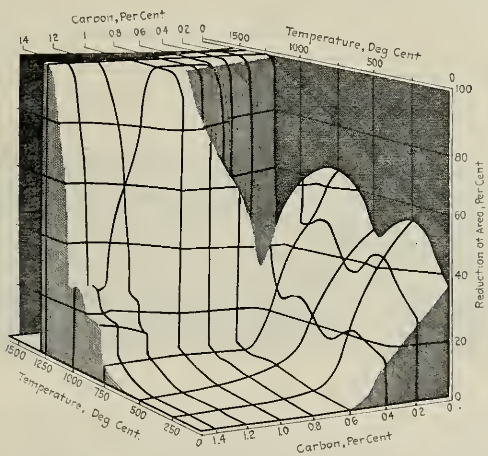


Fig. 1 Temperature-Carbon Content-Reduction of Area Curves for Non-Heat-Treated Ingot Steel

off, showing, however, a slight irregularity from about 450 to 550 deg. cent. (842 to 1022 deg. fahr.) up to a little below 750 deg. cent. (1382 deg. fahr.), the curve in this region having a shape somewhat like the letter U. Thereafter the breaking load decreases again up to the point where liquidus appears and the breaking load suddenly falls to zero. The U characteristic of the curves appears, however, only in hypoeutectoid steels and is absent in eutectoid steels.

These various phenomena are still more apparent in connection with reduction of area. At first there is a slight decrease of reduction of area, reaching a minimum at about 300 deg. cent. (572 deg. fahr.), or a temperature corresponding to the maximum on the curve of breaking loads. Then around 450 deg. cent. (892 deg. fahr.) there is a rapid decrease all the more marked the less ferrite the metal contains. After a short level stretch the reduction of area diminishes slightly and then begins to increase until a temperature of about 775 deg. cent. (1427 deg. fahr.) is reached. From this point on various steels show a different behavior depending on their carbon content. Mild steels show a rapid decrease of reduction of area up to 875 deg. cent. (1607 deg. fahr.). This is followed by a wavy curve with a maximum of 100 per cent at about 1050 deg. cent. (1922 deg. fahr.) which occurs simultaneously with the zero of breaking loads (appearance of liquidus).

The minimum in the region of 900 deg. cent. (1652 deg. fahr.) is the less pronounced the greater the carbon content. In the case of eutectoid steels the curve of reduction of area begins to rise at about 600 deg. cent. (1112 deg. fahr.) and attains 100 per cent at 760 deg. cent. (1400 deg. fahr.)

The behavior of 1.25 carbon steel proved to be different from that of the other steels. From this point of view, Fig. 1 is of considerable interest as showing the relation between temperature carbon content and reduction of area in ingot metal not submitted to any previous heat treatment.

The author divides all carbon steels into the following classes below the A_1, and A_2 as a limit:

Extra mild steel; The ferrite breaks by cleavage before rupture.

Hypo-eutectoid steels: The ferrite alone undergoes noticeable deformation, the rupture taking place when the little islands of pearlite come together.

Eutectoid steels: Rupture practically without deformation.

Hypereutectoid steels: Brittleness due to the presence of cementite.

Austenitic region: No matter what the content of carbon may be, the γ iron is completely plastic.

The region between A_1 and A_2: Plasticity increases with the content of γ iron.

Region between A_2 and A_3: Rupture takes place practically without deformation because of the low content of γ iron and the brittleness of iron in the β region.

Appearance of liquid material: Sudden and simultaneous falling off in the value of the rupturing load and plasticity. (*Revue de Metallurgie*, vol. 18, no. 6, June 1921, pp. 331–365, numerous illustrations, *etA*)

FOUNDRY

Description of Foundry Plant at Warren, Ohio

Continuous Foundry for Pipe Fittings. Henry M. Lane, Mem. Am.Soc.M.E. Description of a foundry plant built at Warren, Ohio, and designed with the view to minimum handling of sand, castings, cores, hot metal and flasks. Only some of the outstanding features will be noted here.

For core making a mixture has been adopted composed of a sharp or lake sand like Michigan City sand, a certain amount of molding sand, and a binder made from waste-liquor refuse from the sulphite paper process. No oil is used. After the mixture is made, it is dropped directly from the bottom of the mixer through a chute into the elevator and passes up to the sand-storage bins over the core room. The secret of the success of this mixture is believed to be largely due to the fact that in a continuous foundry a water-soluble binder may be used as the cores do not remain in the mold long enough to draw dampness.

The production is arranged along the following lines: The molders set out a group of molds at one side of the floor and the pouring gang then comes along and pours this while a group of molds is being put up on the opposite side of the floor. The first group is poured and shaken out and the flasks stacked back before the second group is completed. It is said that they have been able to utilize the floor from four to seven times, depending on the type of work.

In the design of the plant an earnest effort was made to reduce the handling distance to a minimum. It has already been shown how the arrangement of molds minimizes the distance that a molder must carry his molds to set them out. Another economy in distance of handling has been obtained by placing the tumbling bars adjacent to the ends of the casting chutes. The series of casting chutes and the Sly tumbling barrels on the first floor are interspersed. Over the molding floor are a series of underslung cranes with Brillion pouring devices, so that the pouring gang can pour off without the use of hand ladles. The metal is distributed down the gangway in the center by means of monorail. There are other monorails; e.g., one carries the sand from the sand chutes to a bin at the end of the plant, where it is fed to a mixing machine (*The Iron Age*, vol. 108, no. 9, Sept. 1, 1921, pp. 519–524, 10 figs., *d*)

HYDRAULICS

Large High-Head Turbine Unit—Water Leakage and New Labyrinth Seal

Big Creek Development of the Southern California Edison Company. F. H. Rogers. Description of a 30,000-hp. unit designed to operate under a 680-ft. head at a speed of 428 r.p.m., and consisting of a vertical-shaft single-runner Francis type turbine directly connected to a 22,500-kw. 14-pole 50-cycle 11,000-volt generator. The water is led to the turbine through a penstock 2800 ft. long with a diameter of 7 ft. at top and 6 ft. at bottom.

Particular effort was taken to reduce leakage at the runner seals, which is an important factor in the design of high-head units. In this case it is claimed that it is considerably reduced by the use of the Moody labyrinth seal device shown in Fig. 2. In this the leakage water must pass through a series of six seals, at each of which the velocity head is destroyed owing to changes in section and direction of flow. It is claimed that the effective head causing the leakage is only one-sixth of the head for a single seal and that the use of this device will reduce the leakage to only about 0.9 per cent of the full-load quantity, which is about one-third of that which would occur with the single seal.

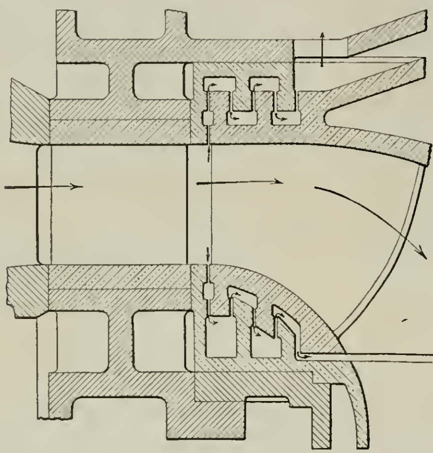


Fig. 2 Section Through Runner of 30,000-Hp. Hydraulic Turbine Showing Labyrinth Seals

As the operation of the unit is continued this leakage loss increases, since the wear at the seals is directly proportional to the velocity of flow through the seals, and as this velocity is about three times as great for the single seal as compared to the labyrinth seal, the wear at the former would be about three times as rapid as for the latter type. It is claimed that after continuous operation for a period of a year the leakage through the labyrinth seal would be only 22 per cent (as compared with 33 per cent for a new turbine) of the leakage occurring with the single seal.

In the usual design of the guide vane there is constant leakage between the top and bottom of the vane and the distributor plates and as this water is not properly guided by the vane it strikes the runner vanes at an incorrect angle causing considerable trouble. The guide vanes in this plant are of the type known as the Overn disk vane (Fig. 3) in which two heavy disks are cast at the junction between the vane and the upper and lower seams. When installed in the turbine the faces of these disks are flushed with the distributor plates so that they prevent any flow above or below the guide vane proper, except for that small portion of the vane which extends beyond the disk. As a result all the water is guided to the runner faces at the proper angle, and when the vanes are in the closed position there is very little leakage.

The original article describes also the draft-tube design, the casting design and the design of the valve.

One of the interesting features of the governor control is the method of change from governor to hand control. In former designs this change usually entailed the closing of three or four large governor valves and the opening of three or four smaller hand-control valves under high pressure. This not only takes considerable time but might lead to serious trouble in case the operator through excitement closes the valves in wrong sequence. In the present installation the governor is furnished with an automatic device known as the Taylor control system, consisting of plunger valves in the governor-base stand operated by oil pressure from the governor system. A single movement of a lever automatically operates all the valves at the same time, closing the governor valves and opening the hand-control valves. (*Power*, vol. 54, no. 7, Aug. 16, 1921, pp. 244–248, 9 figs. *dA*)

Flow of Water Through Galvanized Spiral Riveted Steel Pipe, F. W. Greve. Data of experiments performed in the hydraulic laboratory of Purdue University. The diameters of pipes tested were 4, 6, 8 and 10 in., respectively. The average spacing of the rivets was $^{7}/_{8}$ in. for the smaller and $1^{1}/_{8}$ in. for the larger pipe. The rivet heads on the inside of the pipes projected $^{1}/_{10}$ in. from the pipe wall and were flattened to reduce the resistance to flow.

The relation of friction head per 100 ft. of pipe to velocity of flow both with and against laps, is shown in the original article by a graph. The graphs are straight lines indicating that the head loss varies directly as some power of the velocity. They are nearly parallel lines, which demonstrate that the slope varies but little with the size of pipe. From the figure it also appears that the loss decreases with increase of diameter for any given velocity; that the loss is greater for flow against than with laps and that the difference of loss with and against decreases with increase of diameter. It would appear, therefore, that the flow in large sizes approaches the conditions of smooth pipes.

Fig. 3 Guide Vane of the Overn Disk Type

The friction loss may be expressed as $h_L = mv^n$, where h_L is the loss due to friction expressed in feet of water, v the true mean velocity in feet per second, m the value of h_L when v is 1 ft. per sec., and n is the slope that the graph expressing the relation of h_L to v makes with the horizontal.

The original article gives a table showing certain of the variations of m and n, these relations being of such a character that they are readily established. On the whole it would appear that the friction loss in galvanized spiral riveted steel pipes when the flow is with the laps is little different from that in smooth cast-iron pipes. (*Engineering News-Record*, vol. 87, no. 4, July 28, 1921, pp. 159–160, 3 figs., *e*)

MACHINE TOOLS

Hydraulic Speed Control for Machine Tools

The Oilgear—A Variable Speed- and Feed-Control System for Machine Tools. Description of a speed-control system employing what appear to be some novel devices and permitting a large number of variations of speed and feed without stopping the machine.

The pump unit of the oilgear system comprizes a revolving driver carrying five or seven crossheads and plungers with a corresponding cylinder barrel revolving with the driver and carrying the cylinders in which the plungers reciprocate. By shifting the center of the cylinder barrel the stroke may be varied to suit the conditions to be met. This stroke variation may be met either directly by the

operator or controlled by an outside influence, such as pressure, temperature, centrifugal force, etc.

The motor unit may either be a simple plunger or a revolving multiple plunger unit similar to the pump, except that in the motor the plungers generally have a constant stroke, so that stroke changing mechanism is absent. Because of this the speed of the motor is dependent upon the rate at which the working fluid is delivered by the pump and it varies as the stroke of the pump is increased or diminished.

In addition to this, there is a third unit called the gear pump and acting as a make-up pump for the system. It draws working fluid, which is usually oil from the surplus supply, and keeps several pounds pressure constantly on the intake line of the main pump. It may be also used as a means of rapidly transversing the tool carriage at a speed many times that required for feeding.

The principal unit in the feed-control system is the feed controller, shown in Fig. 4. The controller is essentially a casing including a small variable-delivery pump having a capacity suitable for the small volumes called for in feeding tool carriages, a much larger constant-delivery pump (gear pump) for rapid traverse, a stroke-changing mechanism whereby the operator can accurately set the variable pump-stroke-changing handle, and operating to selectively connect one or the other of the two pumps to the feeding motor according to whether feeding movements or rapid traverse movements are required at the moment.

The plungers are fitted in radial reamed cylinders in the circular cylinder barrel *A*, closely fitted for rotation on a hardened and ground ported pintle *B* and fitted into a swinging arm *C* by means of which the revolving cylinder barrel may be shifted from one side to the other of the revolving driver *D* carrying and operating the plungers. Both driver and cylinder barrel continuously revolve around centers which coincide when the swinging arm is placed in central position and whose distance from one another may be increased in either direction by swinging the arm either to right or left. As the cylinder-barrel axis is moved to right or left the length of stroke of the plunger is correspondingly increased, and results in a flow of oil through the pump in direct ratio to the length of the stroke. This mechanism also gives a reversal of the flow, oil passing through the pump in one direction when the swinging arm *C* is moved to the right, and in the opposite direction when it is moved to the left.

Cam *G* is made with extreme accuracy, giving a speed variation for the tool carriage capable of the finest degree of adjustment. Moreover, after the cam has been swung about through a certain angle it again returns the cylinder barrel to neutral position, thus cutting off the flow from the high-pressure pump and preparing the way for further swing of the control valve which connects the flow from the gear pump to the feed motor, to effect the rapid traverse.

The feed cylinder or motor on a machine tool must have hydraulic fluid on both sides, and the entire system including pipe connections must always be full of fluid under a moderate pressure to exclude air and insure an absolutely steady movement of the tool carriage. The maintenance of this make-up pressure, return of leakage, etc., is an additional function of the gear pump.

Two types of feeding motors are employed—the direct-acting pushing cylinder and the rotary motor. (*American Machinist*, vol. 55, no. 7, Aug. 18, 1921, pp. 271-274, 11 figs., *d*)

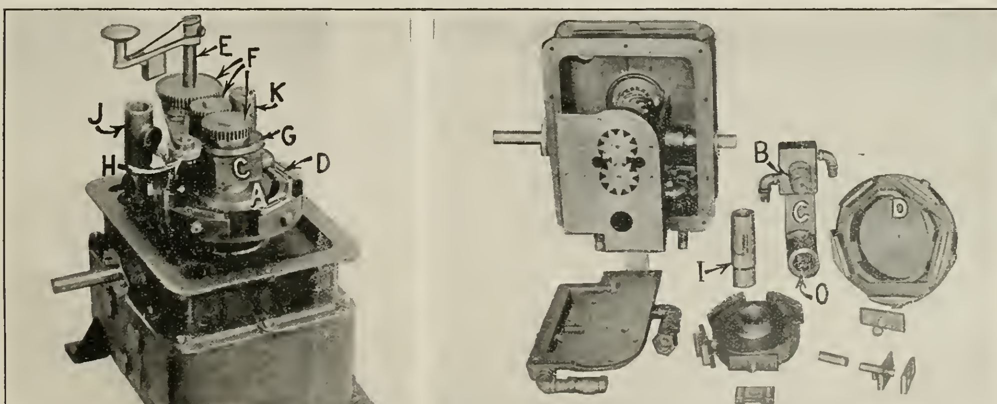


Fig. 4 Control Box with Cover Removed and Its Working Parts

Combination Lathe, Milling and Drilling Machine. Description of a combination machine of American manufacture designed primarily for use in garages, on shipboard and in other places where a rather complete equipment is required and floor space is at a premium (Fig. 5).

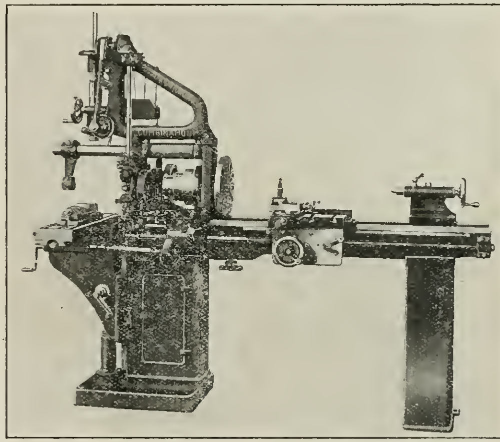


Fig. 5 Combination Lathe, Milling and Drilling Machine

The single hollow spindle serves both the lathe and the milling machine. By removing a section of the shears near the headstock in the lathe it becomes a gap lathe capable of handling face-plate work $18^1/_2$ in. in diameter by $6^1/_2$ in. long, although the lathe itself swings 13 in. over the shears. The removable block is held in place by a tapered dowel bolt.

The drill press can be used only by removing the over arm of the milling machine. A round table is furnished to be attached to the table of the milling machine.

The spindle of the millling machine can be locked rigidly in any position of its vertical travel and it then becomes a vertical milling

machine having all the movement of a standard machine. Handwheel and worm, as well as lever feed is provided for the vertical movement.

While the lathe and drilling machine, or the lathe and drill press, may be used simultaneously, the tool is a one-man machine. Usually it can be set up on a floor space of 40 sq. ft. including the room necessary for the operator to get around it. (*American Machinist*, vol. 55, no. 5, Aug. 4, 1921, p. 202, 2 figs., *d*)

MECHANICS (See Shipbuilding)

POWER-PLANT ENGINEERING

Australian Tests on Condenser-Tube Corrosion

Corrosion in Condensers, Ernest Bate. Data of experience and investigation at the Ultimo and White Bay power houses of the New South Wales Railways at Sydney.

The present experience is that pitting causes failure of about 2 to 3 per cent per year of the Admiralty metal tubes in service in the condensers at White Bay, while at Ultimo very little pitting is now experienced but a certain loss of tubes takes place from end erosion and dezincification. Both power houses draw circulating water from Sydney Harbor, though from different bays, and in both cases the water is liable to the usual contamination from ships, surface drainage, stormwater discharges and factories.

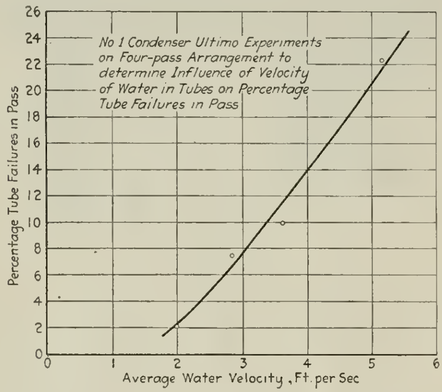


Fig. 6 Influence of Velocity of Water Flow on Erosion of Condenser Tubes

Various kinds of tubes have been used, such as hard-drawn Admiralty mixture brass tubes, practically pure copper tubes, and tubes of patent metal containing about 70 per cent copper and about 29 per cent zinc with small amounts of lead and iron. Formerly tubes tinned inside and out were used, but none have been purchased since 1912 and very few are now in service.

With tubes of similar composition it appears that very different results in the resistance of the metal to corrosion are obtained according to the treatment to which the metal has been subjected.

H. Moore and S. Beckinsale in a paper read before the Sydney Division, Institution of Engineers, Australia, March 10, 1921, stated that almost complete relief of internal stress without softening of Admiralty brass tubes can be obtained by annealing for five hours at 250 deg. cent. (482 deg. fahr.), though the present author shows that annealing of an unsuitable mixture will not enable the metal to give good results in the way of resistance to pitting.

Into one of the units of the White Bay plant, out of a total of 3830 tubes there were placed 342 hard-drawn copper tubes of the composition—copper 99.82 per cent, lead 0.03 per cent, iron 0.04 per cent and arsenic 0.05 per cent. These copper tubes failed by pitting at 80 times the rate of the brass tubes. Within a year about 70 per cent of the copper tubes had become faulty and were removed.

As regards dezincification, trouble was mainly observed with the ferrules. Of tube metal the most liable to dezincification has been found to be a tube of the patented metal above referred to.

Bengough and Jones state that layer dezincification is often associated with acid conditions in fresh water. A phenomenon occurred in No. 1 condenser, Ultimo, while under test, which seems in many respects to be a parallel to this redeposit action, and may help to discover the conditions causing it. This condenser was by accident allowed to remain full of circulating water, and very foul, for about three weeks. When opened at the end of that time a rich deposit, consisting of many pounds of crystal copper in tiny fernlike formation, was found over the tube ends, ferrules, tube plates, and end boxes. No other condensers had ever been found in this condition. It was surmised that the condition of standing foul had caused this effect to be produced, and accordingly the copper was cleaned away by flushing, and the conditions repeated. Ultimately it was found that the redeposit could be obtained by allowing the condenser to stand from two to three weeks, but could not be obtained as a rule for one week. During the standing period both injection and discharge valves on the circulating water main were closed.

A sample of water from the injection pipe close to the waterbox was taken on the first occasion of this redeposit. The water was somewhat dark and rusty in appearance. After filtering, the solution was found to contain—zinc, 3.06 grains per gallon; copper 1.40 grains per gallon; iron, 1.19 grains per gallon; free ammonia (inorganic), 0.192 part per 100,000; albuminoid ammonia (organic) 0.640 part per 100,000.

This water sample was, of course, that furthest from the tubes. The filtered water, on standing in a Winchester quart bottle, steadily threw down a brown deposit, the water near the surface appeared brown, and gradually varied to a faint green tint near the bottom. The deposit on analysis proved to be—copper oxide, 10.6 per cent; zinc oxide, 1.44 per cent; oxide of iron and alumina, 49.32 per cent; insoluble matter, 15.46 per cent; organic matter, 17.93 per cent; combined water, 4.38 per cent; undetermined, etc., 0.78 per cent.

This was not a large condenser. The tubes are mostly tinned and of Admiralty mixture. It is clear that during the standing period copper had passed into solution very freely, that this copper-rich solution had by convection or otherwise appeared at the water box, and had there deposited most of the copper held in solution. The ferrules showed no sign of attack. It seems clear that the condition of the solvent in the tubes was such that the solution pressure of zinc was, for some period at any rate, less than that of copper. Moving to the water boxes this solution of copper underwent a change such that zinc and iron slowly displaced the copper.

An attempt was also made to investigate the influence of velocity of flow on pitting, and it would appear from Fig. 6 that the percentage of failures was about proportional to the square of the velocity of flow. However, the tubes tested were mostly old and the result obtained is regarded purely as indicating the effect of flow in accelerating corrosive effects. The thermal factor appears to be also of importance in this connecton.

An investigation of the influence of intake water particularly as affected by its composition has been started and some data are presented in the original article. (*The Commonwealth Engineer* [Melbourne, Australia], vol. 8, no. 11, June 1, 1921, pp. 339–343, 8 figs., *e*)

Ford's Power Plant May Be Abolished. The enormous power plant at the Ford Highland Park factory, long the pride of Henry Ford, is soon to be transformed from a gas-steam plant to an all-steam plant, or is to be abolished entirely. Engineers, headed by Wm. B. Mayo, are now determining the most economic method of handling the power situation.

The gas-steam plant has been in operation for over ten years and a point has been reached where gas-steam power is no longer as economical as steam power alone.

Two plans are under consideration. The first involves the junking of the producing gas plant and installation of additional steam boilers. This would cost approximately $2,000,000. The second plan is to eliminate the Highland Park power plant entirely and bring high-tension power from the River Rouge, which would require an addition to the latter plant. This cost approximates $3,000,000.

There will be no interference with operations at the Highland Park plant while the power changes are under way. The Detroit Edison Co., which has a power house nearby, would furnish 90 per cent of the present peak power, which runs about 75,000 hp. (*Automotive Industries*, vol. 45, no. 9, Sept. 1, 1921, p. 438)

RAILROAD ENGINEERING

Consolidation Locomotives on the D. & H. and W. M.

High-Capacity Consolidation-Type Locomotives. During the past 10 or 12 years locomotives of the Mikado type have to a large extent displaced Consolidations in heavy main-line freight service. The consolidation is still used to a considerable extent, especially for heavy drag service where slow speeds suffice and fuel conditions do not require the boiler and firebox proportions that can be obtained in the Mikado type. The purchase of 40 heavy Consolidation-type locomotives by the Western Maryland Railway and the use of locomotives of the same type purchased a few years ago by the Delaware and Hudson Company show the vitality of this type. In particular, it is claimed that with driving wheels of the size that are suitable for slow-speed heavy-duty service, it is possible in a Consolidation design to use a firebox throat of sufficient depth to install a brick arch without raising the boiler to an excessive height.

Among the particular features of the new Western Maryland locomotives may be mentioned the following:

The frames are 6 in. wide, spaced 41 in. between centers, and each frame is cast in one piece with a single front rail to which the cylinders are bolted. A substantial steel casting, placed just back of the cylinders, extends the full length of the leading driving pedestals and serves as a fulcrum for the driving brakeshaft. The guide-yoke cross-tie is also of cast steel, and it is extended back sufficiently far to brace the second driving pedestals. This cross-tie also serves as a support for the driving-brake cylinders, one of which, because of the lack of room, is placed in a horizontal, and the other in a vertical, position.

The driving boxes are of cast steel and are fitted with bronze hub faces and brass-lined pedestal faces. Cast-iron shoes and wedges are used, the latter being of the self-adjusting type. The driving axles and engine-truck axle are of heat-treated steel, and flanged tires are used on all the wheels. Flange oilers are applied to the front and back drivers. The ashpan has two hoppers with swing bottoms, both of which are controlled by one handle. Flushing pipes are applied for washing ashes from the slopes of the pan. The injectors and steam turret are placed outside the cab and have extension handles identified by small aluminum plates with raised letters. The equipment includes a breather pipe for providing fresh air while passing through tunnels. This arrangement consists of a 1/2-in. pipe placed across the boiler back head and having five 1/4-in. globe valves equally spaced, each fitted with three feet of 1/2-in. hose. The air supply is drawn from the brake system.

In the Delaware & Hudson Consolidations, the design of the ashpan proved to be quite a difficult problem which was met by the construction of an ashpan having six distinct hoppers and doors. Ample airway for combustion requirements is provided through a 6-in. opening between the pan and the mud ring. The tender construction is unusual for a locomotive of this capacity, in that it is supported upon an underframe of built-up structural shapes with heavy center-sill section, such as is employed in car construction.

In the Delaware & Hudson units the per cent of boiler horsepower to cylinder horsepower is higher than in the Western Maryland (92 as compared with 85 per cent), and this difference is ascribed to the relatively larger percentage of firebox heating surface to total heating surface in the Delaware & Hudson Consolidation, since each square foot of firebox surface is equivalent in evaporating capacity to more than 5 sq. ft. of tubular heating surface. This only serves to emphasize an inherent limitation in the Consolidation-type locomotive. On account of the limited flue length and firebox dimensions, it is impossible to secure horsepower equal to cylinder powerhorse in high-capacity locomotives of this type without the use of thermic siphons or other means of augmenting firebox or tubular heating surface. (*Railway Review*, vol. 69, no. 7, August 13, 1921, pp. 197–205, 15 figs., *d*)

SHIPBUILDING

Gyroscopically Stabilized S.Y. "Lyndonia"

Gyroscopic Stabilization for Ships. Compounded abstract of several articles devoted to the subject of reducing the rolling of a ship by means of gyroscopic stabilization.

E. A. Sperry, Mem. Am.Soc.M.E., points out that in gyroscopic stabilization the roll of a ship is not actually reduced but suppressed by dealing only with its beginnings. All rolling of ships is a gradual accumulation of individual wave increments, and if these single increments are quenched the rolling is done away with.

In the actual construction a little gyro "feeler" (control gyro) detects the incipient roll at its beginning and also shows its direction. From it, through a relay and motor, the large gyro is artificially precessed and delivers stresses of opposite sign to the ship. As a result the ship never starts to roll. The process is said to involve not only a relatively small apparatus but entails merely comparatively small stresses in the hull, said to be from one-sixth to one-tenth those present in a rolling ship.

Alexander E. Schein, Mem. Am.Soc.M.E., in an article entitled, The Gyroscopic Stabilizer on the S.Y. *Lyndonia*, covers practically the same field as the previous article in a much more detailed way.

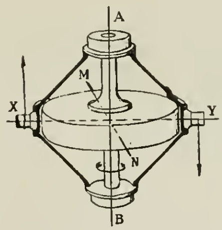


Fig. 7 Simple Gyro Illustrating Precession

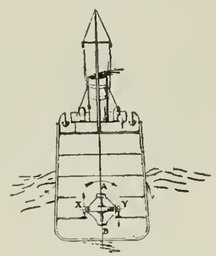


Fig. 8 Elementary Form of Ship Stabilizer

Fig. 7 shows a simple gyroscope which will illustrate the principle of the stabilizer. It consists of a rapidly spinning wheel with axis vertical, mounted in pivot bearings within a vertical ring. There are two trunnions on this ring forming a horizontal axis XY. If the trunnions X and Y are mounted in bearings the whole mass is then free to turn about the horizontal axis XY. Imagine the wheel to be spinning in the direction of the arrow on its rim, and that we apply forces at X and Y. The effect would be to turn the whole mass about a third axis MN. But just here is where the gyroscopic effect comes in. If we assume that the wheel is of sufficient size we can represent forces X and Y by two people, one of whom attempts to lift at X and the other depress at Y. There will be two very evident effects due to gyroscopic action. The first to be noticed is the great resistance the gyroscope offers to any effort to turn it about the axis MN by means of forces X and Y. The second effect is that point A will be seen to move away from us, and point B toward us about the axis XY. These two actions together are known as precession. One is never present without the other. In order to have resisting forces we must have angular movement, and conversely with an angular movement there must be forces. It will be noticed that there are three axes involved in precession. First there is the axis of spin—the axis about which the wheel rotates. Secondly, there is the axis of spin at right angles to the first, about which the forces act. And third, there is the axis of precession about which the gyro turns when forces are applied about the second axis. This third axis is perpendicular to each of the other two. The first axis is represented in Fig. 7 by AB, the second by MN, and the third by XY. Precession may therefore be simply defined as an angular movement accompanied by a resisting moment, both of which are at right angles to the axis of spin and to each other. This principle

is made use of in the gyro ship stabilizer. Just how it is done is evident from Fig. 8, which shows the same gyroscope mounted in a ship. The axis MN is now the axis about which the ship rolls. As soon as there is any angular movement due to rolling, the gyroscope resists it by forces at X and Y, and at the same time precesses about axis XY. If the direction of roll reverses the forces will also reverse and so will the precession about XY. The gyro automatically exerts forces in the proper direction and it is continually oscillating back and forth on the XY axis. In a general discussion about the ship stabilizer the turning movement of the gyro is known as precession, although as defined above precession strictly takes into consideration the forces acting. In this article "precession" will be taken to mean the angular motion of the gyro, and when the forces are referred to, the term will be "gyroscopic force" or "gyroscopic moment." This separation of the two actions simplifies the discussion and is the common practice when speaking of stabilizers.

In Fig. 8 is shown the simplest form of ship stabilizer. In actual design the rotating wheel, or rotor, is mounted in bearings and enclosed in a casing. On this casing there are two gudgeons corresponding to points X and Y through which the forces are transmitted to the ship. It remains only to limit these forces so that they will not be excessive and cause undue stresses in the hull. The well-known formula for gyroscopic moment is:

$$M = \frac{k^2WR}{307}\,n$$

where k^2W is the moment of inertia of the rotor, R the revolutions per minute of the rotor, and n the angular velocity of precession in radians per second. The moment will be in foot-pounds. If we omit the complexity of mathematical expressions the above moment is approximately equal to the tilting moment produced by the maximum effective wave slope, and if such a moment were applied to a non-rolling ship during the period of oscillation it would cause the ship to roll an amount about equal to the maximum roll increment. The stabilizing moment is therefore only slightly greater than the natural effect of the waves causing the ship to roll, and in case of the *Lyndonia* is only about 375,000 ft-lb.

From the formula it is seen that we can control the magnitude of the gyroscopic moment by varying either R or n. It would be impossible to vary R quickly and easily. But with R constant it is an easy matter to vary n and hence M. Stabilizers are therefore designed for some known value of R which will not overstress the wheel, and the gyroscopic forces transmitted to the ship limited by limiting the speed of precession by mechanical brakes or other means. This type of stabilizer is known as the passive gyro stabilizer. It uses the forces of the waves to start gyro precessing, and mechanical brakes suitable pistons and levers to control within close limits the speed of precession. Due to the fact that the mass of the casing and wheel is necessarily large it takes several seconds to get the speed of precession up to normal velocity, and therefore the ship has gained considerable roll before full stabilizing is obtained. The passive-type stabilizer cannot decrease the roll to less than six or seven degrees.

Mechanical details of construction of the *Lyndonia* stabilizer are given in an article by W. T. Manning, while the electrical equipment is described by T. P. Kirkpatrick and H. C. Coleman. (*The Electric Journal*, vol. 18, no. 8, Aug. 1921, pp. 335–349, illustr., *dA*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

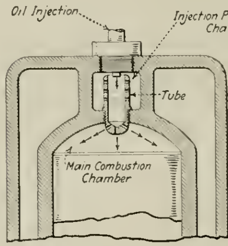
From information published in some of the British motor papers it would appear that the famous German Mercedes motor works, which during the war have built many of the German aircraft motors, are now working on a supercharged type of engine for automobiles and trucks. The president of that company states, though, that only very slight increases in power can be obtained by applying the principle of superinduction without a complete re-design of the motor.

IMPORTANCE OF OIL-INJECTION TYPE OF INTERNAL-COMBUSTION ENGINE

(*Continued from page 658*)

form, by Nielsen, who also provided for adjustment of injection-chamber volume by a special cover or cap.

Still another type brought out in the course of development of the divided combustion chamber is the Leissner, Fig. 23. Leissner adds to the Nydahl or Neilsen injection chamber a tube which has holes in the sides and bottom to form the old-fashioned fuel distributor used with air- and solid-injection spray valves. The Leissmer tube comes up close to the injection spray nozzle which delivers the oil inside the tube. Just as the small injection chamber alone prevents development of explosive shocks by limited contact of air and fuel, so does insertion of this tube add something to further limit the contact control. Leissner specifies that the holes through the bottom and sides of the tube, and the space above it, shall be so related to each other in area as to produce the following series of actions: Compression carried first to ignition temperature; injection inside the tube in the injection chamber and partial combustion in the tube, producing a rise of pressure in the tube, which in turn projects jets of still unburned oil sidewise into the air around the tube. Combustion of these jets raises the pressure outside of the tube and causes reversal of flow back into the tube and down through it to the cylinder, helped by the movement of the piston; the air left around the tube finally passing through the tube and expelling the fuel charge in front of it into the cylinder, the space around the tube and in the tube being in series. This



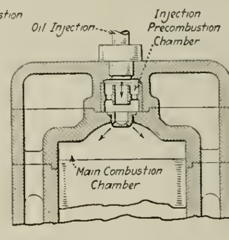


Fig. 23 Leissner Divided Cold Combustion Chamber
Fig. 24 Worthington Divided Cold Combustion Chamber

is a new engine brought out in Sweden, and it is now being introduced into this country.

Finally, in this class of divided-combustion-chamber injection engines there is a new one developed by Worthington—the class in which the injection or precombustion chamber is used to limit the development of explosive shocks and connected to the cylinder by an ejection orifice through which gasified fuel is expelled to the cylinder by a pressure differential due partly to the movement of the piston and partly to the precombustion. This is shown in Fig. 24. It has a tube open at both ends and supported from the side walls with wide spaces at each end. The bottom of the injection chamber has a passage to the cylinder of the usual fuel-distributing sort, forming a fuel-ejection orifice. There are large holes through the tube-supporting web, so that the injection chamber acts as a single chamber, with the tube acting as a sort of fuel baffle or guard. The charge being injected into the tube is limited by the tube as to air contact. The tube constitutes a fuel guard, by means of which the amount of precombustion can be controlled and at the same time the fuel is gasified in the hot limited amount of air. A rise of pressure in the injection chamber, due to partial combustion, is suppplemented by depression of the pressure on the cylinder side due to the piston movement, which starts the flow of parallel streams of air and fuel toward the cylinder. This action creates in effect a bunsen burner in the top of the cylinder. This arrangement gives a construction practically as simple and foolproof as the little Hvid, except for the injection pump, but one that seems to be adapted to a wider range of cylinder sizes and speeds and less limited by fuel quality.

Much experimental research has already been completed and more is planned, to be presented in a later paper.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

Aircraft A3-21. Air Propellers. The work of Prof. W. F. Durand and E. P. Lesley on (*a*) air screws in yaw and (*b*) a general analysis and résumé of the results of detailed investigations of 88 air-propeller models for the determination of the general laws covering the entire series has been completed and submitted to the National Advisory Committee for Aeronautics. Address Prof. W. F. Durand, Leland Stanford Junior University, Stanford University, Cal.

Apparatus and Instruments A8-21. Tearing Instruments and Tests for Paper. Technologic Paper 194 of the Bureau of Standards may be obtained from the Superintendent of Documents, Washington, D. C. at 5 cents per copy. The paper reports the study of the effect of different sizes of test samples on tearing strength of paper. It has been found that the larger the sample the greater the value of the tearing strength owing to fabric assistance. One instrument is used for tensile strength and two instruments for tearing strength. It was impossible to calibrate one type of tearing instrument because of friction in certain parts of the mechanism. The other was accurate within 5 per cent. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A10-21. Fire Tests on Building Columns. The fire tests on building columns reported previously were made at the Underwriters Laboratory at Chicago, Ill. The report of these tests is found in a publication which may be obtained at $2 per copy in paper covers and $2.50 per copy in cloth covers from the Associated Factory Mutual Fire Insurance Companies at 31 Milk St., Boston, Mass., or at the Underwriters Laboratories, 207 East Ohio St., Chicago, Ill. The report covers 389 pages and contains the following sections:

1 Introduction
2 Description of Columns
3 Schedule of Tests
4 Placing of Covers and Concrete Columns
5 Auxiliary Tests of Materials
6 Description of Furnace and Related Equipment
7 Temperature Measurements
8 Deformation Measurements
9 Method of Testing
10 Results of Fire Tests
11 Results of Fire and Water Tests
12 General Summary and Discussion
13 Fire Resistance Periods from the Test Results

The appendices give various data, including photographs of the columns before and after testing, curves of temperature and time and curves of deformation and average temperature.

There were 106 tests of columns, of which 91 were fire tests and 15 fire-and-water tests. The fire tests included tests of representative types of unprotected structural steel, cast iron, concrete-filled, pipe and timber columns; columns with metal partially protected with concrete, columns with 2-in. or 4-in. thickness of concrete, tile, brick, gypsum block or plaster as a protection, and reinforced-concrete columns with 2 in. of integral concrete protection. Materials used for protection and the constituent materials were tested. The columns were designed for a working load of approximately 100,000 lb. and the load was maintained constant during the test. Measurements were taken of temperature of furnace and the deformation due to the load when heated. In the fire-and-water test the columns were loaded and exposed to the fire a predetermined time. Address Underwriters Laboratories, 207 East Ohio St., Chicago, Ill.

Cement and Other Building Materials A11-21. Fire Test of Brick Panels. A fire test of 8-in. solid restrained panel of eastern brick and two tests on 8-in. hollow unrestrained panels, one of eastern and one of western brick, were made at the Bureau of Standards during July. Except for the fact that the eastern brick did not fuse on the exposed side during test, no difference was noted in the two kinds of bricks. No collapse occurred. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cellulose and Paper A2-21. Tearing Instruments and Tests. See *Apparatus and Instruments A8-21.*

Fuels, Gas, Tar and Coke A13-21. Iowa Coals. Technical Paper 269 on Analysis of Iowa Coals by George S. Rietz, A. C. Fieldner and F. D. Osgood, includes the geology of the coal beds, the coal resources, the character of the coal, development and transportation, uses, fusibility of ash, coking properties, markets, future developments and chemical analysis. The paper ends with list of publications on the composition of coal. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A14-21. Water-Gas Apparatus. Water-Gas Apparatus and the Use of Central District Coal as Generator Fuel is the subject of Technical Paper 246 of the Bureau of Mines. The paper was prepared under a coöperative agreement with the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois. The paper describes modern apparatus, distribution of heat, blasting reactions, requisites for efficiency, production of coke and coal as generator fuel, design of generator set, depth of fuel, and closes with a list of publications on producer gas. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Internal-Combustion Engines A4-21. Fuel Economy. The Bureau of Standards has investigated the effect of introducing exhaust gases with the explosive mixtures for a gas engine for the purpose of obtaining a high compression ratio for low powers. An engine was operated with the leanest air-fuel ratio which would ignite regularly and it was again operated with a sufficient amount of exhaust gas with a charge to reduce the engine power to the same value as had been obtained in the first test by throttling. Although the pressures in the latter test were considerably higher than in the first test, the limiting air-fuel ratio for firing was not as great and a lower thermal efficiency resulted. It seems fair to conclude that the dilution of the charge by the spent gas makes it impossible at low throttles to employ the air-fuel ratios which give maximum efficiency. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Machine Design A3-21. Strength of Screw Fastenings in Plywood. It is important that size of screw spacing and margin of screw fastenings in plywood should be adapted to the species and thickness of plywood used. The Forest Products Laboratory has found that commonly used plywoods are divided into the following groups:

Group I, Low Density		Group II, Medium Density		Group III, High Density
Basswood	Hemlock	Ash, black	Hackberry	Ash, white
Cedar, Spanish	Pine, sugar	Ash, pumpkin	Magnolia	Beech
Cottonwood	Pine, white	Elm, white	Mahogany	Birch
Cypress, bald	Poplar, yellow	Gum, black	Maple, soft	Cherry, black
Douglas fir	Redwood	Gum, cotton	Sycamore	Elm, cork
Fir, true	Spruce, Sitka	Gum, red	Walnut, black	Maple, hard

The data regarding screws are found in the following table, the gage being the smallest that can be used with the thickness specified and not cause failure through breaking of the screws when full strength of plywood is developed and the length being the shortest that will prevent the screw pulling out before the full strength of the wood is reached. The margin is the minimum margin for full development of strength.

Species of plywood	Thickness of plywood, in.	Gage (Number) of screw	Screw length, in. Species receiving point: White ash	Spruce	Margin, in.	Spacing, in.
Group I	3/30	4	1/2	5/8	1/2	3/8
	3/24	5	1/2	5/8	5/8	1/2
	3/20	6	5/8	3/4	5/8	1/2
	3/16	7	5/8	3/4	5/8	5/8
	3/10	9	3/4	1	3/4	3/4
	3/8	11	1	1 1/4	3/4	3/4
Group II	3/30	5	1/2	5/8	1/2	1/2
	3/24	6	5/8	3/4	5/8	1/2
	3/20	7	3/4	7/8	5/8	5/8
	3/16	8	7/8	1	5/8	3/4
	3/10	10	1	1 1/4	3/4	3/4
	3/8	12	1 1/4	1 1/2	3/4	7/8
Group III	3/30	6	5/8	3/4	1/2	1/2
	3/24	7	3/4	1	5/8	5/8
	3/20	8	1	1 1/4	5/8	3/4
	3/16	9	1 1/4	1 1/2	5/8	3/4
	3/10	11	1 1/2	1 3/4	3/4	7/8
	3/8	13	1 3/4	2	3/4	1

Equally good results were obtained with flat-headed screws without washers and round-headed screws with washers. Round-head screws without washers proved an inferior means of fastening. The spacing given in the table is for screws in a single row, but staggering is recommended when possible. The tests were made without reference to the member to which the plywood was attached. Until further information designers must take care that the frame is not split or weakened through the use of the size of screw and spacing necessary to make the fastening as strong as the plywood. U. S. Forest Products Laboratory, Madison, Wis. Address Director.

Metallurgy and Metallography A14-21. Graphitization in Cast Iron. The microscopic study of various specimens of cast iron after prolonged annealing indicates that considerable change in the combined carbon occurs below the thermal critical range (about 700 deg. cent.). This graphitization does not occur below 500 deg. cent. after a very prolonged heating period. The microscopic study reveals many interesting and valuable facts not shown by chemical analysis alone. In

low-temperature graphitization only the pearlite is not affected. The free carbide does not appear to change until the thermal critical point has been passed and the solution of this constituent has begun. The form in which the graphite exists after annealing depends on initial structure. If flakes of graphite exists they act as nuclei for the deposition of the graphite formed during annealing. If no flakes are present the graphite takes the form of small globules. The data from furnace work, chemical analysis and microscopic examination are being put in shape for publication for a supplement to Technologic Paper 129. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A15-21. TEMPERING HARDENED STEELS. An investigation on the structural changes occurring in hardened steels upon tempering has progressed far enough to show that there is a decided change brought about by tempering at approximately 240 deg. cent. Up to that temperature no structural change is to be seen. In all cases the changes which occur are relatively inconspicuous and this accounts for the lack of data relating to this subject. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Mining, General A6-21. VENTILATION IN METAL MINES. Technical Paper No. 251 by Daniel Harrington is devoted to a preliminary report on ventilation in metal mines. The bulletin explains the method used in determining the physical data as a basis of the paper and then describes the elements which control metal-mine ventilation. It also describes the conditions effecting the temperature of mine air, relative humidity of mine air and the composition of mine air, giving the effect of dust and velocity, as well as methods for providing efficient ventilation, with its control and cost. A list of publications of the Bureau of Mines dealing with mine gases and mine ventilation is appended. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Mining, General A7-21. ACCIDENTS IN METAL MINES. During the calendar year 1919 the number of operators reported to the Bureau of Mines was 145,262. The average employment of these men was 281 days per year per man. The number of men killed was 468 and the number of men injured was 31,506. The report shows that for every thousand men employed for 300 working days 3.31 were killed and 231.8 injured enough to cause them to lose at least one day's time. This is the lowest record of fatality in the metal-mining industry of the United States and the injury rate is lower than any year since 1914. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Mining, General A8-21. COAL-MINE FATALITIES. Technical Paper No. 228 of the Bureau of Mines states that during 1920, 2260 men were killed in the coal mines of the United States, a decrease of 57 from the record of the year before. This reduction occurred with an increase of 18 per cent in the output of coal. 3.50 lives were lost for every million tons of coal in 1920, while in 1919 there were 4.24 lives lost. In 1920 there were 775,000 men employed in mines while in 1919 the number was 765,000. The total production of coal was 645,663,000 tons, of which more than five-sixths was bituminous coal. There was a decrease of 64 per cent in fatalities due to fires, a decrease of 38 per cent in fatalities due to explosives and a decrease of 14 per cent in deaths resulting from the explosion of gas and coal dust. This bulletin includes a list of permissible explosives, lamps and motors and gives a list of certain approved mine-rescue apparatus. It gives a list of state mine inspectors and other mine officials. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Railway Rolling Stock and Accessories A1-21. STRESSES IN CAR WHEELS. Special runs on car wheels were made in which strain measurements in radial and tangential directions on both faces of the wheel were taken. Results indicate that no tangential stresses are set up in the wheel as a result of heating. On the front side of the wheel tension exists near the hub and compression near the rim, while stresses of equal magnitude but of opposite sign exist on the other side. The stress distribution appears to be a result of the shape of the wheel. Similar tests will be made on wheels from each of the other manufacturers. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Steam Power A2-21. STEAM CONSUMPTION OF TURBINES. Carroll Stansbury and Louis Weil have determined that the steam consumption of a steam turbine may be found by measuring the quality of the steam at entrance to and discharge from a turbine. From the steam tables the heat contents at the two points may be found and from these the water rate is given by

$$w = \frac{2546.5}{F\,(H_1 - H_2)}$$

where w = lb. of steam per hp-hr.
F = factor = $p/(p + pf)$
H_1 = heat content at entrance for observed pressure and quality
H_2 = heat content at discharge for observed pressure and quality
Steam should be superheated at both points for simple measurement of quality.
p = horsepower developed by turbine
pf = horsepower equivalent to heat in radiation residual velocity and mechanical friction

$$= \frac{K}{2546.5}$$

where $K = w_0\,(H_{01} - H_{02})$
w_0 = steam consumption per hour at no load.
H_{01} = heat content at entrance, no load
H_{02} = heat content at discharge, no load.

Tests of this method have shown very close agreement with practice. Johns Hopkins University, Baltimore, Md. Address Prof. A. G. Christie.

Wood Products A6-21. STRENGTH OF SCREW FASTINGS IN PLYWOOD. See *Machine Design A3-21.*

Wood Products A7-21. GLUE STAINS. Casein and vegetable glues containing caustic soda produce stains on certain woods such as oak, maple, cherry, elm, ash, birch and beech. This is due to the action of the alkali on the tannins and other constituents of the wood whereby an inky substance is formed. No means can be found to prevent this chemical action. Precaution will keep the discoloration from the finished surface. If veneers are less than $^1/_{20}$ in. thick, glue will seep through pores, hence thicker glues are used with fillers added when staining is feared. If a panel is dried promptly the caustic soda will have difficulty in coming to the surface. Rapid drying by removing panels from press as soon as possible and placing them on stickers is advisable. These stains can be removed by sponging the stained surface with a solution prepared by dissolving one ounce of oxalic acid crystals in 12 ounces of water. Still better results may some times be obtained by first moistening wood with sodium sulphite solution of similar concentration to the oxalic solution. U. S. Forest Products Laboratory, Madison, Wis. Address Director

Wood Products A8-21. SUBSTITUTES FOR ASH. The Forest Products Laboratory has published Technical Note 147 showing how maple, elm, birch, hickory, red gum, oak and Southern yellow pine may replace ash for certain parts of automobile bodies. The note gives the relative values of these different woods in terms of ash as per table below.

U. S. Forest Products Laboratory, Madison, Wis. Address Director.

SPECIES	Strength as a beam or post	Stiffness	Shock-resisting ability	Hardness
Ash, white, forest-grown..	100.0	100.0	100.0	100.0
Ash, black...............	71.3	79.3	90.1	62.3
Ash, white, second-growth	122.5	117.6	119.6	118.9
Basswood...............	59.1	80.6	40.5	29.6
Beech..................	93.5	96.9	96.0	90.0
Birch, yellow...........	104.8	116.8	120.6	80.9
Chestnut...............	66.0	71.9	53.4	49.2
Cottonwood.............	60.6	79.0	54.3	35.3
Cucumber..............	85.4	112.4	76.7	54.9
Elm, rock or cork........	98.8	92.9	140.5	101.6
Elm, white..............	79.2	79.5	89.5	57.1
Gum, red...............	80.7	91.5	75.5	59.0
Gum, tupelo or cotton....	81.4	82.5	63.5	77.3
Hickories, pecan.........	103.5	103.8	119.7	139.6
Hickories, true..........	126.6	120.2	173.9	150.4
Maple, red..............	90.0	101.2	78.7	75.4
Maple, silver............	66.9	68.5	71.7	64.3
Maple, sugar............	104.7	105.9	90.5	103.0
Oaks, all kinds..........	92.6	101.3	94.9	104.5
Poplar, yellow...........	67.3	93.8	41.5	37.9
CONIFERS				
Fir, Douglas, Pac. Coast .	95.7	122.1	59.9	58.3
Pine, loblolly............	93.7	105.6	71.0	60.0
Pine, longleaf............	112.2	122.1	77.7	74.8
Pine, shortleaf...........	94.1	100.6	69.7	64.0
Pine, western white......	75.5	99.7	53.8	37.0
Pine, western yellow.....	67.0	75.6	42.9	41.0
Spruce, Sitka............	69.5	94.1	63.3	44.9

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Air B5-21. REHEATING. The effect of internal- and external-combustion air reheaters and the thermodynamic efficiencies secured through the use of reheated air in air motors is being investigated by Dean C. R. Richards and J. N. Vedder. Three types of reheaters were tested and also steam was used as the reheating agent. The reheated air is used in a small Corliss engine, the load being adjusted to give complete expansion. The results so obtained were compared with those when cold air was used. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Automotive Vehicles and Equipment B6-21. COST OF OPERATING TRUCKS. The Automobile Section of the Mechanical Engineering Laboratory of the University of Michigan is calibrating several four-ton trucks so that the Highway Department can determine economical data regarding trucks in service. These trucks are being calibrated to determine the losses in the engine, in the transmission system from engine to bearings and differential gears and to determine the power required to roll the truck along the level road on various grades with different loads. In doing this the truck is brought into the laboratory and the engine placed on a testing stand to determine horsepower, fuel economy and mechanical efficiency. The manifold suction is observed for every run. The engine is then replaced in the truck which has been mounted between two dynamometers with axle jackshafts connected to the armature shafts of the dynamometers. The engine is then run at a speed and manifold suction corresponding to one of the runs on the engine stand. The power output of the transmission is then determined and from the previous calibration of the engine alone the efficiency of the transmission system is then determined. The truck is then operated on the road with different loads and on different grades by pulling it

will then be operated on various grades and at various loads and the fuel consumption measured at different stations at about 100-ft. intervals. University of Michigan, Ann Arbor, Mich. Address W. E. Lay.

Boilers and Accessories B1-21. Super Boiler Test. The Detroit Edison Company is making a test on one of its large boilers at the Connors Creek plant. This test will cover a period of about ten weeks. The purposes of this test are:

1 To determine the most economical coal with particular reference to the ash content of the coal

2 To determine how many improvements can be made in the present baffle arrangement.

3 To determine the relation between frequency of blowing the flues and economy, and

4 To determine the banking losses of the boiler.

Detroit Edison Company, Detroit, Mich. Address Paul W. Thompson.

Cement and Other Building Materials B2-21. Concrete. A number of researches have been planned by Prof. A. N. Talbot on the measurement of mobility of fresh concrete and a general investigation of concrete and one on the effects of graduating the particles of the aggregate as well as varying the amount of water and cement in making the mixture. It is planned to determine the proper quantity in a mixture to obtain a workable concrete, to find the effect of storage of test specimens, the method of capping, the effect of moisture when tested, the effect of age, the effect of time of removal from mold, the strength of concrete specimens cut from various portions of a structural member or from a pavement to determine the effect of different elements entering a mixture of concrete, and lastly, to find the effect of various sands on the effect of concrete. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Fuels, Gas, Tar and Coke B3-21. Ignition Point of Fuels. The ignition point of fuels is being investigated by Prof. H. H. Stoek and R. W. Arms by observing the action of coal when gradually heated. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Fuels, Gas, Tar and Coke B4-21. Dewatering Coal Slime. H. F. Yancy and Thomas Fraser, under the direction of the U. S. Bureau of Mines, are investigating the dewatering of coal slimes, conducting experiments at the filter plant in Urbana in connection with the sludge work of the state water supply. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Fuels, Gas, Tar and Coke B5-21. Coal Washing. H. F. Young and Thomas Fraser are investigating the washing of coals of different kinds and under different conditions and also the separation of pyrite and organic sulphur by washing with jigs and tables. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois Urbana, Ill.

Fuels, Gas, Tar and Coke B6-21. Sliding Friction. Professors Stoek and Holbrook are determining the sliding friction of bituminous coal and the subsidence used for chutes in conveying coal. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Heat B21-21. Buried Pipe. An investigation to determine the temperature gradient of heat flow from steam pipe buried in ground to surrounding earth in connection with the fellowship of Ric-wil Company is being continued at the University of Michigan. Thermocouples are distributed in a plane normal to the pipe and one or two readings are taken a day. At the same time the pressure and quality of the steam is observed. University of Michigan, Ann Arbor, Mich. Address J. E. Emswiler.

Machine Design B5-21. Stresses in Boiler Heads. Prof. G. A. Goodenough is investigating the stresses in boiler heads. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B4-21. Web Stresses in Beams. Prof. A. N. Talbot and others are investigating the web stresses in beams to determine the best method of reinforcing beams to take diagonal tension stress. Stirrups and bent-up bars are used in various proportions, amounts and spacings, tests being made with steel gages on both samples and restrained beams. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B5-21. Reinforced-Concrete Columns. An investigation by the use of the strain gage on the reinforcement to determine the strains in the reinforcement and the action of the spiral reinforcement. The investigation will include the effect of pitch, spiral length of column, eccentricity, richness of concrete and longitudinal reinforcement as well as frictional resistance of granular material restrained by hooping. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Railway Rolling Stock and Accessories B4-21. Journal Friction. A considerable amount of data has been collected on friction of railroad-car journals in relation to and as a component part of the resistance of trains. The investigation will include the analysis of existing information and the analysis of data possessed by the Railway Engineering Department of the University of Illinois as well as additional test results obtained by the railway electrical test car. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

The method of reducing the pounding of trolley cars and the possibility of increasing the pressure between the trolley wire and collector with increased speed of car has been undertaken by J. K. Tathill under the direction of Prof. J. N. Snodgrass. This work is being done with the electrical test car of the University of Illinois. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Railway Rolling Stock and Accessories B6-21. Tractive Effort. An investigation has been begun under the direction of Prof. J. N. Snodgrass to determine the values of locomotive tractive effort. Address Dean C. R. Richards, Engineering Experiment Station. University of Illinois, Urbana, Ill.

Transportation B1-21. Wire-Rope Fastenings. The strength of wire-rope fastenings including clips, clamps, sockets and other devices, is to be investigated at the Ohio State University for the Director of Safety of the State of Ohio. Ohio State University, Columbus, Ohio. Address Prof. W. T. Magruder.

C—Research Problems

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

Transportation C1-21. Wire-Rope Fastenings. To aid the Engineering Experiment Station of the Ohio State University to publish a report on the Strength of Wire Ropes and Their Fastenings, information regarding results of tests or information regarding reports on this subject is greatly desired. The questions which have arisen are as follows:

1 What are the relative strengths of wire-rope eyes, or loops, made up with clips and clamps, and of wire ropes with sockets of various kinds and constructions, as compared with the rope itself, either spliced or tested over sheaves?

2 Sockets are usually considered to be a permanent fastening, but when should clips be used rather than clamps?

3 How should they be applied? How tightly should they be drawn up?

4 What effect has the size of the thimble on the strength of the rope?

5 How many fastenings should be used on each loop or eye?

Ohio State University, Columbus, Ohio. Address Prof. W. T. Magruder.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

University of Alabama E1-21. The Legislature of the State of Alabama has created a special School of Mines fund of $25,000 per year for four years to be used in coöperative work with the U. S. Bureau of Mines, the Bureau of Mines to provide equal funds. As a result a thoroughly modern mining and ore-dressing laboratory for the School of Mines of the University of Alabama has been installed. Five fellowships are to be offered during the coming year. These are open to graduates of universities and engineering schools. The value of each fellowship is $540 per year of nine months. The following subjects are to be investigated during the coming year:

1 Beneficiation of iron ores.

2 The preparation, treatment and uses of non-metallic minerals such as barite and ocher in industries other than ceramic or chemical industries.

3 Metallurgical coke.

University of Alabama, University, Ala. Address Prof. H. D. Pallister.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society

Transportation F1-21. Wire-Rope Fastenings. A bibliography of two pages on Wire Ropes, Clips, Clamps and Sockets. Search 3411. Address Arthur M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Question of Entropy

TO THE EDITOR:

Professor Goldman's demonstration on page 621 of MECHANICAL ENGINEERING for September that "Entropy is a complete error" is interesting but not convincing. In his notation he says that H denotes the heat energy. If we knew precisely what heat energy is under consideration, it would be easy to point out the fallacy in the demonstration; not knowing which of the various heat energies H stands for, we must examine each of the possible cases.

In thermodynamics there are three thermal magnitudes that demand attention:

1 Q, the heat absorbed by a system when it changes state
2 U, the intrinsic energy of the system
3 I, = V + $(pV/778)$.

This last quantity, I, is one of the so-called thermodynamic potentials devised by Duhem, Gibbs, and others in the consideration of the equilibrum of thermodynamic systems. The intrinsic

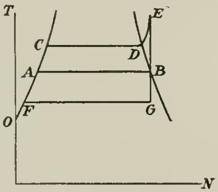


FIG. 1

energy U, which is due to the molecular motion and molecular configuration of the system, is fixed by the state of the system; that is, the change of U between two states is independent of the path followed. Evidently, therefore, since the product pV is fixed by the state, the value of the potential function I is likewise determined solely by the state of the system.

On the other hand, the quantity of heat Q absorbed by the system in a change of state depends on the path. Thus:

$$Q = \text{increase of energy } u + \text{external work}$$

and since the external work varies with the path, Q likewise depends on the path.

It is most unfortunate that the name "heat content" is often given to the potential function I. This name gives rise to endless confusion in the minds of students and possibly in the minds of professors also. The association of Q and I in the case of saturated steam is probably responsible for the troublesome situation. Professor Goldman says that the heat content (that is, the value of I) of steam at a pressure of 100 lb. is fixed and definite, irrespective of how the steam was produced. This statement is strictly true; but it is *not* true of the heat Q absorbed in the change from water at 32 deg. to steam at 100 lb. The accompanying figure illustrates this point.

If, as usual, the water is heated and vaporized at constant pressure the area between QAB and the N-axis represents the heat absorbed and also the change of I from water at 32 deg. to saturated steam in the state B; or, neglecting the small value of I at point O, the area under OAB represents the value of I (the heat control) at state B. But the same state B may be attained by some other path as $OCDEB$ or $OFGB$. In the first of these the water is boiled at a higher pressure, then superheated as indicated by DE and then expanded adiabatically, as shown by EB. The heat absorbed in this case is represented by the area under $OCDE$. Or, if the water is vaporized at a lower pressure along FG, and the mixture in the state G is compressed adiabatically from G to B, the heat absorbed is represented by the area under OFG. Thus the Q absorbed between O and B may have different values depending on the character of the process, but the I at point B is fixed and definite and is represented by one area, that under OAB.

The object of the preceding discussion is to emphasize the point that there is no necessary connection between the so-called heat content of a system and the heat Q absorbed in some change of state of the system. In just one case, that in which constant pressure is maintained in the system, the change of I gives the heat absorbed; in all other cases the two magnitudes have different values.

Professor Goldman says that H denotes the heat energy. It may be assumed that his H stands for either Q or I. In the former case his definition of entropy, namely $dN = dQ/T$, agrees with the authorities from Clausius down. If such is the case, the alleged functional relation $N = f(H,E)$, which translated into the customary notation becomes $N = f(Q,T)$, simply does not exist. Since Q depends upon the path it is not a function of the variables that define the state, and to say that any of these variables is a function of Q is nonsense. Hence, with the proper definition of entropy, the mathematical discussion under section (a) breaks down completely.

But from the discussion (b) it seems probable that Professor Goldman has confused Q and I, and has used dI instead of dQ in his definition. In this event the mathematical discussion is correct, and the entropy that "is an error" is a new, special brand of entropy defined by the equation $dN = dI/T$. Thus Professor Goldman demonstrates that his particular entropy, not the time-honored entropy of Clausius and Thomson, does not behave in accordance with the established rules. In other words, he knocks down a man of straw that he has himself constructed.

G. A. GOODENOUGH.

Urbana, Ill.

The Hardness Testing of Metals

TO THE EDITOR:

The writer has just read, with considerable interest, in the July issue of MECHANICAL ENGINEERING the report of a committee of the Engineering Division of the National Research Council on The Hardness Testing of Metals, and having spent some time on the hardness testing of steel, both in the annealed and hardened state, feels that comment will not be out of order. To all of those who are connected in any way with the acceptance of raw material upon its entering the shop or of the same material after different operations throughout manufacturing there comes a time (particularly in the fabrication of high-carbon or alloy, steel products which are to be more or less highly stressed or abraded in operation) when the acceptance or rejection of those parts is absolutely dependent upon some method of hardness testing, and it is at this time that the inadequacy of our present methods of determining hardness is most forcefully brought home, particularly if the material is near the dividing line between "hard" and "soft." That, it is almost universally conceded, is a fairly well-established fact.

The suggestion of Mr. Hultgren of the use of etched balls to bring out more clearly the indentations made by the Brinell testing machine, may at first seem to be a decided step for the better, and undoubtedly on some grades of steel this will give satisfactory results, but on extremely hard, tough alloy steels the etched ball has little, if any, effect in making readings easier unless etched very

deep. The writer has tried this where the indentation of a polished ball was vague, and although the imprint of the etched ball was plain at the bottom of the crater it grew less distinct at the edges, in many cases being imperceptible. If the ball is etched very deeply, say three or five minutes in concentrated HNO_3, then the print is more clear, but the value of the test has been lost if accuracy is to be adhered to. In connection with this the writer has tried several methods, some of which work satisfactorily, namely etching the specimens, coloring the ball with various substances such as carbon or prussian blue, or so polishing the specimen that very fine streaks are left on the surface, which, when struck by light rays, will stand out in relief. It may be argued by some that etching the specimens will tend to break down the surface; however, of the two evils it is better to break down the surface of the sample than that of the ball, for the depth of indentation is reached when an equilibrium is established between the pressure exerted by the ball and the resistance to penetration offered by the metal, and this

Micrograph Showing Effect of Bluing the Ball in Hardness Testing

is reached at the end and not at the beginning of the travel of the ball into the metal.

In using some coloring substance prussian blue seems most satisfactory, for as the ball penetrates the sample the fluid is squeezed to the boundary and in no way interferes with the test. The accompanying micrograph illustrates this. It is not offered as an ideal sample of indentation, but to show the effect of bluing the ball. In this connection it is of interest to note that all of the bluing has not been squeezed to the boundary, which would indicate that the ball was not absolutely spherical. On investigation this was found to be true, for the ball (10 mm. in diameter) was measured before loading and while under a load of 3000 kg. it was found to be some 0.0004 in. larger on an equator equidistant from the points of contact with the specimen and plunger. This explains the fact that the bluing was not all forced out, for while under pressure the ball fits the indentation, but as soon as the load is released the ball assumes its original form and no longer fits the crater except at a small area at the bottom, allowing the bluing to creep back. This accounts for the possible error of reading width rather than depth of indentation in determining hardness values and speaks decidedly in favor of the depth method.

Referring to the sections of the report dealing with the Brinell meter and Morin hardness-testing apparatus, the only advantage these instruments have is their portability, which of course is the reason for their development. There is certainly more chance for error, for, first a standard is determined in the regular way and then a sample tested and compared with that standard. To say that for very hard steels the Brinell method is more or less guesswork would be making a rather broad statement, but it is an established fact that a hardened ball can be forced into a flat surface, even though the surface is harder than the ball; furthermore, there is no present absolute method of determining hardness or softness, it being a matter of comparison, and there can easily be variation enough in ball hardness, even though the balls be specially selected, to give variant results and incorrect readings.

R. H. Coolidge.

Chicago, Ill.

What of the Young Engineer?

To the Editor:

Prominent men in the engineering profession are today turning their attention to the various industrial problems now confronting the nation. An investigating committee, headed by Mr. J. Parke Channing and L. W. Wallace, has recently completed an industrial survey that was nation-wide. The gentlemen conducting this survey have gone over the ground in a thorough and painstaking manner and have gotten results that are admittedly accurate. Their report, among other things, places the responsiblity for the elimination of business waste, depression, and general debility upon management.

Admitting that lack of knowledge on the part of management is the prime cause of wasteful, inefficient running and even failure in business, does it not show that there is a general lack of training in this most important phase of industrial activity? It would seem that the heads of these concerns, the general executive staff, have not had the proper grounding in the rudiments and fundamentals of executive knowledge. The remedy is obvious—select the right men for the governing heads of the particular industry in question and let them renovate and instill new life and energy into it. But men of this type are not easily procurable, nor can they be trained at a moments' notice. The few national geniuses in this line need not be reckoned with in this discussion. Where are men who possess the necessary qualities for such a position to be found?

Our technical colleges and our universities are turning out just such men year after year; turning out men who have been trained to think for themselves along orderly lines. The curriculum of these schools endeavors to give to all their students as broad an industrial education as can possibly be combined with the necessary purely technical knowledge that they must assimilate. It would seem, then, that the technical graduate is not only the logical man to train for such a position, but also practically the only candidate with a full complement of the necessary mental equipment.

The cause of the waste has been found, a preventive measure for the future is at hand, but is it being used? Not if we are to take into account the situation as it stands today. Vast numbers of recent technical graduates are today without positions, without a chance to get one. These men have put in four or five years, as the case may be, of the hardest grind. They have, for the most part, made great sacrifices of time and money; they have worked, scrimped and saved for their education because of their determination to fit themselves for a career. Now that the constructive work is finished and ready for use, they are worth—if the present attitude of the older engineers and business men is to be considered—*exactly nothing*.

Why, then, do prominent engineers make exhaustive investigations and reports upon business diseases and yet have no thought for remedying a condition which will further aggravate the situation? Machinery improvements may speed up production, new cost systems and routing methods may cut costs and time of handling merchandise, but in the last analysis brains and human energy are the motive power behind them all. Why try to doctor the disease without removing one of the chief causes? What the country's business needs is more trained men and plenty of them.

The potential creative power, the potential wealth of knowledge and intensive training that is stored up in the brains of these young men, if allowed to go to waste through lack of opportunity, will be a staggering loss to the engineering field. Engineers view, with grave concern and some alarm, the diminishing of our oil reserves, our forests and our coal mines; but they allow this waste of human energy and ability of the highest order to go unchecked. This enormous waste, of graver consequence than all the others put together, is still allowed to go on because engineers do not perceive, or will not perceive, the far-reaching ill effects of such a policy.

Does the present condition of affairs indicate that there is no further need for the technical graduate, at least for the next year

(*Continued on page 697*)

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

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Powdered Coal as a Boiler Fuel

While powdered coal has been burned under boilers for over twenty years, the installations have consisted mainly of small units designed for burning coal on grates which were changed over, with only minor alterations, to burn this new form of fuel. These rebuilt installations, however, were not without their value, since they demonstrated very clearly that for best results with this type of fuel a design of furnace was required which differed radically from that used with stoker- or hand-fired boilers.

Edwin B. Rickets

The first large central station designed for the exclusive use of powdered coal is the Lakeside plant of the Milwaukee Electric Railway and light Company and great credit is due Mr. John Anderson, chief engineer of the company, for his pioneer work in this field and his courage in making such a radical departure in power-station design.

The tests on No. 8 boiler at the Lakeside plant, made by Henry Kreisinger and reported elsewhere in this issue, have clearly demonstrated that efficiencies are possible with this fuel fully equal to those obtained in the best oil-burning plants and 2 or 3 per cent better than has been done with the best stoker installations. The difference in best test efficiencies between powdered coal and stokers would not be sufficient to overcome the handicap of extra preparation costs with powdered coal, but, due to its greater ease of regulation, it is much easier to maintain with powdered coal—as with oil—efficiencies in regular operation closely approaching those obtained on tests than with stokers. The difference in efficiency in regular operation would probably be in the neighborhood of 6 or 7 per cent in favor of powdered coal.

Of the problems which confronted the would-be user of powdered coal some years ago, many are approaching solution. The efficiencies obtained at Lakeside leave little to be desired, and while as high capacities have not been realized as with stokers, it has been demonstrated that capacity is largely a matter of furnace volume and draft. The problem of driers has for most cases been eliminated, as evidenced by the fact that the River Rouge plant of the Ford Motor Company is operating satisfactorily on coal having 15 per cent moisture without driers. Considerable progress has been made in reducing the fineness of grinding, and while we may never reach our ultimate aim of burning crushed coal in suspension, the indications are that in the future we will burn much coarser coal than is thought possible now. On the matter of grinding costs there is much to be desired in the data available, figures from various plants running all the way from 30 cents to $3 per ton. It is hoped that costs on some of the modern grinding plants which have been installed in the last year or two will be published as soon as the plants have been operating long enough to make the data reliable. While the fact that about 90 per cent of the ash in the coal passes out the stack may not be a problem in some industrial communities, it is a very vital one in our large cities. Experiments are now being made to catch this material, but so far no satisfactory means has been perfected.

That powdered coal as a boiler fuel is here and here to stay, few will question; that it will eliminate other means of burning coal is hardly possible. There is undoubtedly a field where this fuel will prove the best, as there are others where stokers, oil or gas will reign supreme. When only very low-grade coal which is burned with great difficulty on stokers is available and where coal is very high in price, powdered coal would seem to have a decided advantage over stokers. Where good stoker coal is available at a low price, the advantage is with the stokers. With eastern seaboard conditions—a good grade of coal available at a medium price—the best method of burning fuel becomes a matter for very close calculation. The extent of the place which powdered coal will occupy in the future none can foresee, but the problem of the engineer in considering this fuel in the same as that with all other types of fuel, namely, the careful balancing of efficiency against the cost of obtaining that efficiency. Edwin B. Ricketts.

Engineers Conducting Pre-College Education

It is to be hoped that no engineer, whether specially interested in the subject of education or not, will fail to read the article in the *Atlantic Monthly* for July entitled Mastering the Arts of Life. The article is an account of the efforts of Col. E. A. Deeds, Mr. C. F. Kettering and Mr. Arthur E. Morgan to break away from the conventional methods of education for the young, whether as a preparation for "life" or for college, and of the results so far achieved.

Colonel Deeds needs no introduction to our readers, and Mr. Kettering also is a man of achievement in the automotive field, while Mr. Morgan is the engineer who has directed the colossal work of flood prevention in the Miami Valley in Ohio.

Starting with the desire only to provide for the primary education of their own children in a way which they believed would be a much better preparation for real life in a real world, than is afforded by the standard pedagogic methods of the primary, grammar and high schools of the country, this school has grown into what appears to be an institution and it seems to answer thoroughly and satisfactorily many of the problems of those who, having children to train for a life of honorable usefulness, feel that the standard school methods do not meet the requirements of the present time, and are at a loss as to what to do about it.

All the methods followed in this school seem to be as different from the usual pre-college educational methods as could well be yet its graduates are really educated in the best sense of the word and if they wish are admitted upon certificate to colleges.

No condensation of the short article in the *Atlantic* can do it justice; but, suffice it to say that all the usual tests by means of examinations are eliminated and new standards are set up—such standards as the pupils will be judged by in the actual world in which their lives are to be spent.

Referring to the earlier period, before the elaboration of the modern school system, when the farm boy "had but three months of schooling in the year; which left nine months for him to get an education," it is declared that we have copied our school methods largely from the Germans or the classic English schools and have crowded out the American sort of education. "To make Americans you must inculcate and strengthen American traits. That, our schools are not doing. Initiative is a prime American trait, but our schools teach conformity. We are an ambitious people, but

our schools tend to delegate athletics to specialists. The American is many-sided, but our educational system aggrandizes only one side of the mastery of living. Business shrewdness is another distinctive American trait, but our education does not give us business power. We believe in democracy and self-government, and our schools are autocracies. We are a religious people, and our schools are unreligious, repressing the spiritual element in education through fear of offending sectarian prejudices."

Aside from the interest this article has for every intelligent person interested in education, it possesses special interest for engineers as an account of how competent engineers have applied the methods of the engineer to educational problems: i.e., sat down and carefully considered what training a young person should have to best qualify him, not solely for making money, or for "being successful" in the ordinarily accepted sense of that term, but for that real success which comes from not alone the ability to make money, but the ability to render service and to live a full and well-rounded life of usefulness and of satisfactory achievement as an individual and as a citizen member of coöperative society. The school has been designed to accomplish that object and in its design the traditional methods of pedagogy have been almost entirely discarded and the result is most excellent as regards the physical well-being and the mental and moral development of its very fortunate pupils.

This school has also a very interesting relation to the paper by Mr. H. E. Miles, which appeared in the August number of MECHANICAL ENGINEERING, and which has attracted a great deal of attention as a masterly presentation of points in which the standard educational methods fail in their adaptation to present-day conditions, and offers suggestions for improvements such as would scarcely occur to anyone not acquainted by experience with what most of the worlds' producers really need by way of education to enable them to lead the most useful and successful lives.

The Airship Disaster

WHEN the Quebec Bridge failed the general feeling in the engineering profession was that the disaster was due not to lack of competence on the part of the designers and erectors, but rather to a lack of knowledge of thebehavior of structures of such size.

In the early days of ore transportation on the Great Lakes there were several failures of steel ore boats which simply broke in the middle and plunged to the bottom like a stone. This again, was ultimately found to be due to peculiar, and, until then, unknown stresses to which vessels of such great length were subjected in certain parts of the Great Lakes. Once this became known, a comparatively simple change of design was made and ore transportation became safe.

There is good reason to believe that the fundamental cause of the airship disaster lies also in lack of knowledge of vital elements underlying the design of large airships. It is, at times, difficult to realize how slight our knowledge of airship engineering really is. We are dealing with structures 600 to 700 ft. long, weighing in the air next to nothing. At both ends of these immensely long structures we have operable planes (rudders and elevators) of very considerable size, presenting resistance to the air equal to a pressure estimable in tons, which, with a leverage of some 300 ft., must impose tremendous stresses amidships. What these stresses are we do not know, nor have we either experimental or mathematical bases for computation. This is particularly so, as we do not even know to what extent the theoretically rigid dirigible is capable of flexure.

Such a situation would have been bad enough if we were dealing with materials with whose behavior we are familiar, but we are not. The main resistance parts of the dirigible are constructed of the so-called "duralumin"—an alloy of aluminum and copper, or aluminum and zinc, or all three of them. Duralumin is, however, a new alloy, practically a "war baby," and we have only scant knowledge as to its behavior and next to no knowledge as to its ability to withstand repeated stresses—something of particularly great importance in a structure that is vibrating like a string all the time. In airship design we have therefore to meet unknown stresses with a material of unknown qualities, which would be bad enough in itself but is stupendously aggravated by another circumstance, and that is the very low factor of safety employed in airship construction.

In a bridge, an ore boat, an automobile, generous factors of safety are used wherever there is doubt as to the stresses to which a member is likely to be submitted, because there is no vital gain outside of the cost consideration, which should be secondary in using excessively light members. But this is not so in an airship. If the latter is designed to fly across the Atlantic it must carry a certain weight of gasoline, oil and useful load, and every pound of these supplies reduces by a pound the weight of the metal that can be put into the structure, and hence the factor of safety, with the result that members one sixteenth to one eighth of an inch in thickness are by no means uncommon in dirigible construction; and members of such slender dimensions in duralumin, under the tremendous stresses they are called upon to withstand, no longer possess a factor of safety but rather a factor of daring.

The airship has a certain military value, and in a war structure the lack of sufficient safety may not be considered a vital objection to its employment. For peace purposes the airship can probably be also made sufficiently safe after enough time and money have been spent in experimental work. It may be of interest to note that out of about fifty big dirigibles built so far at least one-third have met a violent end.

It was evidently from such a point of view as that, that the National Advisory Committee for Aeronautics passed a resolution recommending the government to continue its work on dirigibles, and to purchase for this purpose a discarded German Zepplin. A more thorough investigation of the properties of duralumin, its heat treatment, "ageing," behavior under alternating stresses etc., might also be of interest, and not for the design of dirigibles airships only.

The Lakeside Plant Pulverized-Fuel Tests

Much interest was aroused at the A.S.M.E. Spring Meeting in Chicago by the high boiler efficiencies reported by Mr. Henry Kreisinger as having been obtained in tests at the Lakeside Plant of the Milwaukee Electric Railway and Light Company, where pulverized coal is exclusively used as fuel. These tests and an additional one, which are commented on editorially in this issue, have been recalculated with the B.t.u. determinations made by the Bureau of Mines and are printed below, together with further particulars regarding the plant which have been kindly supplied by Mr. Kreisinger for publication.

SUMMARY OF RESULTS OF FIVE BOILER TESTS WITH PULVERIZED ILLINOIS COAL. TESTS MADE ON BOILER NO. 8, LAKESIDE STATION OF THE MILWAUKEE ELECTRIC RAILWAY AND LIGHT CO.

Test No.	1	2	3	4	5
Duration, hr.	42.33	23.97	19.92	24.20	24.17
Coal as Fired:					
Per cent through 100 mesh	89.2	90.8	90.5	92.2	90.5
Per cent through 200 mesh	67.7	68.7	69.1	70.5	66.7
Moisture content, per cent	2.25	3.56	3.59	5.24	5.61
Volatile matter, per cent	36.60	36.48	35.66	36.30	35.85
Fixed carbon, per cent	49.60	48.33	48.70	46.10	47.16
Ash, per cent	11.55	11.63	12.05	12.36	11.38
Sulphur, per cent	2.26	2.74	2.28	3.91	3.39
Hydrogen, per cent	4.97	5.18	5.01	5.10	5.06
Carbon, per cent	68.88	67.20	66.22	63.44	65.41
Calorific value, B.t.u.	12321	12022	11917	11483	11661
Total fuel fired, lb.	253161	233477	190334	160881	274640
Fuel fired hourly, lb.	5980	9740	9560	6650	11350
Fuel fired hourly per cu. ft. combustion space, lb.	0.85	1.39	1.36	0.95	1.62
Ash and Refuse:					
Carbon in second- and third-pass refuse, per cent of coal fired	3.60	5.06	5.06	5.31	7.17
Carbon in uptake dust, per cent	6.26	5.09	3.39	2.82	5.95
Unburned carbon per lb. coal, per cent	0.45	0.45	0.40	0.40	0.74
Ash Account:					
From bottom of furnace, lb.	6240	6414	5230	4120	1000
From second and third pass, lb.	13565	12236	9278	8260	12270
Determined from dust-collector data, lb.	10580	8640	8632	7290	18120
Air:					
Temp. of air entering furnace, deg. fahr.	86	89	91	104	93
Pressure of air at feeders, in. of water	11.0	12.2	13.6	12.2	13.6
Air entering with coal, lb. per lb. coal	2.05	1.25	1.27	1.85	1.03
Air entering at burners, lb. per lb. coal	....	....	....	2.07	....
Air through hollow wall, lb. per lb. coal	....	....	....	5.64	....
Excess air in flue gases, per cent	13.3	21.9	21.2	10.7	25.2

Flue Gas:					
Carbon dioxide in fourth pass, per cent	15.8	11.6	14.7	16.0	14.1
Oxygen in fourth pass, per cent	3.3	4.6	4.6	3.3	5.2
Carbon monoxide, fourth pass, per cent	0.05	0.0	0.03	0.0	0.09
Carbon dioxide entering economizer per cent	....	12.6	12.6	14.4	11.5
Carbon dioxide leaving economizer, per cent	10.4	11.9	12.0	13.2	10.8
Lb. dry gas per lb. coal leaving boiler	11.04	11.63	11.37	10.06	11.56
Lb. dry gas per lb. coal entering economizer	.....	13.36	13.16	11.14	14.10
Lb. dry gas per lb. coal leaving economizer	16.45	14.11	13.80	12.07	15.01
Temp. flue gases leaving boiler, deg. fahr.	434	475	482	430	496
Temp. flue gases entering economizer, deg. fahr.	388	400	424	400	431
Temp. flue gases leaving economizer, deg. fahr.	168	196	205	204	251
Draft:					
At furnace, in. of water	0.017	0.19	0.16	0.045	0.206
In fourth pass, in. of water	0.314	1.11	1.185	0.39	1.40
Entering economizer, in. of water	0.424	1.23	1.28	0.40	1.66
Leaving economizer, in. of water	0.525	1.67	1.72	0.51	2.38
Steam and Water:					
Steam pressure, lb. absolute	276	280	280	276	281
Degrees of superheat	137.4	180.8	186.8	118.4	178.6
Total water fed to boiler, lb.	2260018	2012452	1615530	1393250	2228514
Water fed to boiler per hr., lb.	53390	83953	81121	57572	92202
Water evaporated per lb. coal, lb.	8.92	8.62	8.49	8.66	8.12
Heat absorbed per lb. water, boiler and superheater	1149.6	1151.0	1158.4	1132.0	1146.6
Temp. feedwater entering economizer, deg. fahr.	126	129	124	126	127
Temp. feedwater entering boiler, deg. fahr.	168	192	188	175	195.4
Rates of Heat Absorption:					
Per cent rating developed	137	215	209	147	236
Horsepower developed	1833	2886	2798	1946	3156

Test No.	1		2		3		4		5	
Heat Balance—Boiler:	B.t.u.	Per cent	B.t.u.	Per cent	B.t.u.	Per cent	B.t.u.	Per cent	B.t.u.	Per cent
Heat absorbed by boiler and superheater	10260	83.3	9924	82.6	9835	82.5	9803	85.4	9309	79.8
(a) Loss—carried away in dry gases	928	7.5	1086	9.0	1076	9.0	794	6.9	1130	9.7
(b) Loss—steam from burning hydrogen	511	4.2	524	4.3	506	4.3	480	4.2	488	4.2
(c) Loss—steam from moisture in coal	27	0.2	43	0.4	44	0.4	62	0.5	69	0.6
(d) Loss—steam from moisture in air	10	0.1	10	0.1	13	0.1	21	0.2	23	0.2
Loss—by carbon monoxide	22	0.2	0	0.0	14	0.1	0	0.0	42	0.4
Loss—carbon in ash and flue dust	66	0.5	62	0.5	59	0.5	59	0.5	108	0.9
Loss—radiation	166	1.4	125	1.1	125	1.1	147	1.3	114	1.0
Loss—errors and unaccounted for	331	2.6	248	2.0	245	2.0	125	1.0	378	3.2
Total	12321	100.0	12022	100.0	11917	100.0	11491	100.0	11661	100.0
Heat Balance—Economizer:										
Total heat supplied—items (a), (b), (c) and (d) above	1476	12.0	1663	13.8	1639	13.8	1357	11.8	1710	14.7
Heat absorbed by economizer	375	3.0	543	4.5	543	4.5	432	3.8	556	4.8
Loss—dry gases delivered from boiler	219	1.8	301	2.6	314	2.6	244	2.1	444	3.8
Loss—air leaking into economizer	107	0.9	63	0.5	67	0.6	49	0.4	132	1.1
Loss—water vapor	483	3.9	506	4.2	491	4.1	493	4.3	505	4.3
Total heat accounted for	1184	9.6	1413	11.8	1415	11.8	1218	10.6	1637	14.0
Radiation and unaccounted for	292	2.4	250	2.0	224	2.0	139	1.2	73	0.7
Heat absorbed by boiler and economizer	10635	86.3	10467	87.1	10378	87.0	10235	89.1	9865	84.6

PRINCIPAL DIMENSIONS OF BOILER AND ECONOMIZER AT THE LAKESIDE PLANT

Boiler.—Edgemoor four-pass with 563 4-in. tubes 20 ft. long (15 high by 37 and 38 wide), and 5 steam drums. Total heating surface, 13,060 sq. ft.

Water Screen.—22 4-in. tubes each with an average exposed length of 13¾ ft.; total heating surface of exposed part of tubes, 320 sq. ft. Total heating surface of boiler and water screen, 13,380 sq. ft.

Superheater.—Foster.

Economizer.—Sturtevant, with 528 4½-in. O. D. cast-iron tubes 12 ft. long (12 wide by 44 long); provided with a steam-turbine-driven induced-draft fan.

Furnace.—Average width, 22 ft.; average length, 14 ft.; height under tubes, 25 ft., height under arch, 22 ft.

Burners.—6 flat Lopulco burners used; air supplied to feeders and burners under pressure of 12 in. water.

Peter Cooper Hewitt Dies

Peter Cooper Hewitt, one of America's well-known inventors and engineers, died in Paris on August 25, 1921, from pneumonia following an operation. Mr. Hewitt was born in New York on March 5, 1861, and was educated at Stevens Institute and at Columbia University, being graduated as a mechanical and electrical engineer. He received the honorary degree of Sc.D. from the latter institution in 1903 and from Rutgers College in 1916.

In addition to his inventions Mr. Hewitt took an active interest in a number of industrial corporations and in the work of many technical and social clubs to which he belonged. He was a trustee of Cooper Union, founded by his grandfather, and in 1915 was appointed a member of the United States Naval Consulting Board.

His chief inventions were the mercury-vapor electric lamp, the static converter or rectifier used to convert alternating currents into direct currents, the electrical interrupter, and the wireless receiver. The telephone relay and electric wave amplifier, as well as apparatus for use in connection with the wireless telephone and telegraph, were also devised by him.

Major L. A. Fischer, Scientist, Dead

Major L. A. Fischer, chief of the Division of Weights and Measures of the U. S. Bureau of Standards, one of the most prominent scientists of Washington and the foremost leader of the movement to promote a uniform system of weights and measures, died on July 25 at his home in Washington, D. C.

L. A. Fischer

Major Fischer was born in Washington, D. C., on January 4, 1864. His activities in the field of weights and measures began early in life when he joined the staff of the old weights and measures office of the Coast and Geodetic Survey. After many years of active service in this office he took a prominent part in the establishment of its successor, the United States Bureau of Standards, in 1901, in which institution he was made chief of the Division of Weights and Measures. In addition his scientific attainments won him a world-wide reputation as one of the leading American metrologists.

For a number of years Major Fischer was regularly appointed by the President to serve on the Assay Commission. In the course of this work he personally tested the standards employed at the mint against carefully calibrated weights which were especially tested in his own laboratories at the Bureau. In 1915 he served as a member of the jury of awards at the Panama-Pacific Exposition. During the war he was commissioned major in the Ordnance Department of the United States Army and placed in immediate charge of the important section of gage design.

Major Fischer was a graduate of George Washington University. He was a member of the Washington Academy of Sciences, the American Physical Society, the Physical Society of France, a fellow of the American Association for the Advancement of Science, past-president of the Philosophical Society of Washington, secretary, since its organization, of the National Conference on Weights and Measures. He was also a member of the Cosmos Club of Washington.

Since his early youth he had been prominently identified with athletics in the District of Columbia. He was a leading oarsman in the Potomac and Analostan Boat Clubs and later became a member of the tennis teams of the Old Bachelor Tennis Club, the Dumbarton Club and the Columbia Country Club.

Major Fischer became a member of The American Society of Mechanical Engineers in 1918 and took most active interest in its work, particularly in the field of screw threads and limit gages. He was but recently elected chairman of the Washington Section of the Society.

Kenneth Rushton Dies

Kenneth Rushton, vice-president in charge of engineering, The Baldwin Locomotive Works, died September 2, 1921, at the age of sixty years. Mr. Rushton was born in Philadelphia, Pa., and was educated in the city schools and Episcopal Academy. He served an apprenticeship as machinist under Hugo Bilgram, of Philadelphia, and afterward entered the employ of The Baldwin Locomotive Works in April 1881.

continued uninterruptedly until the time of his death; first as a draftsman, and later as designer, chief mechanical engineer, and finally as vice-president. He was the inventor of many appliances used in the construction of locomotives, and was closely associated with S. M. Vauclain in the development of the four-cylinder compound that bears the name of the latter. While Mr. Rushton did not travel extensively in the prosecution of his business, he represented Baldwin's abroad on some important missions. In 1913 he was sent to Chile, visiting various points of railroad interest on the west coast of South America, and in 1918 went to France in connection with the design of railway transport for artillery.

Kenneth Rushton

Mr. Rushton became a member of The American Society of Mechanical Engineers in 1918, and served actually on the Sub-Committee of its Boiler Code Committee on Boilers and Locomotives. He was also a member of the American Society for Testing Materials.

Research Laboratory

F. Paul Anderson, dean of the College of Engineering, University of Kentucky, has been appointed director of the Research Laboratory of the Committee on Research of the American Society of Heating and Ventilating Engineers, to succeed the late John R. Allen. L. A. Scipio, who has been acting director since Dr. Allen's death in October 1920, has been recalled to his position as dean of Robert College, Constantinople.

Following his graduation from Purdue University in 1890, Dean Anderson spent some months as designer of special machinery with the Studebaker Company, at South Bend, after which he devoted a year to experimental engineering at Purdue University. For 30 years he has served respectively as professor of mechanical engineering, director of experimental laboratories, and dean of the College of Engineering of the University of Kentucky, formerly the State College of Kentucky. He was for 25 years engineer of tests for the Southern Railway Company, and at the same time carried on a consulting engineering and architectural business.

Dean Anderson has long been noted as an investigator, having been the first engineer in this country to experiment with Roentgen rays. At the University of Kentucky he specialized in steam and locomotive engineering and materially developed the laboratory.

Dean Anderson is a member of the Society for the Promotion of Engineering Education, The American Society of Mechanical Engineers, and the American Society of Heating and Ventilating Engineers, as well as of various other social and technical societies and clubs.

News of The Federated American Engineering Societies

Report of Patents Committee on Stanley Bill

The Patents Committee of American Engineering Council, of which Edwin J. Prindle is chairman, has recently issued a report on the Stanley Compulsory Working and License Patent Bill, S. 1838, which proposes to require that all alien-owned American patents shall be worked in this country within two years after granting. Some of the arguments for and against this bill were set forth in the July issue of Mechanical Engineering, page 494. The report of the American Engineering Council Committee states that the committee "believes that the changes proposed in the Stanley Bill would be much more harmful than beneficial and would probably ultimately be disastrous, and therefore recommends that the Stanley Bill be vigorously opposed." Some of the reasons which the committee report gives for this conclusion are, in part:

There is grave danger that if compulsory working, under penalty of having licenses granted to others, is introduced into our law, as applied to patents issued to foreigners, it will be extended to apply to all American patents. It would be a catastrophe to require that all American patents be worked within any limited period under penalty of losing the monopoly by having licenses granted thereunder by the Government.

Such a provision would strongly tend to impair the value of patents and would, to that extent, discourage or fail to induce the production of inventions. Such inventions as were produced would be largely those which could be monopolized by being kept secret.

The great prevalence of the inventive faculty in America is due to the stimulus of the promise of a monopoly for seventeen years which our patent law offers.

If the individual inventor, or even the corporation, were faced not only with the often back-breaking burden of expense in developing an invention, but also with the necessity of putting that invention on the market within two years, or even a much longer period, they would often not attempt what is now successfully put through.

An invention is often of no commercial value because it is ahead of its time, and the patent must wait until the art has grown up to it before it can be profitably worked. Under these circumstances, the expense of commercially working it would be entirely thrown away.

The making of a successful invention today is not usually a question of a single patent, but in the course of the development of the invention, to a thoroughly commercial form, a group of patents has usually been taken out, either upon the article itself or upon instrumentalities and processes for its manufacture, and the patents of others are often found to be infringed and need to be purchased. In such a case the patents would usually have been taken out successively over a number of years, and thus each patent of the series would, under the Stanley Bill, have to be worked within two years while the working of that patent alone was of no commercial value and the success of the enterprise as a whole was still in doubt and might never be achieved.

The requirements of the Stanley Bill would obviously discriminate strongly in favor of the wealthy, and against the poor, inventor. That would not only discourage the production of inventions, but harm industry in general, for there are many successful businesses in this country which are based upon the inventions of their owners made when they were without capital.

No country which has a compulsory working clause in its patent law produces anywhere near the number of inventions per capita or in importance which are produced in this country. The very small and seemingly insignificant inventions produced under our patent system are often of great value to the public, although usually not to their inventors, because they lead step by step to a point of view from which some one sees an opportunity to make a really important invention that would not otherwise have been produced.

Registration of Engineers

A meeting of the American Engineering Council's Committee on Licensing and Registration of Engineers was held in the rooms of the Western Society of Engineers, Chicago, on September 19, for the purpose of giving a hearing on the Uniform Registration Law recommended by Engineering Council in November 1920. Engineers in general had previously been invited to prepare briefs and submit them to the Committee, either by mail before the meeting or in person at the hearing. The proposed changes were discussed in detail, as were also the recommendations on whether or not the Federation should use its influence to have the uniform law introduced in legislation in states where laws are not already in force. The findings of this hearing will be given in a later number of Mechanical Engineering.

International Cost Conference

Mr. L. W. Wallace, secretary of the American Engineering Council conducted the third session of the International Cost Conference held under the auspices of the National Association of Cost Accountants, at Cleveland, September 14–16. Arrangements for this session were the result of the work on the part of the Committee on the Elimination of Waste in Industry. Three members of the Committee in addition to Mr. Wallace presented papers, namely, John H. Williams, William R. Basset, and Robert B. Wolf.

Chemists Discuss Developments in Scientific Research

American Chemical Society and Society of Chemical Industry Hold Four-Day International Meeting in New York City

THE sixty-second meeting of the American Chemical Society, held in New York September 7–10, was attended by over 6000 chemists representing that society, the American sections of the Society of Chemical Industry and the Société de Chimie Industrielle, the British Society of Chemical Industry and its Canadian sections, the American Electrochemical Society, and the American Institute of Chemical Engineers. The Chemists' Club was the social headquarters for this international gathering and the business sessions were held at Columbia University and the College of the City of New York.

Over a score of papers were presented. Arthur D. Little, chemical engineer and technologist of Boston, Mass., spoke on Energy: Its Source and Future Possibilities, discussing some of the new sources of energy. The radiant energy of the sun, he stated, "is only three small calories per minute per square centimeter of the earth's surface, but it has been calculated that a surface of only 10,000 square kilometers (3860 square miles) receives in a year, assuming only six hours as the effective day, a quantity of heat that corresponds to that produced by the burning of 3,650,000,000 tons of coal. The Desert of Sahara receives daily solar energy equivalent to that of 6,000,000,000 tons of coal. The world awaits the genius who will convert radiant energy into electric current." The energy of the earth's rotation and tidal energy were also discussed by Dr. Little. The former has thus far been utilized only through the gyroscope. Concerning the latter he believed that intermittent flow, varying head and other special conditions involved are likely to hold the development of tidal power within closely restricted limits. Kinetic energy possessed by radium and also by ordinary matter as the constitutional energy of atoms, he said, are further power sources of great interest to chemists.

Wilder D. Bancroft, professor of physical chemistry at Cornell University, presented a paper on Catalysis, the New Economic Factor. He was of the opinion that the most promising way in which chemists could develop methods of increasing production and decreasing costs lies in a better utilization of the possibilities of catalytic action. He predicted the use of a catalytic agent in speeding up the reaction which gives rise to cold light and in causing rain clouds to precipitate into arid regions and was sure that the availability of the energy in sunlight and in atoms involves catalysis. Reid of the Johns Hopkins University had apparently furnished the missing experimental proof. He passed a mixture of the vapors of ethyl aclohol and acetic acid for twenty-four hours over silica gel as catalytic agent, and during the whole of that time he obtained about 10 per cent more of ethyl acetate than corresponds to the theoretical equilibrium. The displacement of equilibrium by a catalytic agent he thinks may be an avenue to extraordinary possibilities in making organic compounds. A displacement of 10 per cent in the right direction in the synthesis of ammonia, for instance, would be revolutionary.

An interesting paper on a Chemically Controlled Automobile was presented by George G. Brown, Jr., an instructor in the chemical engineering department of the University of Michigan. Mr. Brown had been working for some time on the development of a carburetor which automatically delivers the leanest and most efficient mixture possible with every temperature condition when the car is running under light load, and automatically enriches the mixture according to decreased speed or increased load when the car encounters increased resistance, so that acceleration, hill climbing and flexibility are not sacrificed when obtaining maximum economy. This carburetor, he stated, produces a mileage of from 30 to 45 miles a gallon, depending on the car and the roads.

Dr. Sidney Born, of Muskogee, Okla., in speaking of saving petroleum at the wells, said that different processes were used at different fields. Among these processes are the steaming plant, the Cottrell or electrical, and the super-centrifuge. The latter method, by which petroleum is recovered from the emulsion of salt water, oil and various impurities found in many oil wells, makes possible an economy of millions of dollars.

Following a discussion of the German chemical industry by Francis P. Garvan, president of the Chemical Foundation, Inc., the meeting adopted a resolution to Congress, urging, among other things, the necessity of including in the permanent tariff bill a selective embargo for a limited period against importation of synthetic organic chemicals. Sir William Pope, professor of chemistry at Cambridge Univerity, touched on the same subject when in the course of his address on Mustard Gas he stated that every dollar which was spent in this country on German dyes during the war, and every pound spent in England for German dyes, was a contribution to the German war chest.

Dr. Leo H. Baekeland, honorary professor of chemical engineering in Columbia University, in his address on The Engineer: Human and Superior Director of Power, said that there are enormous possibilities in the range of photochemistry. "Our vast coal beds and our petroleum wells and our natural gas," he said, "are simply the results of light energy stored up from the plant or animal life of former geological periods, yet here is a field where the scientist or engineer has accomplished next to nothing."

Some of the other subjects discussed were Organization of Industrial Research in Canada, by Prof. R. F. Ruttan of the Canadian Chemical Society; Theories on the Development of Research, by Dr. Willis R. Whitney, head of the research department of the General Electric Company; Problem of Diffusion and Its Bearing on Civilization, by Prof. Ernst Cohen, professor of chemistry at the University of Utrecht; and Research Applied to the World's Work, by Dr. C. E. K. Mees, head of the research department of the Eastman Kodak Company.

The last day of the meeting was devoted to excursions to various industrial plants in New York, including those of the National Biscuit Company, the American Tobacco Company, Standard Oil Companies of New York and New Jersey, Manhattan Rubber Company, Passaic Print and Dye Works, and the Seaboard By-Product Coke Company.

It was decided to hold the 1922 convention in April at Birmingham, Ala., and the fall meeting at Pittsburgh in September.

Book Notes

THE A.B.C. OF IRON AND STEEL. Edited by A. O. Backert. Penton Publishing Co., Cleveland, 1921. Cloth, 8 × 11 in., 408 pp., illus., $5.

This is a simple, concise, yet comprehensive account of the primary processes involved in the conversion of iron ore into finished products, intended for general readers who wish a knowledge of these processes, and for technical readers wishing general information on phases of the industry outside their own experience. The book is elaborately illustrated.

BROACHING PRACTICE. By E. K. Hammond. The Industrial Press, New York, 1921. Paper, 6 × 9 in., 122 pp., illus., $1.

For many years broaching has been used for cutting keyways and machining holes to a variety of shapes, but the method attracted little attention until comparatively recently. With the rise of the automibile industry, broaching machines came into common use and now are extensively used in building many products. This book is a concise review of modern practice, explaining the machines, the design of broaches and the application of the process to many classes of work.

CONCRETE DESIGNERS' MANUAL; TABLES AND DIAGRAMS FOR THE DESIGN OF REINFORCED CONCRETE STRUCTURES. By G. A. Hool and C. S. Whitney. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 276 pp., $4.

These tables and diagrams facilitate the rapid design of structures in accordance with the Joint Committee recommendations, the American Concrete Institute recommendations, the New York Building Code requirements and the Chicago Building Code requirements. Some of them are general enough also to be used when the requirements are different from those mentioned. The collection is the result of the authors' practical experience.

CONTROL OF CORROSION IN IRON AND STEEL

(Continued from page 662)

are decidedly favorable, confirming the theory stated in the first part of this paper which has now been generally accepted, that corrosion is due primarily to the dissolved oxygen in water. The water is sprayed into a chamber under about 28in. vacuum, by which 90 per cent of the gases are removed and corrosion thereby reduced to one-quarter or one-fifth of the original amount.

It is much easier to study the various factors which influence corrosion in a closed system where all conditions are under better control. Early experiments in 1907 indicated the great influence of dissolved oxygen in water on corrosion. Careful laboratory experiments by Dr. W. H. Walker and the author, covering a period of several years have demonstrated that the amount of corrosion is almost directly proportional to the oxygen in solution, and also varies directly as the temperature. Hot-water heating systems in buildings invariably show no corrosion to speak of after 35 or 40 years' use, whereas frequently hot-water supply systems operating at the same average temperature with the same water last less than half of that time, the only difference being that the former carry no oxygen, while the water on entering the latter is usually saturated with oxygen.

Protection Against Internal Corrosion

From the foregoing it will be seen that in addition to the use of protective coatings, under some conditions it is more economical to prevent internal corrosion by removing the dissolved oxygen from water. In fact, experience has shown that with hot water the latter method is much more effective and economical in the long run.

In practice the removal of oxygen from water has been accomplished in two ways:

1 By mechanical deaeration, for which there are two or three designs of apparatus in use giving satisfactory results.

2 By chemical combination with some material such as scrap sheet iron.

Both methods may be combined by using mechanical deaeration to remove the larger portion of oxygen and the chemical treatment for residual oxygen. Considerable has been written on this subject during the last few years with reference to the control of corrosion in hot-water supply systems, to which those interested may refer.[1] The most economical plan for any particular case depends very largely on local conditions.

The control of corrosion in condensers, especially where salt water is used, may be accomplished by deaeration, and there are probably many other cases where this principle can be applied economically to engineering practice.

For the internal protection of water mains by coating the metal, under most conditions a dip in a bath of well-refined asphalt or coal tar will be sufficient. Again the importance of thorough cleaning and the removal of all scale from the steel, so far as practicable, should be emphasized.

Concrete has been used to a limited extent for the protection of the inside of pipes from 1 in. to 11 ft. in diameter. Small service pipes have been used for thirty years in New England with an internal coating of $^1/_8$ in. of neat cement applied by means of some simple appliances designed for the purpose. This coating has also shown great durability as a lining for steel or wrought-iron pipe carrying mine water, and when properly applied to the clean surface and about $^3/_4$ in. in thickness, is difficult to break off or injure unless there is much variation in temperature.

The 11-ft.-diameter rivited-steel pipe sections of the Catskill Aqueduct were lined with 2 in. of portland-cement grout. The plates of which this pipe was made were first pickled free from scale and given a coat of whitewash to prevent rusting. The outside of the pipe was protected by a coat of 1:3:5 concrete mixture 4 in. thick at the top. The reports from this line, which was put into service in 1915, indicate that this coating has been satisfactory so far as can be ascertained at present. It is interesting to find that the friction losses in the cement-lined Catskill conduits are less than in the unlined pipe under these conditions, notwithstanding the reduction in diameter of the lined pipe.

What has been written above necessarily deals in general principles. The details of the application of these principles to practice in various cases will of course require variation to suit local conditions. Considering the great economical importance of conservation of material in our day, it would seem that the boundaries of engineering practice should be broadened out a little so as to include more of anti-corrosion engineering.

[1] Paper by J. R. McDermet on the Separation of Dissolved Gases from Water and discussion. A.S.M.E. meeting, St. Louis, May 1920. Papers by F. N Speller, W. H. Walker and R. G. Knowland, Trans. A.S.H.&V. Engrs., 1918 and 1920.

What of the Young Engineer?

(Continued from page 691)

or so? Have the bigger men in our profession deliberated upon the question and decided that no help need be given to the new men to find themselves? Again, are over a thousand trained young men to be cast aside as surplus junk? Can the interval be bridged without their help, and without loss to the engineering world? This is hardly conceivable; but if it is so, then why not sound the warning to the colleges to cut down on their engineering personnel? Let these men be guided into less crowded channels to be trained in other lines.

However, it does not seem probable that such is the case. Perhaps conditions are still so abnormal as to aggravate a usually healthy state of affairs. At the same time the problem is here and is a very serious one, not only from the remunerative standpoint, but also in its effect upon the morale of our young men. It is upon the shoulders of this type of young men that the burden rests of keeping a state of healthy normalcy in our country. Education is the best combative measure against bolshevism and anarchism. Any condition of affairs tending to break the spirit of these young men, to reduce them to a state of hopelessness and lethargy, will have its immediate effect upon their attitude toward such matters. They will not champion a state of affairs which they believe in their hearts to be unfair.

Engineers have in the past advocated a far-sighted policy. They have prepared for the future as well as the present. In this work they have been the pioneers, watching our resources, husbanding our reserves, and sounding the warning of waste and inefficiency. Can it be that they are now being overtaken by a wave of materialism; that they are no longer for what may affect the future as long as they make the most material gain in the present? These methods have been consistently condemned by engineers for many years. It is hard to believe they are coming to the same sort of policy against which they have so long fought. Yet why not prepare for the future in man reserve as well as machine and money reserve?

This is the question that is running through the mind of the graduate of today. What is your answer, Mr. Senior Engineer?

New York, N. Y. W. Cullin.

1921 Condensed Catalogues Being Distributed

The eleventh annual (1921) volume of Condensed Catalogues of Mechanical Equipment is now being distributed to the membership. This edition contains more than a hundred pages of catalogue data not included in the 1920 volume, important changes in the pages continued from last year, and a more comprehensive Directory Section, thoroughly revised and brought up to date with respect to the changes that have taken place during the past year.

There are 648 catalogue pages containing the condensed data of 495 firms. The arrangement of this data is uniform and convenient and includes descriptions of over 1300 pieces of apparatus, instruments, materials and the like—illustrated by over 1700 engravings. The indexing and classifying is thoroughly done so that the particular data sought can be instantly found.

The Mechanical Equipment Directory (green pages) contains the names and addresses of over 4000 firms under 3000 classifications of equipment. The names and addresses of over 700 consulting engineers in the Consulting Engineers Directory (yellow pages) appear under 400 classifications.

The volume may be purchased by non-members at $4.00 a copy plus 25 cents carrying charges. Extra copies for members may be had for $3.25.

THE ENGINEERING INDEX

(Registered U. S. Patent Office and Canadian Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Phantom. Grinding with a Phantom Wheel, Ellsworth Sheldon. Am. Mach., vol. 55, no. 2, July 14, 1921, pp. 44–45, 5 figs. Difficulty of grinding thin work without heating. Wheel set at angle eliminates much of the pressure.

AERODYNAMICS

Testing Station. The Aerodynamic Experimental Station at Göttingen. Engineering, vol. 112, no. 2901, Aug. 5, 1921, pp. 218–220, 11 figs. Construction details of new experimental station. Translated from report entitled "Ergebnisse der Aerodynamischen Versuchsanstalt zu Göttingen," published by A. Oldenbourg, Munich and Berlin.

AEROPLANE ENGINES

Clearance Volumes. An Instrument for Measuring Clearance Volumes, H. C. Dickinson. A.S.R.E. Jl., vol. 7, no. 6, May 1921, pp. 460–463, 4 figs. Discusses aircraft-engine cylinders.

Fiat. 300 HP. Fiat Model A-12 Engine. Aerial Age, vol. 13, no. 18, July 11, 1921, pp. 415–416, 4 figs. Aviation engine said to resemble Mercedes 260-hp. engine. It has six vertical water-cooled cylinders and operates with gasoline as a fuel on four-stroke cycle.

AEROPLANE PROPELLERS

Theory. General Theory of Aeroplane Propellers (Théorie Générale de l'Hélice Propulsive), A. Rateau, M. R. Soreau and M. S. Drzewiecki. L'Aerophile vol. 29, nos. 9–10, May 1–15, 1921, pp. 139–146, 7 figs. Development of formulas and comparison with experimental results.

AEROPLANES

All-Metal. German Metal Airplanes (L'avion metallique en Allemagne), Roger Couturier. L'Aéronautique, vol. 3, no. 25, June 1921, pp. 249–254, 11 figs. Describes the Zeppelin-Staaken, Zeppelin-Dornier, also Dornier hydroplanes. (Concluded.)

Ansaldo Commerical Biplane. The Ansaldo A-300 C Commercial Biplane. Flight, vol. 13, no. 26, June 30, 1921, pp. 437–438. Specifications: Span, 44 ft. 9$^1/_2$ in.; chord, 6 ft. 6 in.; overall length, 31 ft. 8 in.; overall height, 10 ft. 9$^1/_2$ in.; total weight, 4187 lb.; useful load, 1653 lb.; speed range, 43–120 m p.h.; climb (15 min.), 7000 ft.

Balancing. Aeroplane Balance. L. Huguet. Aerial Age, vol. 13, no. 18, July 11, 1921, pp. 417–419 1 fig. Influence of wing profile and of passive resistance; influence of steering mechanism; sensitiveness of aeroplane to action of steering mechanism; equilibrium of forces. (Concluded.) Translated from "La Vie Technique & Industrielle."

Bristol Commercial. The Bristol Commercial Ten-Seater Biplane. Flight, vol. 13, no. 27, July 7. 1921, pp. 457–458, 3 figs. Characteristics: Span, 54 ft.; length overall, 42 ft.; height, 11 ft.; total weight as passenger machine, 6801 lb.; as cargo machine, 7100 lb.; speed at ground level full load, 122 m.p.h.; etc.

Farman. Farman Improved Aeroplane. Commonwealth Engr., vol. 8, no. 10, May 1, 1921, pp. 301–302, 1 fig. Specifications: Span, 23 ft. 4 in.; length, 20 ft. 11 in.; height 8 ft. 2$^1/_2$ in.; load-carrying capacity including pilot and passenger, 440 lb., equal to its own weight; engine, 60 hp.; max. speed 87 mi. per hr.; climb, 5000 ft. in 8 mm. 35 sec.

Fiat. Fiat 10 Passenger Airplane. Aviation, vol. 11, no. 5, August 1, 1921, pp. 139, 1 fig. Gives particulars of design and dimensions. Maximum speed 125 m.p.h.

Flotation Gear. DH-4 Emergency Flotation Gear. Aviation, vol. 11, no. 4, July 25, 1921, p. 103, 2 figs. Describes emergency flotation gear developed by Engineering Division of Army Air Service, consisting of a pair of collapsible fuselage air bags, front and rear hydro-surfaces, wing floats, wheel-releasing mechanism and an air system for inflation of flotation bags.

Fokker. The Commercial Monoplane "Fokker F.-III" (Le Monoplan Commercial "Fokker F-III"), Roger Couturier. L'Aéronautique, vol. 3, no. 26, July 1921 pp. 286–288, 2 figs. Made by Nederlandsche Vliegtuigenfabrik at Amsterdam. Description and comparative data.

Horsepower Chart. Aeroplane Flight Endurance—I. Aerial Age Weekly, vol. 13, no. 21, August 1, 1921, pp. 490–491, 1 fig. Describes a chart for determining minimum horsepower required or maximum horsepower available at any altitude possible for the aeroplane to reach.

Lift and Drag Coefficients. The Variation of Aerofoil Lift and Drag Coefficients with Changes in Size and Speed, Walter S. Diehl. Natl. Advisory Committee Aeronautics, Report No. 111, 10 pp., 8 figs. Results of investigation of existing scale-correction data and derivation of an original method for making these corrections rapidly and accurately.

Remington-Burnelli. The Remington-Burnelli Airliner. Aerial Age, vol. 13, no. 18, July 11, 1921, pp. 420–421 and 416, 3 figs. Specifications: Length overall, 41 ft. 2 in.; height, 18 ft.; span, 74 ft.; chord, 10 ft. 6 in.; horse power, 1000; climb, 900 ft. per min.; max. speed, 110 m.p.h.; etc.

Sablatnig P.3. The Sablatnig P.3 Monoplane. Flight, vol. 13, no. 31, August 4, 1921, pp. 521–525, 15 figs. Germany's first commercial aeroplane.

Saulnier Three-Engined Monoplane. The Saulnier Three-Engines Monoplane. Aviation, vol. 11, no. 3, July 18, 1921, pp. 71–72, 2 figs. Characteristics: Span, 93 ft.; length overall, 56 ft. 8 in.; height, 10 ft. 5 in.; max. chord, 19 ft. $^1/_4$ in.; wing area, 1300 sq. ft.; engines, 3500 hp. Liberty; weight loaded, 15,500 lb.; high speed, 150 m.p.h.; ceiling, 15,000 ft.

Spad. The Spad "Berline" S.33. Aerial Age Weekly, vol. 13, no. 21, August 1, 1921, pp. 488–489, 3 figs. The fuselage is of the monocoque streamline type, the wings baving a backswept top plane. Performance data.

Truss Ribs. Experimental Reinforced Plywood Truss Ribs. Aerial Age Weekly, vol. 13, no. 23, August 15, 1921, pp. 539–541, 10 figs. Compares plywood truss ribs with other types and draws conclusions based on tests. (To be continued.)

Wing Beams. Merits of Different Splices for Airplane Wing Beams. Jl. Soc. Automotive Engrs., vol. 9, no. 2, August 1921, pp. 133–138, 1 fig. Discusses the construction of the beam, also discusses scarf and splices and gives results of experiments.

Wing-Load Indicator. The Klemperer Wing-Load Indicator, Leon N. W. Colin. Aviation, vol. 11, no. 6, August 8, 1921, pp. 164–165, 1 fig. Description of operation and advantages.

[See also HYDROPLANES; PARACHUTES; SEAPLANES.]

AIR

Dust Content. Comparative Tests of Air Dustiness With the Dust Counter, Konimeter and Sugar Tube, S. H. Katz & L. J. Trostel. Jl. Am. Soc. Heat. & Vent. Engrs., vol 27, no. 5, July 1921, pp. 519–527 and (discussion) pp. 527–528, 8 figs. Particulars of comparative tests of air dustiness with dust counter, konimeter and sugar tube in granite-working plants.

AIRCRAFT CONSTRUCTION MATERIALS

Fabrics. Airship Fabrics, J. W. W. Dyer. Aeronautical Jl., vol. 25, no. 127, July 1921, pp. 332–348 and (discussion) pp. 349–356. Deals briefly with different types of fabrics, classified according to main functions of each, and describes their structure and behavior and chief factors affecting their permanence when in service.

AIRSHIPS

Masts. Airship Mast at Aerial Terminal in Pulham, Eng. (Le Mat d'Amarrage Pour Dirigeable de la Gare Aérienne de Pulham, Angleterre). Le Génie Civil, vol. 78, no. 24, June 11, 1921, pp. 493–496, 6 figs. Nose of airship is fastened to mechanism at top of mast. Mechanism is capable of rotating as airship is moved by wind.

Rigid. Rigid Airships, J. L. Bartlett. Aeronautical Jl., vol. 25, no. 127, July 1921, pp. 357–377, 8 figs. Two lectures, first dealing with general aerostatical principles governing flight of lighter-than-air craft, and describing various types of airships, with special reference to rigid airships; second referring to some important problems in design of rigid airship. Appendices.

ALIGNMENT CHARTS

Advantages. Note on Some Useful Alignment Charts, J. A. P. Gibb. Bul. Instn. Min. & Metallurgy, no. 200, May 1921, pp. 1–11, 6 figs. on supp. plates. Notes and chart presented with object of drawing attention to advantages which alignment charts offer as compared with the more commonly used intercept and correlation charts.

Uses. Alignment Charts—XIV, Arnold A. Arnold. Mech. World, vol. 70, no. 1880, July 1, 1921, pp. 9–10, 1 fig. Practical example: marine-engine shafts and crankshafts. Principal proportions of chart. Connection between charts. (Concluded.)

ALLOYS

See ALUMINUM ALLOYS; BEARING METALS; MONEL METAL.

ALUMINUM

Exposition, Paris. Exposition of New Industrial Application of Aluminum, Magnesium, Calcium and Sodium at the Société d'Encouragement, Paris (L'Exposition des Nouvellse Applications Industrielles de l'Aluminium, du Magnésium, du Calcium et de Sodium, à la Société d'Encouragement pour l'Industrie Nationale). Le Génie Civil, vol. 79, no. 2, July 9, 1921, pp. 36–39. Particulars of program of exposition and reports of four lectures on aluminum and its alloys.

Properties and Uses. Aluminum, Magnesium, Calcium and Sodium (L'aluminium, le magnésium, le calcium et le sodium). Revue Générale de l'Electricité, vol. 10, no. 1, July 2, 1921, pp. 21–29. Report of eight lectures given at the recent expo-

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

and their alloys.

ALUMINUM ALLOYS

Melting. Constitution of Gas Atmospheres in Aluminum-Alloy Melting Furnaces. Robert J. Anderson and J. H. Capps. Chem. & Metallurgical Eng., vol. 25, no. 2, July 13, 1921, pp. 54–60, 7 figs. Tabulated analyses of atmospheres of various types of aluminum furnaces, sampled at short intervals during operation, furnishing data necessary for study of dross and metal losses due to furnace operation.

Iron-Pot Melting Practice for Aluminium Alloys, Robert J. Anderson. Metal Industry (Lond.), vol. 19, nos. 1 and 4, July 1 and 22, 1921, pp. 8–9 and 65–66. Present-day methods and detailed investigation of them in practice. See also Metal Industry (New York), vol. 19, no. 7, July 1921, pp. 285–287, 4 figs.

Uses. Aluminium and Its Alloys in Engineering, John G. A. Rhodin. Engineer, vol. 131, no. 3417, June 24, 1921, pp. 659–660. Blowing and cracking of castings is attributed to overheating.

AMMONIA

Coke-Oven Gas as Source. Increasing the Ammonia Yield with the Distillation of Anthracite (Beiträge zur Erhöhung der Ammoniakausbeute bei der Destillation der Steinkohle), Friedrich Sommer. Stahl u. Eisen, vol. 41, no. 25, June 23, 1921, pp. 852–859, 5 figs. Process for recovery of hydrocyanic acid contained in coke-oven gas through conversion into ammonium sulphate.

Total Heat Diagrams. Total Heat Diagrams For Ammonia, E. F. Mueller and C. H. Meyers. A.S.R.E. Jl., vol. 7 no. 6, May 1921, pp. 419–425, 6 figs. Discusses the advantages of using total heat-entropy diagrams of which examples are given in rectangular and oblique coördinates, also total heat-pressure diagrams.

AMMUNITION

Colloided Smokeless Powder. Absorption of Moisture by Colloided Smokeless Powder, Tenney L. Davis. Army Ordnance, vol. 2, no. 1, July-August 1921, pp. 9–12, 2 figs. Discusses means of determining the hygroscopicity of the solvent-free material colloid and for comparing the hygroscopicity of various kinds of powder.

ARTILLERY

Post-War Matériel. Post-War Artillery Matériel G. F. Jenks. Army Ordnance, vol. 2, no. 1, July-August 1921, pp. 1–8, 13 figs. Discusses improvements due to the war and pending. Considers gun carriages and anti-aircraft material, motor material, etc.

ASH HANDLING

Plants. Ash-Handling Plant at Poplar Electric Power Station. Engineering, vol. 112, no. 2901, Aug. 5, 1921, pp. 231–233, 24 figs. Construction and operation of plant constructed by Underfeed Stoker Co., Ltd., London.

AUTOGENOUS WELDING

Boiler Repairs. Speeding Up Boiler Repairs by Use of Autogenous Welding Processes, C. E. Lester. Boiler Maker, vol. 21, no. 7, July 1921, pp. 194–195. Details of welding operations used in repairing flue sheets.

AUTOMOBILE ENGINES

Fuel Economy. Effect on Fuel Economy of Refinements in Engine Design, L. Mantell. Automotive Ind., vol. 45, no. 4, July 28, 1921, pp. 161–167, 9 figs. Discusses factors of design which affect performance and economy, such as pulsating flow, valve timing, scavenging, etc.

Localized Charge and Supercharging. Experiments with Localized Charge and Supercharging Engines, Harry R. Ricardo. Automotive Industries, vol. 45, no. 2, July 14, 1921, pp. 61–68, 18 figs. Report of investigations demonstrating how mean effective pressure and economy can both be increased by use of stratified charge. Excess air and cooled exhaust gas are employed as diluents to limit maximum temperature of cycle and prevent detonation. Unusually high fuel economy at part load is obtained by use of nonthrottling engine. (Abstract.) Paper presented before (British) Instn. Automobile Engrs.

AUTOMOBILE FUELS

Efficient Utilization. More Miles Per Gallon, O. C. Berry. Chem. & Metallurgical Eng., vol. 25, no. 2, July 13, 1921, pp. 64–68, 4 figs. Discussion on carburetion as affecting motor efficiency, brake horsepower and work. Spark timing and brake load. Relation between torque and engine speed. Possibilities of more efficient utilization of motor fuels. Paper read at Automotive Symposium, Am. Inst. Chem. Engrs.

[See also GASOLINE.]

AUTOMOBILES

Assembly System. Economy and Efficiency Increased by New Final Assembly System, Norman G. Shidle. Automotive Industries, vol. 45, no. 2, July 14, 1921, pp. 69–72, 8 figs. Describes new final assembly system and discusses methods of equipment.

Benz Chassis. One Four and One Six-Cylinder Chassis Comprise Benz Line, Benno R. Dierfeld. Automotive Industries, vol. 45, no. 2, July 14, 1921, pp. 56–60, 15 figs. Aside from engine, chassis are said to be practically identical and possess but few novel features. Transmission brake has provision for water cooling. Steering gear has unhardened screw with non-adjustable babbitt-lined nut.

Berliet. The 16–20 Hp. Berliet, Model VI, 1921. Auto, vol. 26, no. 27, July 7, 1921, pp. 580–583, 6 figs. Notable features are said to be the pressed steel bridge-type live axle; light but well-base torque-tube; well-extended rear suspension; adoption of dynamotor unit for lighting and starting; and grouping of all connections to concentric brakes.

Buick. New Buick Four Similar to Six of Same Make, J. Edward Schipper. Automotive Ind., vol. 45, no. 6, August 11, 1921, pp. 255–258, 6 figs. Description of design and equipment.

European vs. American Practice. Comparison of European and American Automobile Practice. Jl. Soc. Automotive Engrs., vol. 9, no. 2, August 1921, pp. 109–115 and Discussion 115–117. Comparison of general design, road conditions, etc.

Humber. The 15.9 Hp. Humber Chassis. Automobile Engr., vol. 11, no. 152, July 1921, pp. 234–241, 15 figs. Revised model of the 14-hp. design. A four-cylinder L-headed engine is employed with 80-mm. bore and 140-mm. stroke.

Kerosene Vaporizers. A Paraffin Vaporizer. Automobile Engr., vol. 11, no. 152, July 1921, pp. 252–253, 4 figs. New system for utilizing heavy fuel on commercial vehicles.

Leach. Far Western Custom Built Car Has Many Features. Automotive Mfr., vol. 43, no. 3, June 1921, pp. 7–10, 7 figs. Describes the Leach Six built by Leach Biltwell Motor Co., Los Angeles. Motor is specially built 6-cylinder unit of 3½-in. bore and 5¼-in. stroke, and 60 hp. at 2000 r.p.m.; weight, 3800 lb.

Locking Devices. Automobile Locking-Device Classification and Theft Insurance. Jl. Soc. Automotive Engrs., vol. 9, no. 2, August 1921, pp. 95–100 and Discussion pp. 100–106. Considers design factor in insurance and fire hazard.

Moller. Moller a New American Light Car. Motor Age, vol. 40, no. 2, July 14, 1921, pp. 18–19, 4 figs. Car designed along European lines weighs 850 lb.; chassis has 100-in. wheelbase and 50-in. tread.

Rolls-Royce. Some Unusual Features of the Rolls-Royce Car, Fred H. Colvin. Am. Mach., vol. 55, no. 3, July 21, 1921, pp. 85–86, 7 figs. Power transmitted through large ball joint. Bracing used at rear end of chassis. Axle and torque tubes made of steel forgings.

Star. The 11.9 Hp. Star. Auto, vol. 26, no. 28 July 14, 1921, pp. 600–602, 4 figs. Engine is monobloc with four cylinders 69 mm. by 120 mm. bore and stroke respectively; wheelbase is 9 ft. and track 4 ft.; wheels are 30 in. fitted with 3½-in. tires.

Transmission Cases. Machining and Inspecting Transmission Cases, Fred H. Colvin. Am. Mach., vol. 55, no. 4, July 28, 1921, pp. 143–147, 23 figs. Fixtures hold aluminum cases without springing. Drilling and tapping operations. Inspection gages that insure accurate alignment.

Transmission Gear. Machining the Wrigley Automobile Transmission Gear I and II, I. W. Chubb. Am. Mach., vol. 55, nos. 5 and 7, Aug. 4 and 18, 1921, pp. 176–178 and 252–255, 17 figs. Aug. 4: Modern production methods in English plant. Forms necessary for accurate record keeping. Aug. 18: Using mechanical conveyors to eliminate handling progressive machining of automobile parts. Inspection tools and methods for rough and finished parts.

Voiturette. The 10 Hp. B.A.C. Auto-Motor Jl. vol. 26, no. 31, August 4, 1921, pp. 665–668, 7 figs. Description of a voiturette made by the British Automotive Company.

AVIATION

Aerial Transportion. Value of Airplanes in Transportation (De la Valeur de l'Avion Comme Engin de Transport), L. Hirschauer. L'Aeronautique, vol. 3, no. 25, June 1921, pp. 255–258, 2 figs. Discusses security, regularity, speed, stops, etc. (To be continued.)

Commercial. Commercial Aviation in Germany, Erik Hildesheim. Aviation, vol. 11, no. 5, August 1, 1921, pp. 135–136, 1 fig. Considers conditions of subsidy, planes under construction, air transport service and passenger rates.

Luminous Beacons. Luminous Beacons on Aerial Routes For Nocturnal Flying (Le balisage lumineux des routes aeriennes pour la navigation nocturne). Le Genie Civil, vol. 79, no. 5, July 30, 1921, pp. 111–112, 2 figs. (From l'Aerophile.) Discusses lighthouses with fixed and intermittent light signals.

AXLES

Machining Methods. Machining Front Axles. Eng. Production, vol 3, no. 40, July 7, 1921, pp. 4–6, 7 figs. Methods employed for intensive production.

B

BEAMS

Reinforced-Concrete. Reinforced-concrete Beams —II. T. C. Broom. Mech. Wld., vol. 70, no. 1803, July 22, 1921, pp. 68–69. Discusses rectangular concrete beam with double reinforcement. (To be continued.)

Strength of the Reinforced Thin-plate Beam, Held at Its Ends, and Subject to a Uniformly Distributed Load—Special Case, B. C. Laws. London, Edenburgh and Dublin. Phil. Mag. & Jl. of Sci., vol. 42, no. 248, 6th series, August 1921, pp. 281–287, 3 figs. Continuation of a mathematical investigation started in a previous paper.

BEARING METALS

Properties at High Temperatures. Properties of White Metal Bearing Alloys At Elevated Temperatures, John R. Freeman Jr. and R. W. Woodward. Raw Material, vol. 4, no. 7, July 1921, pp. 241–245, 7 figs. Describes tests carried out by the Bureau of Standards on five alloys.

BEARINGS, BALL

Manufacture. A Modern Ball Bearing Works. Eng. Prod., vol. 3, no. 44, August 4, 1921, pp. 108–115, 24 figs. Production methods on accurate repetition work. Description of works of Rudge-Whitworth, Ltd., Sparkhill, Birmingham.

BELTING

Balata. Balata and Fabric-Belt Formulas and Chart, W. F. Schaphorst. Power Plant Eng., vol. 25, no. 15, August 1, 1921, pp. 769–770.

Rubber. Revised Rubber Belt Specifications Adopted by A.S.T.M. Belting, vol. 19, no. 1, July 1921, pp. 13–14, 1 fig. Principal changes provide for increase in allowable stretch from 5 to 6 per cent and reduction of ultimate strength from 285 to 260 lb. Revised specification submitted by Am. Soc. Testing Materials.

BLAST FURNACES

Electric. The Metallurgy of Electric Blast Furnaces (Ueber die Metallurgie des Elektrohochofens), R. Durrer. Stahl u. Eisen, vol. 41, no. 22, June 2, 1921, pp. 753–757, 1 fig. Discussion of certain metallurgical phenomena in electric blast furnaces with special regard to work of Bo Kalling (see Jernkontorets Annaler, 1919, pp. 413–430) dealing with hot and cold working; part played by direct and indirect reduction in total reduction.

BOILER EXPLOSIONS

Causes. Boiler Explosion at a London Hospital. Engineering, vol. 112, no. 2899, July 22, 1921, pp. 148–149. Report issued by Board of Trade states that explosion was primarily due to generation of excessive pressure in boiler consequent upon fire being lit in boiler with all outlets closed and relief valve inoperative.

BOILER FEEDWATER

Treatment. Power Plant Management—I, Robert June. Refrigerating World, vol. 56, no. 7, July 1921, pp. 21–23. Notes on boiler-water treatment. Specifications for ideal water-purification plant.

BOILER PLANTS

Modernizing. Modernizing a Cotton Mill Boiler Plant, Charles T. Main. Textile World, vol. 60, no. 6, August 6, 1921, pp. 87–89, 4 figs. Change from hand firing to stoker firing.

BOILER TUBES

Charcoal Iron. The Manufacture of Charcoal Iron Boiler Tubes. Boiler Maker, vol. 21, no. 7, July 1921, pp. 187–190 and 212, 9 figs. Methods and machines employed by Parkesburg Iron Co.

BOILERS

Accessories. Boiler Accessories from a Safety View Point. Power House, vol. 14, no. 14, July 20, 1921, pp. 28–31. Discusses various mountings of the modern boiler and makes suggestions for greater safety.

Code Rulings, Pennsylvania. Boiler Code Rulings of Pennsylvania Board. Boiler Maker, vol. 21, no. 7, July 1921, pp. 196–197. Use of autogenous welding in boilers outlined. Inspection and standard stamping of boilers. Rulings adopted May 24, 1921, by Industrial Board, Dept. of Labor and Industry, Pa.

Combustion and Efficiency. Theory of Combustion and Efficiency of Steam Boilers, Arthur R. Norris. Practical Engr., vol. 63, no. 1792, June 30, 1921, pp. 412–413. Gives empirical formula for calculation of calorific value of any fuel when chemical composition is known. Calculation of loss of heat in boilers.

Inspection. Inspecting the Boiler, W. M. McNeill. Power Plant Eng., vol. 25, no. 15, Aug. 1, 1921, pp. 752–753. What to look for and where to look for it.

Losses. Minimizing Steam Boiler Losses—III, Robert June. Gas Age, vol. 48, no. 1, July 11, 1921, pp. 7–9. Notes on steam-power management.

BOMBING

Aeroplane. Airplane Bombing, E. J. Loring. Army Ordnance, vol. 2, no. 1, July-August 1921, pp. 21–22, 3 figs. Discusses trajectory and accuracy of aim.

BRAKES

Hand. Efficient Hand Brakes for Freight Cars, Frank N. Grigg. Southern and Southwestern Ry. Club, vol. 16, no. 3, May 19, 1921, pp. 10–34, 5 figs. General description, causes of accidents, up-keep.

BRASS

High-Resistance. High-Resistance Brass, Pendleton Powell. Metal Ind., (Lond.), vol. 19, no. 4, July 22, 1921, pp. 62–64. Discusses molding, melting, pouring, use of scrap, etc.

Season Cracking. The Season-Cracking of Brass and Other Copper Alloys, H. Moore. Engineering, vol. 112, no. 2902, Aug. 12, 1921, pp. 262–264, 9 figs. Results of investigation of season cracking carried during period of some years by Research Department, Woolwich, England. (Abstract.) Paper read before Inst. Metals. (To be continued.)

BRONZE

Manganese. Methods of Casting Manganese-Bronze Test Bars as a Check on Melts of Small Castings, E. H. Dix, Jr. Metal Ind., vol. 19, no. 8, August 1921, pp. 315–317, 2 figs. Results of experiments made to fix upon a satisfactory method.

BUILDING CONSTRUCTION

Bush Buildings, London. Construction Features in the Bush Buildings, London. Am. Architect, vol. 120, no. 2372, July 20, 1921, pp. 53–60, 12 figs. 30,000 cu. yd. of earth were excavated for foundations and basement. Details of sidewalk vaults, walls and footings, steel framing, etc.

BUILDINGS

Acoustics. Acoustical Properties of Buildings, F. R. Watson. Jl. Western Soc. Engrs., vol. 26, no. 7, July 1921, pp. 241–247, 3 figs. It is shown that one important problem in acoustics of buildings lies in sound proofing of various rooms.

Office. Fire Resistive Construction of Office Buildings, Fire & Water Eng., vol. 70, no. 4, July 27, 1921, pp. 154–155, 163 and 169. Report of Nat. Fire Prot. Assoc. Committee on building construction.

Steel-Frame. Reducing the Cost of Steel-Frame Buildings, R. Fleming. Eng. & Contracting, vol. 56, no. 4, July 27, 1921, pp. 83–86. Considers the questions of design, specifications and standardization in this connection.

C

CABLES

Aerial. Suspension Cables and Their Use in Construction (Les Cables de Suspension et leur emploi dans la construction). Le Génie Civil, vol. 79, no. 3, July 16, 1921, pp. 59–63, 11 figs. Describes the manufacture of cables and gives illustrations of their application.

CABLEWAYS

French. The Cableway in Hohneck (Alsace) (Die Drahtseilbahn am Hohneck). Fördertechnik u. Frachtverkehr, vol. 14, no. 6, Mar. 18, 1921, pp. 71–72. Describes cableway of the French army for transportation of supplies to the front line.

CALORIMETERS

Coal. The Calorimetry of Solid Fuel—III. Eng. & Ind. Management, vol. 6, no. 3, July 21, 1921, pp. 62–64, 3 figs. Deals with the Wm. Thompson, Rosenhain and Darling calorimeter.

Fairweather Gas-Testing. The "Fairweather" Recording Calorimeter. Gas Jl., vol. 154, no. 3031, June 15, 1921, pp. 628–629, 2 figs. Results of tests with described instrument show that it gives a continuous record within $1/2$ per cent of accuracy.

Simmance Recording. Fifth Report of the Research Sub-Committee on the Gas Investigation Committee of the Institution of Gas Engineers. Gas Jl., vol. 154, nos. 3032, 3033, June 22 and 29, 1921, pp. 677–684 and 744–750 and vol. 155, no. 3034 and 3035, July 6, and 13, 1921, pp. 35–40 and 101–103, 22 figs. The Simmance recording calorimeter.

Solid Fuel. The Calorimetry of Solid Fuel—II. Eng. & Indus. Management, vol. 5, no. 26, June 30, 1921, pp. 737–739, 3 figs. Operating method of some of best-known solid fuel calorimeters are explained and explanitory diagrams are given.

CAR LIGHTING

Testing. Principles of Car Lighting by Electricity —XII, Charles W. T. Stuart. Ry. Elec. Engr., vol. 12, no. 7, July 1921, pp. 278–282, 7 figs. Testing and adjusting a car-lighting equipment.

CAR WHEELS

Failures. Studies Failures of Cast-Iron Wheels, H. J. Force. Foundry, vol. 49, no. 15, August 1, 1921, pp. 602–603. Limits recommended for composition of metal based on analyses of failures.

CARBOCOAL

Smith Carbonization Process. The Smith Continuous Carbonization Process. Engineering, vol. 112, no. 2900, July 29, 1921, pp. 175–179, 10 figs. Describes process developed by C. H. Smith, New York, according to which coal is first subjected to low-temperature distillation, after which solid residue is again treated at high temperature to produce hard fuel known as carbocoal. Details of plant at Clinchfield, Va.

CARBURETORS

Automaticity. Principles of Automatic Action In Carburetors (Les Principes d'Automaticité des Carburateurs). La Vie Automobile, vol. 17, no. 732, June 25, 1921, pp. 223–225, 6 figs. Discusses supplementary air supply, simultaneous control of air and gasoline flow, diffusers, etc.

Fundamentals. Fundamental Points of Carbureter Action, F. C. Mock. Jl. Soc. Automotive Engrs., vol. 9, no. 2, August 1921, pp. 85–94, 11 figs. Considers the joint responsibility of the engine designer and the carbureter engineer, and of the latter to produce an instrument that will deliver reliably and consistently a fuel charge with as favorable vaporization conditions as can be obtained.

CARS

All-Metal. New All-Metal Cars in Use on English Railway, F. C. Coleman. Elec. Traction, vol. 17, no. 7, July 1921, pp. 468–470, 3 figs. Cars built by Lancashire & Yorkshire Ry. Details of electrical equipment; automatic control; brake equipment; and interior construction.

All-Steel High-Capacity. New All-Steel Wagons for Bengal-Nagpur Railway. Ry. Engr., vol. 42, no. 498, July 1921, pp. 273–275, 4 figs. Details of high-capacity wagons constructed by Midland Ry. Carriage & Wagon Co., Ltd., Birmingham, for India. Dimensions: Extreme length over buffers, 49 ft. 2 in.; width over underframe solebars, 9 ft. 6 in.; center of bogies, 32 ft.; bogie wheelbase, 6 ft.; buffer height, 3 ft. $7^1/_2$ in.; load, 40 tons.

Dining. New Dining and Kitchen Carriages Built at Derby for the Midland and Glasgow & South Western Railways' Joint Services. Ry. Gaz., vol. 35, no. 3, July 15, 1921, pp. 128–137, 12 figs. 1 supp. pl. Particulars of dimensions and equipment.

Suspension Method. Study of a New Suspension Method for Railway Cars, (Etude d'une nouvelle Suspension pour Matérial Roulant), M. Lotte. L'Industrie des Tramways, vol. 15, no. 171–172, March-April 1921, pp. 51–53, 1 fig. (Concluded.)

CARS, FREIGHT

Concrete. New Reinforced-Concrete Freight Cars (Neue Eisenbahnwagenbauten in Eisenbeton), Gerhard Neumann and Franz Lehner. Beton u. Eisen, vol. 20, no. 2–3, Feb. 4, 1921, pp. 32–34, 6 figs. Details of the first Hungarian reinforced-concrete cars type Kmu; and the Austrian cars type Ke.

Design. Factors To Be Considered in Freight Car Designing, Albert H. Lake, Jr. Ry. Mech. Engr., vol. 95, no. 8, August 1921, pp. 495–496. Arranging details to reduce cost of construction and maintenance and avoiding troublesome defects.

Draft-Gear Tests. Draft-Gear Tests of the Railroad Administration. Ry. Mech. Engr., vol. 95, no. 8, August 1921, pp. 497–501, 8 figs. Results of car impact tests, comparative grading of gears and general conclusions.

CARS, TANK

Reinforced-Concrete. Reinforced-Concrete Tank Cars (Zisternenwagen aus Eisenbeton), Viktor Lazarus. Beton u. Eisen, vol. 20, no. 6, Apr. 4, 1921, pp. 69–70, 4 figs. Details of French tank cars of reinforced concrete for transportation of petroleum, wine, etc.

CASE-HARDENING

High-Temperature Resisting Alloys. High Temperature Resisting Alloys for Carbonizing, A. Bensel. Trans. Am. Soc. Steel Treating, vol. 1, no. 10, July 1921, pp. 598–601. Sets forth desirability of good heat-resisting containers, and discusses standard methods of case hardening employing these containers, namely, pack, liquid bath and gas carbonizing.

CAST IRON

Shrinkage and Piping. The Shrinkage and Piping of Cast-Iron (Schwinden und Lunkern des Eisens), Karl Sipp. Stahl u. Eisen, vol. 41, no. 26, June 30, 1921, pp. 888–890, 2 figs. Supplement to author's article in same journal (Apr. 24, 1921, pp. 675–680), in which theory of shrinkage and piping was developed.

Spiegeleisen, Influence of. Influence of Speigeleisen and Phosphorus Spiegeleisen on Cast Iron (Einfluss von Spiegel- bzw. Phosphorspiegeleisen auf das Gusseisen), E. Schultz. Giesserei-Zeitung, vol. 18, nos. 10 and 12, May 15 and June 15, 1921, pp. 152–155 and 197–200, 3 figs. Based on operating experiences in the Luise Mine in Lünen, Germany, writer explains effect of increase in content of manganese in charge in connection with melting in cupolas caused by addition of spiegeleisen and phosphorus spiegeleisen. Address delivered before Assn. German Steel Works Engrs.

CASTINGS

Cracks, Annular. Annular Cracks, R. R. Clarke. Metal Industry (Lond.), vol. 19, no. 1, July 1, 1921, pp. 2–3, 10 figs. Discussion of various theories accounting for their formation.

CEMENT

Hardening. Law of Hardening of Cement, (Loi de durcissement du Ciment), J. Bied and E. Garnier, Revue de l'Ingénieur, vol. 28, no. 6, June 1921, pp. 269–272, 1 fig. Graph constructed from results of experiments.

Oxychloride. Plastic Calcined Magnesite and Oxychloride Cements, M. Y. Seaton. Chem. & Met. Eng., vol. 25, no. 6, August 10, 1921, pp. 233–236, 1 fig. Physical tests showing and factors influencing the properties of oxychloride cements.

Rapid-Setting. Rapid-Setting Cement (Béton à pris accélerée des fermes du Comptoir suisse d' Echantillons de Beaulieu), A. Paris. Bulletin Technique de la Suisse Romande, vol. 47, no. 15, July 23, 1921, pp. 169–172, 7 figs. Results of tests carried out with Holderbank cement to produce a cement which will harden in ten days instead of the usual 28.

Tests. Tests for the Determination of the Variations of Volume of Cement and Cement Mortar During Setting (Versuche zur Ermittlung der Raumänderungen von Zement und Zementmörtel beim Abbinden, Etc.), Otto Graf. Beton u. Eisen, vol. 20, nos. 4–5 and 6, Mar. 7 and Apr. 4, 1921, pp. 49–52 and 72–74, 12 figs. Influence of water addition, mixture ratio, and cement on extent of volume variations. Measurement of change of length of reinforcement with setting of cement mortar. Investigations of the swelling and contracting of natural stones with moisture and by drying.

CEMENT, PORTLAND

Crushing Plant. Perfect Dry-Mix Control. Rock Products, vol. 24, no. 15, July 16, 1921, pp. 20–28, 29 figs. Details of new crushing plant of Giant Portland Cement Co. at Egypt, Pa.

Coal-Fired. The Economic Limits of Distribution from Coal-fired Stations, William B. Woodhouse. Engineering, vol. 112, no. 2898, July 15, 1921, p. 128, 1 fig. Consideration of steps to be taken to supply an area which extends beyond economical limits of distribution pressure in use. Paper read before Instn. Civ. Engrs.

Equipment. Modern Tendencies in Central Station Construction (Les Tendences Modernes dans la Construction des Centrales), F. Scoumanne. Revue Universelle des Mines, vol. 9, no. 4, May 15, 1921, pp. 346–355. Describes machinery and switchboard equipment.

CHIMNEYS

Brick, Loss of Heat in. Loss of Heat in Brick Chimneys, Alfred Cotton. Power Plant Eng., vol. 25, no. 15, August 1, 1921, pp. 747–748. An investigation into the effect of air infiltration on heat loss.

COAL

Volatile Content. Determination of Volatile Matter in Coal (Determination de la Teneur en Matières Volatiles), Auguste Dessemond. Revue de l'Industrie Minerale, no. 13, July 1, 1921, pp. 451–456. Develops a formula for calculating volatile matter from ash content.

Volatile Matter in Coal (Les Matières Volatiles de la Houille), Achille Delclève. Chimie & Industrie, vol. 6, no. 1, July 1921, pp. 33–40, 5 figs. Shows that present methods require revision.

COAL HANDLING

Plant. A Modern Coal-Handling Plant. Managing Engr., vol. 8, no. 3, July 1921, pp. 47–52, 6 figs. Describe a mechanical coal-handling plant that involves avoidance of waste and will operate day and night, so long as the necessary driving power is available.

Pneumatic Plant. The Pneumatic Handling of Coal. Elecn., vol. 86, no. 2249, June 24, 1921, pp. 801–803, 4 figs. Describes pneumatic plant for discharging coal from barges, constructed by Henry Simon, Ltd.

COAL STORAGE

Submerging in Pits. Concrete Pits for Submerging Reserve Coal Supply. Elec. Rev., vol. 79, no. 5, July 30, 1921, pp. 163–164, 2 figs. Dangers of spontaneous combustion are eliminated and drippage basin is provided by means of which screenings are saved.

COKE

Foundry Slag and, Characteristics of. Characteristics of Foundry Cokes and Slags, Y. A. Dyer. Iron Age, vol. 108, no. 7, Aug. 18, 1921, pp. 407–409. Analyses, units of value and tests. Analyses and value of fluxes. Slagging. Nature of slags and value of melting process.

COKE BREEZE

Boiler Fuel. Coke Breeze Mixtures for Steaming —II, John Blizzard and James Neil. Coal Trade Jl., vol. 52, no. 29, July 20, 1921, pp. 845–846, 2 figs. Tests show advantages of combining breeze with bituminous coal under hand-fired boilers.

Burning Coke Breeze with Mechanical Stokers, William H. Burton. Coal Industry, vol. 4, no. 7, July 1921, pp. 331–333. Successful handling of low-grade fuels in a boiler plant.

COKE-OVEN GAS

Benzol in. Determination of Benzol in Coke-Oven Gas, A. Thau. Part I. Blast Furnace & Steel Plant, vol. 9, no. 8, August 1921, pp. 474–476, 1 fig. Describes European methods of determining benzol. (To be continued.)

COLUMNS

Design. Calculation of Columns (Le Calcul des Colonnes), L. Lemaire. Annales des Travaux Publics de Belgique, vol. 22, series 2, June 1921, pp. 367–384, 12 figs. Develops formulas for wind pressures. (To be continued.)

Fire-Resistance Tests. Fire Resistance of Building Columns as Shown by Test, R. E. Wilson. Eng. News-Rec., vol. 87, nos. 3 and 4, July 21 and 28, 1921, pp. 106–110 and 145–146, 5 figs. Conclusions drawn from test series of 106 columns caried out during 1917–18 show cast iron and timber resist longer than unprotected steel. How various fireproofing materials fail. Concrete makes best showing.

COMBUSTION

Alignment Charts for Fuel. Calculating Charts for the Combustion of A Given Fuel (Rechentafeln für die Verbrennung beliebiger Brennstoffe), Wa. Ostwald. Feuerungstechnik, vol. 9, no. 19, July 1, 1921, pp. 173–177, 9 figs. Writer develops a universal alignment chart which can be used directly for every fuel, or from which special charts can be plotted.

Control. Report of the Exposition of Combustion-Controlling Devices (Compte Rendu de l'Exposition des Appareils de Controle de la Chauffe), P. Frion. Société des Ingénieurs Civils de France, vol. 74, nos. 1, 2, 3, January-March 1921, pp. 7–34, 21 figs. Covers manometers, flow meters, feedwater meters, thermometers and pyrometers, flue-gas analysis, calorific power of coal, etc.

CONCRETE

Age, Effect of. Effect of Age on the Strength of Concrete, Duff A. Abrams. Concrete, vol. 19, no. 1, July 1921, pp. 14–15, 2 figs. Based on careful study of available data, writer states with utmost confidence that under normal conditions, concrete in roads does not deteriorate in strength with age.

Aggregates. A Study of the Composition of Blast-Furnace Slags Suitable for Concrete Aggregate, L. G. Carmick. Eng. & Contracting, vol. 56, no. 4, July 27, 1921, pp. 82–83, 2 figs. Describes tests made for the purpose.

Crusher Screenings, Effect of. Effect of Crusher Screenings in Concrete, Walter C. Adams and James G. Ross. Cement News, vol. 33, no. 7, July 1921, pp. 19–21, 1 fig. Increase in strength of concrete

through use of up to 20 per cent of crusher screenings in aggregate. Economic advantage of utilizing screenings. Report on tests carried out by Milton Hersey Co., Ltd., Montreal.

Elasticity, Modulus of. The Modulus of Elasticity on Concrete, F. C. Lea. Concrete & Constructional Eng., vol. 16, no. 7, July 1921, pp. 435–439 and (discussion) pp. 439–441. 2 figs. Results from compressometer tests show that mixtures in which ration of sand to stone are 1:1 and 1:1½ are not to be recommended, but only mixtures with ratio of 1 : 2, properties of which are summarized. (Abstract.)

Proportioning. Proportioning Concrete By Voids in the Mortar, Arthur N. Talbot. Eng. News-Rec., vol. 87, no. 4, July 28, 1921, pp. 147–152, 8 figs. Proposed method of estimating density and strength of concrete and of proportioning materials by experimental and analytical consideration of voids in mortar and concrete. (Abstract.) Paper presented before Am. Soc. for Testing Materials.

Three Methods of Proportioning Concrete. Eng. & Contracting, vol. 56, no. 4, July 27, 1921, pp. 87–91, 12 figs. Discusses Abrams' water-cement-ratio strength relation, Edward's surface area method of proportioning, Hydro-Electric Power Commission method of proportioning.

Setting Time. Time of Set of Concrete, Watson Davis. Eng. & Contracting, vol. 56, no. 4, July 27, 1921, pp. 79–81. Considers the influence of character of cement, also time and temperature, flow-set method, etc.

Waterproofing. Waterproofing Concrete—III, J. H. Burgess. Commonwealth Engr., vol. 8, no. 10, May 1, 1921, pp. 306–307. Notes on permeability tests. (Concluded.)

CONCRETE, REINFORCED

Design. Suggestions for Concrete Design, Harold A. Axtell. Can. Engr., vol. 40, no. 26, June 30, 1921, pp. 1 and 5, 2 figs. Types of live loads for different buildings. Standardization of design. Three systems of slab design and their relative cost.

CONDENSERS, STEAM

Cleaning Tubes. Cleaning Surface Condenser Tubes D. W. R. Morgan. Elec. Jl., vol. 18, no. 7, July 1921, pp. 313–315, 7 figs. Discusses eight types and methods of cleaning.

Corrosion. Corrosion in Condensers, Ernest Bate. Commonwealth Engr., vol. 8, no. 11, June 1, 1921, pp. 339–343, 8 figs. Discusses results of investigation and experiments of the condensers of the Ultimo & White Bay power houses, Sydney, N.S.W.

CONVEYORS

Belt. Interlocking Belt Conveyor System, A. M. Beebe. Gas Age-Rec., vol. 48, no. 3, August 6, 1921, pp. 105–107, 7 figs. Description of the electrically driven automatic system of the Rochester Gas & Electric Corp.

COST ACCOUNTING

Construction Work. Cost Accounting System for Construction Work, W. N. Connor. Eng. & Contracting, vol. 56, no. 3, July 20, 1921, pp. 66–70, 9 figs. Notes on use of daily labor cost reports; summary and analysis of estimate; timekeeping symbols and field sheet; waste and payroll sheets; invoice and material cost records; tabulating job cost by graphic method; final cost summary and cost comparison. (Abstract.) Paper presented before Boston Soc. Civ. Engrs.

Foundries. The Costing Problem in the Foundry, O. Bertoya. Metal Industry (Lond.), vol. 19, no. 2, July 8, 1921, pp. 21–24. Notes on indirectly apportionable expenses and overhead charges; inspection; and records.

Methods. Necessity of Proper Cost Accounting, J. B. Sehl. Iron Age, vol. 108, no. 7, Aug. 18, 1921, pp. 391–393. Machine-rate or production-center method stressed. Distribution of overhead in bulk or by department. Why some methods fail.

Principles and Advantages. The Necessity of Proper Cost Accounting, J. B. Sehl. Forging & Heat-Treating, vol. 7, no. 7, July 1921, pp. 370–372. Describes principles of cost accounting and explains its advantages. Primary purposes of cost accounting are summarized as follows: (1) to ascertain actual costs; (2) to forecast in order to fix future selling prices; (3) to reduce costs; and (4) to increase efficiency.

Work-in-Progress Account. The Work-in-Progress Account: An Essential Feature in Modern Costing. Robert Stelling. Eng. & Indus. Management, vol. 5, no. 26, June 30, 1921, pp. 734–736, 1 fig. Notes on relation of turnover and finances, cost of idle time, etc.

COSTS

Engineering, Rise in. Rise in Engineering Costs—II, R. J. A. Pearson. Eng. & Indus. Management, vol. 5, no. 26, June 30, 1921, pp. 740–742, and vol. 6, no. 1, July 7, 1921, pp. 11–13, 5 figs. Data contained in paper read before Roy. Statistical Soc. on comparison of pre-war and post-war costs in engineering.

CRANES

Floating. Derricking Jib Type Floating Crane Mammouth. Marine Eng., vol. 26, no. 8, August 1921, pp. 591–592, 2 figs. 200-ton floating crane for the port of Liverpool.

Foundry. 25-ton Electric Overhead Foundry Crane. Engineer, vol. 131, no. 3417, June 24, 1921, pp. 667–668, 5 figs. Span is 47 ft. between centers of rails, maximum available head room 7 ft. 10 in. and end clearance 10 in.

Handling Materials in a Remodeled Foundry. Iron Age, vol. 108, no. 2, July 14, 1921, pp. 76–78, 4 figs. New crane installations saved in a year over double their cost.

Safety Devices. Crane Safety Devices, Nicholas Prakken. Safety Eng., vol. 42, no. 1, July 1921, pp. 27–30. Deals with safety devices on class of cranes used in foundries, machine shops, yards, shipways and warehouses.

Traveling. Electric Motor Drive for Traveling Cranes, Gordon Fox. Blast Furnace and Steel Plant, vol. 9, nos. 7 and 8, July and Aug. 1921, pp. 413–416 and 485–488, 3 figs. Discusses question of manual control versus magnetic control for cranes.

Wharf. Motor-Operated Cranes Used for Cargo Transfer, Henry Cunningham. Elec. Rev. (Chicago) vol. 79, no. 3, July 16, 1921, pp. 90–92, 2 figs. Describes two Shaw overhead wharf cranes installed at pier on East River, New York City.

CUPOLAS

Chemical Reactions. Chemical Reactions in Foundry Cupolas, Y. A. Dyer. Iron Age, vol. 108, no. 5, Aug. 4, 1921, pp. 259–262. Actions and reactions. Combustion, cupola gases, carbon ratio, melting efficiency, metal losses and gains. Cupola balance sheet.

Use in Open-Hearth Practice. Use of Cupolas in Open-Hearth Practice, V. W. Aubel. Iron Age, vol. 108, no. 7, Aug. 18, 1921, pp. 403–405. Melting high-silicon and other pig iron continuously and supplying hot metal to four 60-ton basic open-hearth furnaces.

CUTTING TOOLS

Lathe and Planer. Design of Lathe, Planer, Shaper and Slotter Tools. Can. Machy., vol. 26, no. 3, July 21, 1921, pp. 33–36, 10 figs. Factors which decide what shape of tool will prove most efficient for any given cutting operation.

The Lumsden System for Lathe-Type Tools. Engineering, vol. 112, nos. 2900 and 2901, July 29 and Aug. 5, 1921, pp. 183–186 and 213–216, 17 figs. Details of the Lumsden oscillating grinder with settings required for some of the tools given in table.

CYLINDERS

Calculation. The Calculation of Thick and Thin Cylinders. Machy. (Lond.), vol. 18, no. 458, July 7, 1921, pp. 421–422, 5 figs. Calculating method and examples.

DIES

Trimming. Construction and Action of New Trimming Die. Can. Machy., vol. 25, no. 24, June 16, 1921, pp. 40–41, 4 figs. Describes patented tool that trims surplus metal. In place of downward movement of punch a lateral oscillating movement accomplishes operation.

DIESEL ENGINES

Construction. Building Diesel Engines on the Pacific Coast, Frank A. Stanley. Am. Mach., vol. 55, no. 2, July 14, 1921, pp. 41–43, 12 figs. How principal parts are machined. Good system for keeping order in shop handling big work.

Generator Driving. Diesel Engines for Generator Driving, C. S. Darling. Beama, vol. 9, no. 1, July 1921, pp. 41–45. Construction, operation, maintenance, etc. (Concluded.)

Investigations. Investigations of Diesel Engines—II (Untersuchungen an der Dieselmaschine), Kurt Neumann. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 30, July 23, 1921, pp. 801–804, 10 figs. Results of tests for determination of condition during combustion period and interchange of heat between gas and wall of engine cylinder. The separate phases of combustion are quantitatively determined, and the speed of combustion is established.

Lubrication. Lubrication of Marine Diesel Engines, Louis R. Ford. Marine Eng., vol. 26, no. 8, August 1921, pp. 623–627, 4 figs. Discusses low-pressure and high-pressure systems, cylinder lubrication, selection of oil, oil filters, etc.

Manufacture. Four-Cycle Diesel Engine Specialists. Steamship, vol. 33, no. 385, July 1921, pp. 15–21, 9 figs. Notes on manufacture of Diesel engines by firm of Burmeister & Wain, Ltd., Copenhagen. Gives list of motorships built by firm.

Marine. Injection and Combustion of Fuel-Oil, Part V., C. J. Hawkes. Motorship, vol. 6, no. 8, August 1921, pp. 655, 1 fig. Experiments with solid-injection and air-blast in marine Diesel engines. (To be continued.)

Problems in the Manufacture of Internal-Combustion Engines, John Holloway. Shipbuilding & Shipping Rec., vol. 18, no. 1, July 7, 1921, pp. 13–14. Suggestions on choice of material and best methods of machining various parts of marine Diesel engines.

The Use of Diesel Engines for the Drive of Deep-Sea Fishing Vessels (Verwendung von Dieselmotoren als Antriebsmaschinen für Hochsee-Fischereifahrzeuge), H. Wölke. Schiffbau, vol. 22, no. 38–39, June 22–29, 1921, pp. 917–921, 4 figs. Writer points out advantages and recommends replacing steam engines in older fishing steamers with former U-boat Diesel engines or with described 250-hp. Diesel engine.

Nobel. Development of the Nobel Diesel-Engine, Edwin Lundgren. Motorship, vol. 6, no. 8, August 1921, pp. 648–649, 4 figs. Reviews past work and describes progress of the two-cycle system. (To be continued.)

Recent Progress. Recent Progress in Large Diesel Engines for the Mercantile Marine, James Richardson. Engineering, vol. 112, no. 2899, July 22, 1921, p. 168. Includes list of important Diesel ships in service and building, giving particulars of their machinery. Paper read before Institution of Civil Engineers.

D

DISKS

Spinning, Vibrations of. The Vibrations of a Spinning Disk, H. Lamb, and R. V. Southwell. Proc. Royal Soc., vol. 99, no. A 699, July 1, 1921, pp. 272–280. Treats of the transverse vibrations of a circular disk of uniform thickness rotating about its axis with constant angular velocity.

DRILLING MACHINES

Horizontal. Recent Machine Tool Developments—XX, Joseph Horner. Engineering, vol. 112, no. 2897, July 8, 1921, pp. 33–36, 20 figs. 13 on supp. plate. Horizontal boring and drilling machine constructed by Cunliffe & Groom, Ltd., Manchester, England.

Radial. A New Radial Drilling Machine. Eng. Production, vol. 3, no. 40, July 7, 1921, p. 19, 1 fig. Describes new machine manufactured by Kitchen & Wade, Halifax, of low-base type, baseplate of which is of deep section, well ribbed and planed both top and bottom.

DRILLS

Tap. Tap Drill Sizes, E. C. Peck and T. F. Githens. Am. Mach., vol. 55, no. 5, Aug. 4, 1921, pp. 194–196, 4 figs. Elements to be considered. What constitutes government standard. Minimum and maximum limits for tap holes. Determining ideal drill size.

DROP FORGING

Cost Analysis. Analysis of Costs of Drop-Forging, R. T. Herdegen. Iron Age, vol. 108, no. 6, Aug. 11, 1921, pp. 325–326. Comparison of steam and board drop hammers. Rate of production studied as well as costs. Dividing line established between types.

Economical Shop Practice. Cutting Costs in a Drop Forge Shop, F. L. Prentiss. Iron Age, vol. 108, no. 7, Aug. 18, 1921, pp. 385–388, 6 figs. Trolley system used for handling work between hammers and furnaces. Features include water-reclaiming plant.

Plants. Modern Drop Forge Plant Completed, E. C. Cook. Forging & Heat Treating, vol. 7, no. 7, July 1921, pp. 364–369, 14 figs. The Pittsburgh Knife & Forge Co's. new plant at Coraopolis, Pa., is said to incorporate latest ideas in design for production of special parts. Complete plant layout is given.

DUST

Dust-Removal Plants. Modern Dust-Removal Plants (Neuerungen auf dem Gebiete der Entstaubung und Staubförderung), H. Klug. Fördertechnik u. Frachtverkehr, vol. 14, nos. 4 and 5, Feb. 18 and Mar. 4, 1921, pp. 43–46 and 60–62, 7 figs. Describes the Delbag dust-removal and air filter plant in the grinding and polishing works of the Fritz Heckert Glass Factory, Petersdorf.

E

EDUCATION, ENGINEERING

Gas Course. University of Michigan Gas Course, J. Gerald Ames. Gas Age, vol. 48, no. 2, July 25, 1921, pp. 45–49. Course established under Prof. A. H. White and under patronage of Mich. Gas Assn.

Prerequisites to Technical Study. Engineering Courses Should Be of Professional Grade, Wm. H. Burr. Eng. News-Rec., vol. 87, no. 2, July 14, 1921, pp. 65–66. Argues that technical study should be preceded by three years of general college work. (Abstract.) Paper read before Soc. for Promotion of Eng. Education.

ELASTICITY

Elastic Limit. The Elastic Limit, William E. Dalby. Engineering, vol. 112, no. 2897, July 8, 1921, p. 81, 3 figs. Points out that limit of proportionality of material is not a fixed point, but varies with heat treatment and vanishes with overstrain. Paper read before Instn. Civ. Engrs.

ELECTRIC DRIVE

Blooming Mill. Electric Drive for Blooming Mill Service, B. M. Jones. Power Plant Eng., vol. 25, no. 14, July 15, 1921, pp. 721–724, 6 figs. Bethlehem Steel Co. discards steam engine; results gratifying.

Paper Mills. Electric Driving in the Paper Mill, on Heat-Economy Lines, A. B. Mallinson. Jl. Instn. Elec. Engrs., vol. 59, no. 301, May 1921, pp. 538–553 and Discussion pp. 553–563, 10 figs. Discusses uses of steam in paper manufacture, classes of machinery driven, including suitable electrical gear, driving of the variable-speed end of paper machine. Table of machines converted to electrical working in the United Kingdom.

ELECTRIC FURNACES

Heat-Treating. Automatic Heat-Treating Furnaces, Gilbert L. Lachter. Iron Age, vol. 107, no. 26, June 30, 1921, pp. 1754–1755, 4 figs. Charging, treating, quenching and drawing performed and governed by automatic devices easily set.

Electric Furnace Treatment of Dies and Forgings, E. F. Collins. Forging & Heat Treating, vol. 7, no. 7, July 1921, pp. 387–392, 7 figs. Describes different types of furnaces. Paper presented at Am. Drop Forge Convention, Chicago.

Induction. New Type of Induction Electric Furnace. Iron Age, vol. 108, no. 6, Aug. 11, 1921, pp. 344–346, 6 figs. Primary winding above bath. Experience with 2-ton unit. For refining molten metal and serving as holding reservoir and melting ferromanganese.

Laboratory Types. Electric Furnace—I, Ezer Griffiths. Beama, vol. 9, no. 1, July 1921, pp. 12–18, 4 figs. Laboratory types. Notes on resistor, iridium tube, zirconia, and tube furnaces.

Resistance Type. Electric Furnace Heat Treatment, E. F. Collins. Iron Age, vol. 108, no. 5, Aug. 4, 1921, pp. 266–267 and (discussion) pp. 267–268. Dies and forgings said to be well handled in metallic resistor furnaces. Uniformity of product a big feature. (Abstract.) Paper read before Am. Drop Forge Assn.

Steel. Electric Furnaces for Making Steel, Alfred Stansfield. Blast Furnace and Steel Plant, vol. 9, nos. 7 and 8, July and Aug. 1921, pp. 424–425, 2 figs., and 488–489, 2 figs. General features and advantages of Keller furnace and Stobie furnace. Classification of electric steel-making furnaces. Advantages of electrode hearth arc furnaces having single arc and one movable electrode.

ELECTRIC HEATERS

Immersion Type. Application and Use of Immersion Electric Heaters, John M. Striat. Elec. Rev., (Chicago), vol. 79, no. 5, July 30, 1921, pp. 161–163, 4 figs. Particulars of installing, size and capacity, precautions to be observed.

ELECTRIC LOCOMOTIVES

Industrial. Industrial Electric Locomotives. Engineer, vol. 131, no. 3417, June 24, 1921, pp. 666–667, 3 figs. Types built by English Electric Co.

Mechanical Advantages. Mechanical Advantages of Electric Locomotives Compared with Steam, Vincent L. Raven. Engineering, vol. 112, no. 2899, July 22, 1921, pp. 164–165. Summarizes mechanical disadvantages of steam locomotive, and discusses fuel economy made possible by use of electric locomotives, together with maintenance costs, and various designs of electric locomotives depending upon method adopted to transmit power from motors to driving axles. Paper read before Instn. Civ. Engrs.

Steam vs. Electric Shunting Locomotives. Tramway & Ry. Wld., vol. 50, no. 3, July 14, 1921, pp. 11–13, 3 figs. Describes the advantages of electric over steam locomotives.

Switching. B.T.H. Electric Shunting Locomotives. Elec. Rev. (Lond.), vol. 89, no. 2275, July 1, 1921, pp. 27–28, 2 figs. Details of a 10-ton and 22-ton shunting locomotive weighing 56 tons each and fitted with 90-hp. motors, which can start a train weighing 160 tons on a grade of 1 in 27 and haul it on grade 10 mi. per hr.

ELECTRIC PLANTS

Temperature Measurement. Measuring Temperatures in Electric Installations (La Mesure des Températures dans les Installations Electriques), M. Henry. L'Industrie Electrique, vol. 30, no. 698, July 25, 1921, pp. 265–270, 7 figs. Describes various thermometers and thermocouples and other indicators.

ELECTRIC POWER

Industrial Load, New York State. Industrial Load in the State of New York. Elec. World, vol. 78, no. 5, July 30, 1921, pp. 207–210, 3 figs. Amount of electrical energy used in New York State has increased over 100 per cent since 1914.

ELECTRIC WELDING

Oil Tanks. The Electric Welding of Oil Storage Tanks, William Schenstrom. Ry. Elec. Engr. vol. 12, no. 7, July 1921, pp. 267–271, 6 figs. Welded construction eliminates loss from leakage and it is estimated tanks will outlast riveted containers. (Abstract.) Paper presented before Am. Welding Soc.

Percussive. Electric Percussion Welding, (La Soudure Électrique Par Percussion), L'Industrie Electrique, vol. 30, no. 696, June 25, 1921, pp. 229–231. Applications and advantages of this process.

ELECTRIC WELDING, ARC

Advantages. Electric Arc Welding, Henry M. Sayers. Tramway & Ry. Wld., vol. 50, no. 3, July 14, 1921, pp. 25–29, 12 figs. Notes on its increased use, successes, difficulties and failures.

Cost Data. Notes on Electric Arc Welding. H. L. Unland. A.S.R.E. Jl., vol. 7, no. 6, May 1921, pp. 426–430 and (discussion) pp. 430–431. Gives cost figures for arc welding and a comparison between gas and electric equipment.

Heavy Sections. Welding of Heavy Sections by the Electric Arc. Can. Machy., vol. 26, no. 2, July 14, 1921, pp. 32–33 and 46, 2 figs. Instructions for preparing work to be welded. Welding of cast iron is classed under four heads. (Abstract.) Book entitled Electric Arc Cutting and Welding, published by Elec. Arc Cutting & Welding Co., Newark, N. J.

EMPLOYEES

Care of. The Human Machine in Industry, Walter J. Matherly. Am. Mach., vol. 55, no. 6, Aug. 11, 1921, pp. 226–227. Care of human machine as important as care of machines of metal. Length of working day. Periods of rest. Fuel.

EMPLOYMENT MANAGEMENT

Psychotechnical Tests. Psychotechnical Adaptability Tests and Their Use in Metallurgical Works (Die psychotechnische Eignungsprüfung und ihre Anwendung auf Hüttenbetriebe). Stahl u. Eisen, vol. 41, no. 24, June 16, 1921, pp. 822–827. Contributions by H. Hüttenhain, Heinrich Roser, and Hans Daiber. Report of the Machine Committee of the Assn. German Steel Works Engrs.

EXECUTIVES

Training. Coöperating to Educate a Community's Executives, H. C. Stevenson. Factory, vol. 27, no. 2, August 1921, pp. 182–187, 4 figs. Describes efforts of Rochester Industrial Management Council in this direction.

EXHAUST STEAM

Oil Removal from. Eliminating Cylinder Oil from Exhaust Steam, W. H. Wakeman. Power Plant Eng., vol. 25, no. 15, August 1, 1921, pp. 749–752, 8 figs. Discusses the essential features in a separator to give satisfactory results.

Utilization. Exhaust Steam; Its Employment for Power, Heating, Etc., Ernest Richard Dolby. Engineering, vol. 112, no. 2897, July 8, 1921, p. 74. Notes on better utilization of heat in steam. In author's opinion, most efficient utilization of thermal value in coal cannot be obtained until there are sets of public mains provided by community for public utility. Paper read before Instn. Civ. Engrs.

The Utilization of Exhaust steam in Turbines, Maurice Deacon. Engineering, vol. 112, no. 2899, July 22, 1921, pp. 165–166, 3 figs. Describes general arrangement of mixed-pressure turbine plant. Cost of generating electrical power by exhaust steam is very low due to fact that steam would otherwise be wasted. Paper read before Instn. Civ. Engrs.

EXTENSOMETERS

Calibration. An Extensometer Calibrating Device, R. L. Templin. Chem. & Met. Eng., vol. 25, no. 6, August 10, 1921, pp. 248–251, 5 figs. Describes various instruments and methods of operation.

EVAPORATORS

Multiplex Film. Multiple Effect Evaporation, Burton Dunglinson. Chem. & Metallurgical Eng., vol. 25, no. 3, July 20, 1921, pp. 110–115, 7 figs. Discussion of multiplex film evaporator as regards features of construction and operation. Comparison of multiplex with other types.

Soderlund-Boberg. Evaporation by Vapor Compression, Burton Dunglinson. Chem. & Met. Eng., vol. 25, no. 6, August 10, 1921, pp. 246–247, 2 figs. Describes the Soderlund-Boberg evaporator.

F

FACTORIES

Layout. Features of German Machine Tool Plant. Iron Age, vol. 108, no. 5, Aug. 4, 1921, pp. 256–258, 6 figs. Color of buildings considered. Prevailing winds aid in reducing dust and noise. Welfare of apprentices and workmen emphasized. Built by Fritz Werner Co., Marienfelde near Berlin.

The Layout of a Modern Machine-Tool Plant, Fred H. Colvin. Am. Mach., vol. 55, no. 5, Aug. 4, 1921, pp. 173–175, 6 figs. Layout of Foote-Burt shop. Receiving material and shipping finished machines. Crane and monorail transport. Overhead hot-water heating system.

FACTORY MANAGEMENT

[See INDUSTRIAL MANAGEMENT.]

FEEDWATER HEATERS

Locomotive. Feed Water Heater and Pump for Locomotives. Engineering, vol. 112, no. 2899, July 22, 1921, pp. 150–151, 8 figs. System adopted by G. & J. Weir, Ltd., Glasgow, is that of exhaust heating only, with a surface heater, a pump being employed to force the feed through heater and into boiler.

Types. Selection of Feed Water Heaters for Power Plants, Robert June. Elec. Rev. (Chicago), vol. 79, no. 3, July 16, 1921, pp. 81–84, 4 figs. Relative merits of open and closed heaters. Heated feedwater is said to reduce strains and increase boiler output.

FERROSILICON

Silicon Content. Effect of Silicon On the Property of Ferrosilicon (Influenza del silicio sulle propreita del ferrosilicio), G. Ongaro. Il Forno Elettrico, vol. 3, no. 5, May 15, 1921, pp. 63–66. Discusses various percentages of Si. Metallurgical effect of various silicon contents.

FIRE PREVENTION

Dust Explosions. Incandescent Lamps Used in Dust-Laden Atmosphere, D. J. Price & H. R. Brown. Elec. Rev., vol. 79, no. 5, July 30, 1921, pp. 165–166, 1 fig. Shows that they constitute a fire and dust-explosion hazard unless properly installed and adequately protected.

Explosions of Highly Inflammable Liquids. Stopping Fires in Highly Inflammable Liquids. Charles H. Meigs. Fire & Water Eng., vol. 70, no. 2, July 13, 1921, pp 58–59 and 64–65, 3 figs. Effective method of extinguishment. Application of foam system.

FLOUR MILLS

Rolls. The Manufacture of Chilled Iron Rolls. Am. Miller, vol. 49, no. 8, August 1, 1921, pp. 822–823, 10 figs. Processes employed in producing high grade rolls for flour milling.

FLOW OF WATER

Manning's vs. Kutter's Formula. Manning's Formula Better Than Kutter's. Eng. News-Rec., vol. 87, no. 3, July 21, 1921, p. 96, 2 figs. H. W. King suggests that an abbreviated form of Kutter's equation, eliminating the *s* or slope terms, will give far more consistent results, and that in his opinion Kutter's formula will give just as satisfactory results without the *s* terms.

Riveted Steel Pipes. Flow of Water Through Galvanized Spiral Riveted Steel Pipe, F. W. Greve. Eng. News-Rec., vol. 87, no. 4, July 28, 1921, pp. 159–160, 3 figs. Results of experiments performed in hydraulic laboratory of Purdue University to determine variation of friction loss with velocity for flow; variation in accuracy of four types of piezometer rings; and friction loss compared with that in cast-iron pipes for like conditions of diameter and velocity.

FOREMEN

Classes, Training Leaders for. Training Leaders for Foremanship Classes, D. J. MacDonald. Am. Mach., vol. 55, no. 7, Aug. 18, 1921, pp. 249–251. Fundamental factors involved in training leaders. Outstanding characteristics of typical foreman. Importance of follow-up work in organizing courses.

FORGING

Costs. Comparative Analysis of Forging Costs, R. T. Herdegen. Forging & Heat Treating, vol. 7, no. 7, July 1921, pp. 397–399. States that it costs more to operate a 1500-lb. steam drop hammer than to operate a 1600-lb. board hammer; and it is not desirable to install a steam drop smaller than 2500 lb.

Hand vs. Die Forging. Die versus Hand Forging (Wann ist Gesenkschmieden, wann Schmieden von Hand wirtschaftlicher?), Ferd. Klages. Betrieb, vol. 3, no. 17, May 25, 1921, pp. 519–521, 8 figs. Investigation of relative merits of hand and die forging, taking into consideration saving in time, wages and material. Discusses favorable effect of swaging on structure of material and possibility of setting up more accurate piece-rate wages.

Manipulators. Mechanical Manipulator for Heavy Forgings. Engineering, vol. 112, no. 2899, July 22, 1921, p. 151, 4 figs. partly on p. 154. Machines constructed by Alliance Machine Co., Alliance, Ohio.

FORGINGS

Ingot Sizes for. Cross-Sectional Dimensions of Steel Ingots for Forged Pieces (Ueber Querschnitts-Abmessungen von Stahlblöcken fur Schmiedestücke), F. Pacher. Stahl u. Eisen, vol. 41, no. 27, July 7, 1921, pp. 913–917 and (discussion) pp. 918–919. Deals with faults in forged pieces caused by selection of wrong dimensions of casting mold.

FOUNDATIONS

Bearing Value of Soils. The Bearing Power of Soils, Arthur L. Bell. Engineering, vol. 112, no. 2898, July 15, 1921, p. 132. Brief outline of progress in theories of earth pressure and bearing value of soils for foundations. Paper read before Instn. Civ. Engrs.

Concrete. Foundations, J. C. Hawkins. Power Plant Eng., vol. 25, no. 15, August 1, 1921, pp. 760–762, 5 figs. Templets, forms and process for mixing and placing concrete.

Pneumatic Caisson. Pneumatic Caisson Foundations for Tall Buildings, Frank W. Skinner. Compressed Air Magazine, vol. 26, no. 7, July 1921, pp. 10143–10148, 9 figs. Highly developed use of compressed air for building deep and difficult footings impossible to construct by any other method.

FOUNDRIES

Safety Provisions. Safety in Foundry Equipment, A. R. Bartlett. Mech. Wld., vol. 70, no. 1803, July 22, 1921, pp. 70–72. Discusses danger signs, foundry yard, foundry floor, ventilating and lighting, cranes, chains and slings, etc.

FRAMES

Rigid, Calculation of. Graphic Investigation of Rectangular Rigid Frames (Zeichnerische Untersuchung rechteckiger Steifrahmen), J. Polivka. Beton u. Eisen, vol. 20, no. 4–5, Mar. 7, 1921, pp. 57–60, 12 figs. Graphic calculating method for determination of the moments and normal forces in closed and fixed-in rigid frames.

FREIGHT HANDLING

Danube River. Mechanical Freight Loading and Unloading Plants on the Trans-shipment Docks of the First Danube Steam Navigation Co. (Die mechanische Güterumladung auf den Umschlagplätzen der Ersten Donau-Dampfschiffahrts-Gesellschaft), W. Hollitscher. Fördertechnik u. Frachtverkehr, vol. 14, nos. 2, 3, 4 and 5, Jan. 21, Feb. 4, 18 and Mar. 4, 1921, pp. 21–26, 34–38, 46–49 and 62–65, 15 figs. Described plants are distributed over a stretch of 4000 km. Notes on organization, application of principles of scientific management, etc. The technical and commercial organization of the department for loading plants of above-mentioned company is described in detail.

Mechanical. Mechanical Freight Handling on the New York Central Lines, William T. Gaynor, Transportation Wld., vol. 3, no. 5, July-August 1921, pp. 11–12, 1 fig. Shows the influence of local conditions on mechanical handling methods.

Unit Cost Data. Unit Cost Data Reduce Freight Train Expense, J. E. Hutchison. Ry. Age, vol. 71, no. 4, July 23, 1921, pp. 161–163, 1 fig. Prompt distribution of information aids in cutting wage charges per hundred ton miles. Shows form used in reporting wage cost of handling trains on St. Louis-San Francisco railway system.

FRICTION

Sliding and Rolling. The Theory of the Sliding and Rolling Resistance of Solid Bodies (Zur Theorie des Gleit- und Rollwiderstandes der festen Körper), Sigmund Fuchs. Physikalische Zeit., vol. 22, nos. 6 and 7, Mar. 15 and Apr. 1, 1921, pp. 173–177 and 213–218. Explains so-called dry sliding friction of solid bodies through the hydrodynamic friction of air stratum between the bodies; and the friction phenomena between specially cleaned surfaces in a vacuum. The rolling resistance of elastic bodies under assumption of an incomplete elasticity is determined. Discusses cause of so-called slip with rolling of the elastic body; and influence of distribution of mass of rolling body on size of moment of resistance.

Colloidal. Colloidal Fuel. Pac. Mar. Rev., vol. 18, no. 7, July 1921, pp. 394–396, 1 fig. Article compiled from interviews with and printed material submitted by Linden W. Bates, who controls basic patents covering process for colloidalization of oil and fuels. Describes small colloidalizing plant, and points out principal advantages of colloidal fuel.

Colloidal Fuel Applied to Bar-Heating Furnaces Engineering, vol. 112, no. 2898, July 15, 1921, pp. 124–125, 5 figs. Report by J. C. Marble on trials made on rod-heating furnace at Swansea Works of Steel Co. of Canada. Attention is drawn to fact that fuel, though old, showed no signs of sedimentation, and that owing to its specific gravity fire risk was capable of being greatly reduced as compared with oil.

Future Problems. Fuel Problems of the Future, George T. Beilby. Gas Jl., vol. 154, no. 3033, June 29, 1921, pp. 737–743; also Gas World, vol. 75, no. 1928, July 2, 1921, pp. 6–8 and 9–10; also Engineering, vol. 112, no. 2896, July 1, 1921, pp. 26–30. Writer points out that coal is likely to remain for a long time the world's chief source of fuel, and its more efficient use may be secured by more careful sorting and preparation of mines; improvement of boiler firing; and sorting out of its combustible constituents into fuels of higher availability or convenience by preliminary carbonization at either high or low temperatures. James Forrest lecture before Instn. Civ. Engrs.

Industrial Heating. Selection of Fuel for Industrial Heating. Chem. & Metallurgical Eng., vol. 25, no. 3, July 20, 1921, pp. 116–118, 1 fig. Includes chart showing comparative fuel costs, and table giving characteristics of various industrial gases. (Abstract.) Pamphlet copyrighted by W. S. Rockwell Co.

Research Station. The Fuel Research Station at East Greenwich. Gas World, vol. 75, no. 1928, July 2, 1921, pp. 3–4. Notes on work being carried out and significance in connection with gas and fuel problems.

Substitutes for Coal. Alternatives to Coal for Power Production, Percy E. Rycroft. Elecn., vol. 86, no. 2249, June 24, 1921, pp. 783–787, 10 figs. Discusses value of refuse destructors, oil, coke, colloidal fuel, lignite, etc., as substitutes.

Utilization. University of Public Works, Commission on Utilization of Fuels (Ministère des Travaux Publics, Commission d'Utilisation du Combustible), Revue de l'Industrie Minérale, no. 11, June 1, 1921, pp. 423–426. Continuation of report. (To be continued.)

[See also CARBOCOAL; COAL; COKE; COKE BREEZE; OIL FUEL; PEAT; PULVERIZED COAL; TAR OILS.]

FURNACES, BOILER

Flue-Dust Abatement. The Formation and Abatement of Flue Dust (Flugaschenbildung und Flugaschenbeseitigung), F. Kaiser. Zeit. des Bayerischen Revisions-Vereins, vol. 25, no. 12, June 30, 1921, pp. 106–108, 2 figs. Discusses various means for prevention and removal of flue dust.

FURNACES, BRASS-MELTING

Natural-Draft Type. A Type of Natural Draft Melting Furnace—1, Charles Vickers. Brass World, vol. 17, no. 7, July 1921, pp. 197–201, 4 figs. Particulars of construction, types of furnaces and dimensions, location and building of furnaces.

FURNACES, HEATING

Ingot. The Siemens Regenerative Gas Ingot-Heating Furnace with Divided Flame (Der Siemens-Regenerativ-Gas-Stossofen mit Flammenteilung), Arthur Sprenger. Stahl u. Eisen, vol. 41, no. 22, June 2, 1921, pp. 749–753, 6 figs. Describes regenerative furnace with divided flame and vertical U-shaped flame arch, and points out its adaptability to any given conditions and construction types. It is claimed that the new furnace type will greatly contribute to utilization of low-grade gases with simultaneous recovery of by-products.

FURNACES, HEAT-TREATING

Die Blocks, for. Furnaces for Heat Treatment of Die Blocks, S. Trood. Forging & Heat Treating, vol. 7, no. 7, July 1921, pp. 393–397, 7 figs. Discusses proper proportioning and mixing of fuel and air, temperature of ignition, time element, velocity and space required by products of combustion and recirculation.

Molydenum Steel Parts. Special Heat-Treating Furnaces for Molydenum Steel Parts. Automotive Manufacturer, vol. 63, no. 4, July 1921, pp. 19–21, 4 figs. Description of unusual automatic furnaces installed and principle of operation.

FUSION WELDING

Possibilities. The Possibilities of Fusion Welding, A. S. Kinsey. Iron Age, vol. 108, no. 6, Aug. 11, 1921, pp. 337–338. Conditions for this type of weld. Control of welders. Test of welds. Success with alloy steels. (Abstract.) Address before Cleveland Section Am. Welding Soc.

G

GAGES

Economic Selection. Suggestions for an Economic Selection of Types of Gages from the Systems of Standard Holes and Standard Shafts (Richtlinien für eine wirtschaftliche Auswahl der Lehrenarten aus den Systemen der Einheitsbohrung und der Einheitswelle), K. Gottwein. Betrieb, vol. 3, no. 18, June 10, 1921, pp. 266–273, 10 figs. Author's recommendation is approved by sub-committee of German Industry Committee on Standards (NDI), and is thought to be especially adapted to mixed production, for giving the different firms a basis for selection of the necessary gages for all cases in which the use of unit systems is not required.

Hoke. Hoke Gages, Earle Buckingham. Army Ordnance, vol. 2, no. 1, July-August 1921, pp. 36–38, 4 figs. Discusses the importance of accurate gages in the production of munitions.

Industrial. Study of Industrial Gages at International Bur. of Weights and Measures. (L'Etude des Calibres Industriels au Bureau international des Poids et Mesures). Le Génie Civil, vol. 78, no. 24, June 11, 1921, pp. 500–503, 9 figs. Standard Gages of Johansson type. Gaging by light-interference method. (Concluded.)

GAS ENGINES

British Type. Machinery at the Royal Agricultural Show. Engineering, vol. 112, no. 2896, July 1, 1921, pp. 7–10, 6 figs. Details of suction gas producer for wood refuse 50-hp. gas engine constructed by Davey, Paxman & Co., Ltd., Colchester.

GAS PRODUCERS

Operation. Graphic Investigations in Produce Operation (Graphische Untersuchungen im Generatorbetrieb), W. Claus and L. Neuszel. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 29, July 16, 1921, pp. 769–773, 8 figs. Discusses Ostwald's method for the graphic presentation of performance in producer and describes further use of this method for simple determination of the special properties of producer gases. Exemplifies use of derived tables and recommends a standard international terminology for producer gases.

GASES

Throttling Effect. The Throttling Effect and Equation of Condition (Drosselwirkung und Zustandgleichung), K. Schreber. Zeit. fur komprimierte u. flüssige Gase, vol. 21, nos. 1, 2, 3, 4, 5 and 6, 1920, pp. 1–7, 17–21, 29–33, 44–45, 53–56 and 65–68, 4 figs. Presents equation which can be used to calculate throttling effect when equation of condition is known, or to derive an equation of condition when throttling effect is known.

GASOLINE

Casinghead Gas. Casinghead Gas. Oil Field Eng., vol. 23, no. 7, July 1921, pp. 70–72. Gives particular of the production of gasoline from casinghead gas.

Engine, Specifications for. Problems Involved in Developing Engine Gasoline Specifications, E. W. Dean. Jl. Soc. Automotive Engrs., vol. 9, no. 2, August 1921, pp. 131–132. Gives general properties of satisfactory engine gasoline and specification limits.

GEAR CUTTING

Hobbing Worms. A Novel Method of Hobbing Worms. Automotive Ind., vol. 45, no. 4, July 28, 1921, pp. 171–172, 3 figs. Uses a helicoidal cutter.

Methods. Recent Gear-Cutting Practice—IX. Mech. Wld., vol. 70, no. 1803, July 22, 1921, pp. 58–59, 14 figs. Discusses small spur gears, including internal, and ratchets. (To be continued.)

Multiple Shapers. Cuts Teeth of a Gear at One Operation. Iron Age, vol. 108, no. 4, July 28, 1921, pp. 197–200, 7 figs. Stevenson multiple shaper, how it operates and its field.

Racks. A New Rack Cutting Attachment. Eng. Prod., vol. 3, no. 44, August 4, 1921, pp. 100–101, 4 figs. Details of a useful device for use on milling machines.

GEARS

Comparator, Gear-Tooth. The Sykes Gear Tooth Comparator. Machy. (Lond.), vol. 18, no. 459, July 14, 1921, pp. 454–455, 3 figs. For comparing and measuring thickness of gear teeth.

The Sykes Gear-Tooth Comparator. Engineering, vol. 112, no. 2898, July 15, 1921, p. 103, 3 figs. Instrument consists of short bar fitted with one fixed and one sliding jaw, arranged with needle of a dial indicator between the two, and is used for comparison of thickness of gear teeth and uniformity of pitch. Other uses.

Teeth, Strengthened. Stengthened Gear Teeth. Eng. Production, vol. 3, no. 41, July 14, 1921, pp. 28–30, 8 figs. Notes on principles applied. Includes summary of various formulas for long addendum gear teeth.

Testing Machine for Teeth. The Odontometer for Testing Gear Teeth, Earle Buckingham. Machy. (Lond.), vol. 18, no. 458, July 7, 1921, pp. 412–413, 6 figs. Describes instrument for testing accuracy or uniformity of gear-tooth profiles and spacings of teeth in production work, developed by Pratt & Whitney Co.

GRAIN ELEVATORS

Oakland, Cal. Bulk Handling of Grain in California, Charles W. Geiger. Ry. Rev., vol. 69, no. 7, August 13, 1921, pp. 205–208, 5 figs. Particulars of a new 1¼-million-bushel elevator at Oakland and others, carloading equipment for bulk grain, etc.

GRAIN HANDLING

Unloader. Electrically Operated Grain Car Unloaders, R. T. Kintzing. Elec. Jl., vol. 18, no. 7, July 1921, pp. 301–304, 7 figs. Describes car dumpers of Northern Central grain elevator of P.R.R., four of which side by side, with operating crew of 18 men, can unload 400 cars daily, each car containing from 1200 to 2000 bushels of grain.

GRINDING

Automobile Parts. Grinding the Automotiv ni Industry—1, P. M. Heldt. Automotive Ind., vol. 45, no. 6, August 11, 1921, pp. 265–269, 11 figs. Describes the various kinds of grinding wheels, their selection, cutting speeds, balancing, truing, etc.

Data. Recent Data on Grinding Room Production. Abrasive Industry, vol. 2, no. 7, July 1921, p. 241. Data on grinding valves, steel pins, square shafts and valve stems.

Modern Methods. The Economy of Modern Grinding Methods, Harlowe Hardinge. Chem. & Met. Eng., vol. 25, no. 6, August 10, 1921, pp. 229–232. Considers high cost of obsolete grinding plant, classification of grinding operations, etc.

GUNS

16-In. 50-Caliber. 16-Inch 50-Caliber Gun and Barbette Carriage, G. M. Barnes. Army Ordnance, vol. 2, no. 1, July-August 1921, pp. 15–20, 9 figs. Gives particulars of gun and projectiles.

H

HANDLING MATERIALS

Loading Cars from Boats. Transshipping Bulk Freight (Umladevorrichtungen), Otto Kummel. Fördertechnik u. Frachtverkehr, vol. 14, no. 4, Feb. 18, 1921, pp. 49–50, 2 figs. Notes on transshipping gears for bulk freight (coal, ore, gravel, etc.), with utilization of differences in altitude of land in ship-canal locks.

Pressed-Steel Plant. Routing of Material Feature of Plant, F. L. Prentiss. Iron Age, vol. 107, no. 26, June 30, 1921, pp. 1741–1745, 5 figs. Youngstown Pressed Steel Co. introduces tunnels under new shops to avoid congestion of traffic. Other operating economies.

Ship Cargoes. Speed and Economy Follow Mechanical Handling of Ship Cargoes, Roy S. MacElwee. Transportation Wld., vol. 3, no. 5, July-August 1921, pp. 24–27. Discusses special handling equipment, demountable bodies as an economic factor, tonnage, etc.

HEAT

Mechanical Equivalent. A New Method of Determining the Mechanical Equivalent of Heat, T. H. Laby & J. K. Roberts. Proc. Royal Soc. of Victoria, vol. 32, Part II, September 1920, pp. 148–155, 8 figs. Describes design and operation of a new apparatus for this purpose in which a copper cylinder is heated by a rotating magnetic field.

HEAT TRANSMISSION

Experiments. A New Thermal Testing Plate for Conduction and Surface Transmission, F. C. Houghten & A. J. Wood. Jl. Am. Soc. Heat. & Vent. Engrs., vol. 27, no. 5, July 1921, pp. 529–542 and (discussion) pp. 614, 12 figs. Particulars of investigation and results of experiments.

Liquids and Gases. Heat Transmission in Liquids and Gases as Function of Velocity (Der Wärmeübergang bei Flussigkeiten und Gasen als Funktion der Geschwindigkeit), H. Preussler. Stahl u. Eisen, vol. 41, no. 24, June 16, 1921, pp. 827–830. Investigation of influence of velocity of gas and liquids on heat transmission, demonstrating advisability of introducing heat capacity in place of velocity. Formulas for heat transmission through conduction and radiation are tested with regard to their feasibility for steam-boiler and heat-storage calculation.

Problems. A Survey of Heat Transmission Problems, W. M. Selvey. Elecn., vol. 87, no. 2250, July 1, 1921, pp. 11–12. Review of trilogy of books by R. Royds entitled, Measurement of Steady and Fluctuating Temperatures; Heat Transmission by Radiation, Conduction and Convection; and Heat Transmission in Boilers, Condensers and Evaporators.

HEATING AND VENTILATION

Westinghouse Works, East Pittsburgh. Heating Equipment for a Large Industrial Plant, O. H. Bathgate. Heating & Ventilating Mag., vol. 18, no. 7, July 1921, pp. 29–32, 4 figs. Method followed in East Pittsburgh Works of Westinghouse Elec. & Mfg. Co.

HEATING, FACTORY

Requirements. Requirements for Industrial Heating, Harold Fulwider. Elec. World, vol. 78, no. 4, July 23, 1921, pp. 167–169, 2 figs. How to determine power required for ovens and energy consumption per unit of product. Typical calculations for japanning and core-baking ovens. Selection of ventilating equipment.

HEATING, HOT-WATER

Gravity System. Advanced Ideas Applied in Design of a Gravity Water Heating System, William F Devendorf. Heat & Vent. Mag., vol. 18, no. 8, August 1921, pp. 25–28, 5 figs. Describes an installation that circulates hot water through supply mains at all times.

HELICOPTERS

New Types. Recent Helicopters (Nouveaux Hélicoptères), Jean-Abel Lefranc. La Nature, no. 2466, July 9, 1921, pp. 20–25, 9 figs. Describes the Damblanc-Lacoin, Oehmichen, Petroczy-Karman, Lamé and Pescara.

HOBBING MACHINES

Hobbing Worms, New Method of. Gould & Eberhardt Method of Hobbing Worms. Am. Mach., vol. 55, no. 4, July 28, 1921, pp. 141–142, 3 figs. Worms cut with hob having a broaching action. Short hob permits cutting worms having shoulders at both ends.

Theory and Practice. Hobs and Hobbing, T. A. Stoddart. Eng. Prod., vol. 3, no. 44, August 4, 1921, pp. 102–104, 4 figs. Theory and practice of modern machines.

HOISTS

Mine. The Graphical Dynamics of a Winding Engine—III, Charles D. Mottram. Colliery Guardian, vol. 122, no. 3159, July 15, 1921, pp. 170–171, 5 figs. Discusses the question of friction between lubricated surfaces. (To be continued.)

HOUSES, CONCRETE

England. Concrete House Building. Concrete & Constructional Eng., vol. 16, no. 7, July 1921, pp. 425–431, 10 figs. Housing scheme at Southport, England.

HOWITZERS

75-mm. Pack. 75-mm. Pack Howitzer vs. 2.95-inch V. M. Mountain Gun, O. L. Beardsley. Army Ordnance, vol. 2, no. 1, July-August, 1921, pp. 38–44, 11 figs. Table of characteristics.

HYDRAULIC TURBINES

Development. Recent Development of Water Turbines (Die neuere Entwicklung der Wasserturbinen), Dieter Thoma. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 26, June 25, 1921, pp. 679–686, 21 figs. Modern Francis turbines; new types of draft tubes and their influence on motion of water in rotor; limited sphere of present turbine theory; useful scope of Kaplan turbine; the Moody turbine; vertical single-wheel turbines; high-pressure Francis turbines with vertical shaft; transformer installations; success of Bauersfeld's analytical turbine theory.

HYDROAEROPLANES

Caproni Giant. The Caproni Giant Hydroplane (L'hydravion triplan geant Caproni). Le Génie Civil, vol. 79, no. 2, July 9, 1921, pp. 39–40, 5 figs. Particulars of dimensions and tests.

HYDROELECTRIC PLANTS

California. Caribou Power Plant Completed, Charles W. Geiger. Power Plant Eng., vol. 25, no. 14, July 15, 1921, pp. 693–702, 17 figs. Details of power-transmission system, hydraulic equipment, power and efficiency guarantees, etc.

Kern River Plant Number Three of Southern California Edison Company Serves a Dual Purpose. Elec. Rec., vol. 30, no. 1, July 1921, pp. 12–15, 6 figs. Description of concrete dams, generator, and other equipment.

Semi-Automatic Operation Economical in Small Hydro Stations, E. R. Stauffacher & G. Clingwald, Elec. World, vol. 78, no. 5, July 30, 1921, pp. 213–216, 6 figs. Southern California Edison Company plant saves cost of extra equipment in seven months.

India. Hydro-Electric Supply in Bombay, India. Managing Engr., vol. 8, no. 3, July 1921, pp. 53–58, 8 figs. Principal features of the Tata Hydro-Electric system. (To be continued.)

Norway. The Hydroelectric Plants on Glomfjord in Norway (Die Wasserkraftwerke am Rjukanfos und am Glomfjord in Norwegen), Gg. v. Troeltsch. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 27, July 2, 1921, pp. 707–712, 20 figs. Location of plant on the Glomfjord in the extreme north. Water supply and equalization in lakes, galleries and pipe lines; machine house; cost of installation and price of current; turbines of 25,000 and 27,500 hp. respectively with 442 m. head; double regulation with needle nozzle and deflector.

Sweden. Trollhättan Hydroelectric Plant (Installations Hydro-électriques de Trollhättan), A. Tétrel. L'Electricien, vol. 52, no. 1278, June 15, 1921, pp. 265–271, 7 figs. Describes equipment, including d.c. and a.c. apparatus, insulation, etc., also substations.

Switzerland. Large Modern Hydroelectric Plants in Switzerland (Grandi Impianti Idroelettrici Moderni in Svizzera), Giovanni Rodio. L'Industria, vol. 35, no. 12, June 30, 1921, pp. 272–277, 17 figs. Detailed description of the Ritom plant, including dams, water supply, Pelton wheels, turbogenerators, transformers. (To be continued.)

The Construction of the Oberhasle Hydroelectric Plants According to the Projects of the Bernese Power Works Corp. (Die Bauten für die Kraftwerke Oberhasle gemäss den Projekten der B.K.W.). Schweizerische Bauzeitung, vol. 78, nos. 1 and 2, July 2 and 9, 1921, pp. 1–6 and 22–24, 15 figs. Account of project developed by G. Narutowics. Notes on water supply and available energy; building installations and transportation arrangements; water storage plants; the power stations Guttannen and Innertkirchen; costs of installation and price of energy.

The Hydroelectric Plant of Fully (Switzerland) [Die Wasserkraftanlage von Fully (Schweiz)], H. Fernau. Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 73, no. 24–25, June 24, 1921, pp. 163–166, 5 figs. Describes plant with total head of 1654 m., with special details of a pressure pipe line laid underground without any masonry support or anchorage. Operating experiences since 1914, when plant was completed.

HYDROGEN

Commercial Production. Commercial Production of Hydrogen Gas For Aeronautics (Procédés de Fabrication Industrielle de l'Hydrogène Aerostatique, Capt. Verneuil. L'Aéronautique, vol. 3, no. 25, June 1921, pp. 232–239, 4 figs. A review of existing methods, including the Hembert and Henry and the Badische Anilin.

I

IGNITION

Magnets. Magnetos for Ignition Purposes in Internal Combustion Engines, E. A. Watson. Jl. Instn. Elec. Engrs., vol. 59, no. 301, May 1921, pp. 445–466, Discussions pp. 467–490, 26 figs. Discusses conditions to be fulfilled by ignition magnetos on internal combustion engines and deals with the principles of operation of a magneto.

IMPACT TESTING

Suggestions. Impact Tests and Allowances, Harry John Fereday. Engineering, vol. 112, no. 2897, July 8, 1921, p. 80. Suggestions for conducting future tests in order to obtain, if possible, new formula for impact effect. Paper read before Instn. Civ. Engrs.

INDUSTRIAL MANAGEMENT

Cost Reduction. Reducing Manufacturing Costs by Studying Power Demand, R. S. Lowry. Elec. Wld., vol. 78, no. 6, August 6, 1921, pp. 257–258. Draws attention to inefficient operating conditions and causes of unnecessary expenditure.

Efficiency Control. Controlling Efficiency in the Clay Plant, Arthur H. Kaeppel. Brick & Clay Rec., vol. 59, no. 3, August 9, 1921, pp. 188–191, 3 figs. Discusses factory efficiency reports and production charts.

Factory Managers. The Duties of a Modern Factory Manager (Vilka krav böra ställas pa en modern arbetsledare?), Oliof Kärnekull. Teknisk Tidskrift, vol. 51, no. 19, May 14, 1921, pp. 221–226, 3 figs. Duties of a manager with regard to carrying out and standardization of production methods, selection of personnel with aid of psychology, etc. Loss of time in industrial plants is said to average 30 per cent of working time, half of which is unavoidable loss. This, it is claimed, can be considerably reduced by suitable working plans. In one case it was reduced in four months from 70 to 10 per cent.

Factory Statistics. Factory Statistics (Betriebsstatistik), Rudolf Reischle. Zeit. des Bayerischen Revisions-Vereins, vol. 25, nos. 10 and 11, May 31 and June 15, 1921, pp. 81–84 and 94–95, 3 figs. Deals with purpose and character, fundamental principles, carrying out and utilization of factory statistics; bookkeeping and net cost accounting; commercial bases for calculation of general operating costs.

Follow-Up System. Follow-Up System for the Drawing Office. Machy. (Lond.), vol. 18, no. 457, June 30, 1921, pp. 385–388, 6 figs. System for recording status and daily progress of work during process of manufacture.

Inspection. An Inspection and Progress System, E. A. Allcutt. Eng. & Indus. Management, vol. 6, no. 3, July 21, 1921, pp. 58–61 and 64. Explains the three main objects of successful management; good work, rapid work, economical work.

Instruction Sheets. Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 19, June 25, 1921, p. 136. Proposal of Works Dept. of German Federation of Technical and Scientific Societies for care and operation of lifting magnets.

Proposals for New Factory Instruction Sheets (Entwürfe neuer Betriebsblätter). Betrieb, vol. 3, no. 17, May 25, 1921, pp. 126–128. Proposal of Works Dept. of German Federation of Technical and Scientific Societies for care of ball bearings; measures for prevention of fire; and care of gear drive.

Motion Study. Scientific Management and Motion Study, F. James Butterworth. Royal Engrs. Jl., vol. 34, no. 2, August 1921, pp. 59–70, 7 figs. Discusses the work of Taylor and Gilbreth.

Output, Measurement of. The Measure of Output in Engineering, J. E. Powell. Mech. Wld., vol. 70, no. 1803, July 22, 1921, pp. 67. Discusses formulating the measure and responsibilities of management. (Abstract paper read before Inst. Ind. Admin.)

Overhead Costs. Cutting Overhead Cost Instead of Wages, Don. F. Kennedy. Iron Age, vol. 108, no. 2, July 14, 1921, pp. 79–81. Large Detroit automobile company paid war-time wages, ran half time and in same period made profits.

Purchasing System. What is a Comprehensive Purchasing System? Wilfred G. Asble. Can. Machy., vol. 26, no. 2, July 14, 1921, pp. 27–29, 9 figs. Suggestions for organizing effective system. Illustrations of form cards suitable for purchasing department.

Small Shop. Organization and Management of the Small Shop—I, II and III, Elmer W. Leach. Am. Mach., vol. 55, nos. 3, 5 and 7, July 21, Aug. 4 and 18, 1921, pp. 81–84, 190–193 and 262–266. July 21: How one small shop started and won battle against odds. Aug. 4: How to analyze manufacturing and marketing problems. Aug. 18: Methods of market analysis; different ways of reaching ultimate consumer; importance of establishing definite sales policy.

Storeroom Methods. Six Ways to Simplify Stockroom Routine, V. C. Kreuter. Factory, vol. 27, no. 2, August 1921, pp. 192–194, 5 figs. Shows how, through changes in stockroom routine, difficulties in routing, production, cost-keeping and inventory work may be adjusted.

Stores Keeping. Continuous Stores Keeping Cuts Investment. Iron Age, vol. 108, no. 5, Aug. 4, 1921, pp. 253–254, 2 figs. System checks and almost automatic control of ordering materials economizes in space required and in amount carried.

Toolroom Organization. Organization of the Tool Room, G. W. Tripp. Eng. & Indus. Management, vol. 6, no. 1, July 7, 1921, pp. 2–5, 3 figs. Outlines method of organizing tool room. Notes on arrangement of tool store, manufacture of jigs, grouping of cards and planning of work.

[See also TIME STUDY.]

INDUSTRIAL RELATIONS

Justice in. The Way Out in Industrial Relations, John Calder. Iron Age, vol. 107, no. 26, June 30, 1921, pp. 1766–1767. How shall management, labor and public secure justice? What underlies movement for a conference footing in individual companies. (Abstract.) Address before Iowa Mfrs. Assn.

INTERNAL-COMBUSTION ENGINES

Cast Iron, Use of. Cast Iron in the Construction of Internal Combustion Engines. Eng. & Indus. Management, vol. 5, no. 26, June 30, 1921, p. 736. Describes effect of increases of temperature on gray cast iron employed in construction of automobile cylinders and pistons.

Electric Starters. Electric Starters for Explosion Engines (Sur l'installation des demarreurs electriques pour moteurs a explosions), M. Digeion. Révue Générale de l'Électricité, vol. 10, no. 3, July 16, 1921, pp. 103–106, 4 figs. Considers conditions necessary, power absorbed, coupling, etc.

Influence of Fuels. The Influence of Various Fuels on the Performance of Internal Combustion Engines—VI, H. R. Ricardo. Automobile Engr., vol. 11, no. 152, July 1921, pp. 242–247, 6 figs. Experimental investigation into their behavior.

Installation. Practical Notes on the Installation and Running of Petrol, Petrol-Paraffin, and Semi-Diesel Engines, D. P. Lamb. Mech. Wld., vol. 70, no. 1803, July 22, 1921, pp. 72–73. Considers shafting, motor-seating, stern tube, fuel tanks, etc. (To be continued.)

Large Cylinders. Internal-Combustion Engines with Large Cylinders, James McKechnie. Engineering, vol. 112, no. 2898, July 15, 1921, pp. 132–134, 5 figs. Includes indicator cards and summaries of some of the trials of engines referred to, and also of Vickers' Narragansett type commercial marine engine with 24½-in. cylinder. Paper read before Instn. Civ. Engrs.

Types. The Internal-Combustion Engine. Steamship, vol. 33, no. 386, August 1921, pp. 49–53, 14 figs. Description of the two-stroke-cycle, four-stroke-cycle and semi-Diesel engines.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Corrosion. A Colloid Theory of the Corrosion and Passivity of Iron, and of the Oxidation of Ferrus Salts, John Albert Newton Friend. Jl. Chem. Soc., vol. 119–120, no. 704, June 1921, pp. 932–949, 2 figs. Author directs attention to a few important observations which cannot be explained by any known theory, and suggests new theory which appears to account for facts in reasonable manner.

A New Theory of the Corrosion of Iron, J. Newton Friend. Am. Electrochemical Soc. 40th Gen. Meeting 1921, advance paper, June 4, 1921, 13 pp., 9 figs. Writer puts forward auto-colloidal catalytic theory which postulates corrosion as starting by formation of colloidal ferrous hydroxide, which latter is alternately reduced by contact with iron and oxidized by contact with air, thus continuing corrosion and production of rust.

Corrosion of Iron and Its Prevention by Degassing Feedwater (Les Corrosions du Fer et Leur Suppression Par le Dégazage de l'Eau), G. Paris. Chimi & Industrie, vol. 6, no. 1, July 1921, pp. 11–32, 33 figs. Discusses theories of corrosion, effect of bodies dissolved in water, action of electric current, degasification and apparatus used.

Electrodeposition. Researches on the Electrodeposition of Iron, W. E. Hughes. Am. Electrochemical Soc. 40th Gen. Meeting 1921, advance paper, Apr. 25, 1921, pp. 15–33. Notes on electrodeposition of iron from sulphate, chloride, and sulphate-chloride solutions, stating results obtained by different workers. Writer also discusses various researches upon other solutions, with his own experiences and comments.

IRON AND STEEL

Canada. The Present Status and Future Possibilities of the Iron and Steel Industry in Canada, J. F. K. Brown. Iron & Steel of Can., vol. 4, no. 6, July 1921, pp. 159–166. Review of fundamental conditions of existence and growth of iron and steel manufacture, and discussion of advisability of capital investment in iron and steel enterprises in Canada.

England. Conditions in the Iron and Steel Industry. Engineer, vol. 131, no. 3417, June 24, 1921, pp. 675–676. Memorandum drawn up by British National Federation of Iron and Steel Manufacturers, representing employers, and Iron and Steel Trades Confederation, representing workmen.

Production on Pacific Coast. Factors in the Production of Iron and Steel on the Pacific Coast, Clyde E. Williams. Min. & Sci. Press, vol. 123, no. 3, July 16, 1921, pp. 94–96, 1 fig. Problem as to whether cheaper iron and steel can be obtained by producing them on Pacific Coast is said to depend upon a number of factors, chief among which are supply of raw material, amount and nature of market, and size and type of smelting operation. Paper presented at Int. Min. Convention, Oregon.

Protective Coatings. The Relative Values of Protective Metallic Coatings for Iron and Steel, Sherrard O. Cowper-Coles. Engineering, vol. 112, no. 2899, July 22, 1921, p. 167. Relative advantages and disadvantages of zinc coatings. Discusses four methods in which it can be applied, namely dipping in molten zinc, sherardizing, electro-zincing and spraying. Paper read before Instn. Civ. Engrs.

IRON CASTINGS

Loam Process. British Shop Casts Big Ingot Mold. Foundry, vol. 49, no. 14, July 15, 1921, pp. 565–566,

casting in Sheffield district. Casting annealed for two weeks. Special arrangements made for shipment 60 miles by rail.

Reversed Chilled. Reversed Chilling of Castings (Der umgekehrte Hartguss), P. Bardenheuer. Stahl u. Eisen, vol. 41, nos. 17 and 21, Apr. 28 and May 26, 1921, pp. 569–575 and 719–723, 32 figs. As results of investigation, the nature and origin of this phenomenon is explained. Outer zone of white congealed iron due to overcooling becomes gray through subsequent formation of graphite. Overcooling is due to a high sulphur content and a low casting temperature. Photomicrographs.

IRON FOUNDING

Centrifugal Casting. Chill Casting and Centrifugal Casting (La Coulée en Coquille et par Centrifugation) La Fonderie Moderne, no. 4, April 1921, pp. 87–89. Discusses operation of both methods.

IRON, PIG

Dephosphorizing. The Dephosphorizing of the Ilsed Basic Pig Iron in Converter and Open-Hearth Furnace (Die Entphosphorung des Ilseder Thomasroheisens im Konverter und im Martinofen), Arthur Jung. Stahl u. Eisen, vol. 41, no. 20, May 19, 1921, pp. 687–692. Describes dephosphorizing in open-hearth furnace of pig iron with 3 per cent phosphorus content and utilization of the phosphoric acid, with use of a poor and a rich ore in preliminary melting. Results are compared with basic process, which is said to insure a better utilization of phosphorus in pig iron.

Synthetic. Synthetic Production of Foundry Pig Iron and Its Properties (Synthetische Herstellung von Giessereiroheisen und dessen Eigenschaften), J. Bronn. Stahl u. Eisen, vol. 41, no. 26, June 30, 1921, pp. 881–888, 13 figs. Physical and chemical results of comparative tests of Rombach special process iron and Swedish charcoal pig iron show former to be of equal value, and its more frequent use is recommended.

J

JIGS

Design and Use. Jigs for Intensive Production. Eng. Production, vol. 3, no. 40, July 7, 1921, pp. 8–12, 14 figs. Observations on design and use of typical examples.

K

KEROSENE

Carburation of. Present State of Carburation of Kerosene (État Actual de la Carburation au Pétrole Lampant), Drosne. Société des Ingénieurs Civils de France, vol. 74, nos. 1, 2, 3, January-March 1921, pp. 35–52, 3 figs. Describes the Le Grain type of carburetor, fulfilling practically all required conditions.

L

LATHE TOOLS

Precision-Lathes. Tools Used in Making of Precision Lathe, Robert Mawson. Can. Machy., vol. 26, no. 1, July 7, 1921, pp. 68–69 and 74, 9 figs. Notes on different operations.

Ring Tools. The Ring Tool. Engineering, vol. 112, no. 2898, July 15, 1921, pp. 95–96, 5 figs. Article is said to complete geometry of ring tool and will be found useful for reference in drawing offices using these tools extensively.

LATHES

Manufacture. Making Flather Lathe Parts Interchangeable. Am. Mach., vol. 55, no. 2, July 14, 1921, pp. 50–53, 21 figs. Each part a separate unit. Jigs and fixtures eliminate individual fitting. All parts made to gages.

Turret. Obtaining Production on the Vertical Turret Lathe. Machy. (Lond.), vol. 18, no. 459, July 14, 1921, pp. 447–453, 18 figs. Application of vertical boring and turning mill to machine shop practice, including typical examples and description of tooling used.

Tooling in the Modern Turret Lathe. Eng. Production, vol. 3, nos. 42 and 43, July 21 and 28, 1921, pp. 61–66, 18 figs. and 83–89, 19 figs. Methods and fixtures for economical production.

LIGHTING

Charts and Data. Charts and Data for Industrial Lighting Designs, P. A. Powers. Elec. Rev., vol. 79, no. 7, August 13, 1921, pp. 231–234, 4 figs. Height of suspension related to spacing, reflector and lamp.

Illuminating Engineering. Illuminating Engineering, J. H. Asdell. Beama, vol. 9, no. 1, July 1921, pp. 25–29. Future field

Office Buildings. High-Intensity Illumination of Office Buildings, Ivan M. Kirlin. Elec. Rev. (Chicago), vol. 79, no. 7, August 13, 1921, pp. 235–238, 7 figs. Equipment employed and results obtained in lighting new offices of the Detroit Edison Co.

Railway Buildings. Electric Lighting of Railway Buildings, J. H. Kurlander. Ry. Elec. Engr., vol. 12, no. 7, July 1921, pp. 273–277, 11 figs. Three fundamental considerations of successful lighting installation are said to be intensity, quality and distribution. Recommendations.

LOCK WASHERS

Standards for. Current Standardization Work. 1921, pp. 118. Gives proposed dimensions of lock washers.

LOCOMOTIVE BOILERS

Repairing Cracks in Tubeplates. Repairing Cracks in the Copper Tubeplates of Locomotive Boilers, A. Wrench. Engineering, vol. 112, no. 2902, Aug. 12, 1921, pp. 251–252, 11 figs. Discusses methods of repairing.

Steel vs. Brass Tubes. Steel or Brass Boiler Tubes For Locomotives (Le Tube de Chaudiere de Locomotive acier ou Laiton?), O. Hock. Revue Universelle des Mines, vol. 10, no. 2, Series 6, July 15, 1921, pp. 117–128. Discusses the influence of the war and price of metals, life of steel tubes, etc. (To be continued.)

LOCOMOTIVES

Air-Operated Auxiliaries. Maintenance of Air Operated Auxiliaries. Ry. Mech. Engr., vol. 95, no. 8, August 1921, pp. 484–487, 5 figs. Discusses saving effected by the application of Air Brake Association condemning limits.

Booster Tests. Locomotive Booster Tests on Timiskaming & Northern Ontario Railway. Can. Ry. & Mar. World, no. 280, July 1921, pp. 356–357, 4 figs. Results of tests conducted with Can. Nat. Rys. dynamometer car 84.

British. Great Central Railway Four-Cylinder Engines—III. Supp. 3. Engineer, vol. 131, no. 3417, June 24, 1921, pp. 660–661, 5 figs. Characteristics: Type, 4-6-0; driving effort, 29,500 pounds; diameter of driving wheels, 5 ft. 8 in.

Heavy Locomotive Work on the Great Northern Railway (England). Ry. Gaz., vol. 35, no. 1, July 1, 1921, pp. 11–14, 3 figs. Passenger trains with 18 to 20 coaches and weighing from 590 to 650 tons are daily hauled between Doncaster and London by one engine of No. 1000 class. Discusses performance of locomotives on recent typical run.

Consolidation. High Capacity Consolidation Type Locomotives. Ry. Rev., vol. 69, no. 7, August 13, 1921, pp. 197–205, 13 figs. Discusses design and equipment, fuel consumption, fuel and tonnage performance, etc. Tractive effort, 68,200 lb.

Cut-off Control. The Automatic Control of Locomotive Cut-off, E. S. Pearce. Ry. Mech. Engr., vol. 95, no. 8, August 1921, pp. 488–493, 13 figs. Utilizing back pressure as actuating force.

Engine Design. Modern Locomotive Engine Design and Construction—LXXII. Ry. Engr., vol. 42, no. 498, July 1921, pp. 255–258, 2 figs. Considerations and factors determining most suitable cross section for locomotive connecting rods.

4-8-0. Recent Designs of Twelve-Wheel Locomotives. Ry. Age, vol. 71, no. 6, August 6, 1921, pp. 251–252, 4 figs. Description of various 4–8–0 types.

4-6-2 vs. 2-10-2. Heavy Locomotives for the Southern Pacific. Ry. Mech. Engr., vol. 95, no. 8, August 1921, pp. 481–483, 5 figs. Comparison between the 4-6-2 and 2-10-2 types. Tractive efforts are 43,660 and 75,150 lb., respectively.

Malay States Railways. Locomotives for Federated Malay States Railways. Ry. Age, vol. 71, no. 3, July 16, 1921, pp. 119–120, 3 figs. Locomotives manufactured by Baldwin Locomotive Works are of most up-to-date type and have open bar steel frames. Weight and dimensions are tabulated.

Mechanical Efficiency. Locomotive Resistance and Mechanical Efficiency, Kiichi Asakura. Ry. Age, vol. 71, no. 5, July 30, 1921, pp. 211–216, 9 figs. Establishes a formula for calculating mechanical efficiency.

Mikado. Heavier Mikado Type Locomotives Cut Operating Cost. Ry. Rev., vol. 69, no. 3, July 16, 1921, pp. 83–85, 3 figs. Improved type used on Baltimore & Ohio railroad handle 5800 tons over 0.3 per cent grade and are said to be more economical on account of ability to use mine-run coal.

Oil-Burning. Oil-Burning Locomotives in India and Mesopotamia, A. M. Bell. Ry. Engr., vol. 42, no. 498, July 1921, pp. 247–250, 6 figs. Information with regard to utilization of oil fuel for locomotives in the East.

Oil-Burning Locomotives on the Great Eastern Railway (England). Ry. Gaz., vol. 35, no. 1, July 1, 1921, pp. 9–10, 3 figs. Describes how G.E.R. locomotives are being fitted up for oil-fuel burning on the Holden system.

Shops, England. Methods Employed in the Locomotive Shops of the Great Western Railway Co., Swindon—IV. Machy. (Lond.), vol. 18, no. 458, July 7, 1921, pp. 405–407. Details of heat-treating plant and machining operations on various components of brake gear and link motion.

Southern Pacific Lines. New Pacific, Santa Fe and Switching Locomotives for the Southern Pacific Lines. Ry. & Locomotive Eng., vol. 34, no. 7, July 1921, pp. 199–200, 3 figs. Marked increase in weight and tractive power.

Superheaters. The Application of Superheaters to Light Locomotives. Ry. & Locomotive Eng., vol. 34, no. 7, July 1921, pp. 188–189, 5 figs. Examples of recent construction in which installations have been made.

Tank. Heavy Tank Locomotives on the London & South Western Railway. Ry. Gaz., vol. 35, no. 1, July 1, 1921, pp. 16 and 22, 2 figs. New 4-8-0 side tank locomotive built for work at Feltham concentration yard and for transfer service between Nine Elms and Feltham.

Tire-Fixing Appliance. A New Machine for Railway Work. Eng. Production, vol. 2, no. 39, June 30, 1921, p. 772, 1 fig. Appliance for use in connection with tire fixing.

Roller Bearings on. Roller Bearings on Looms. Textile World, vol. 60, no. 6, August 6, 1921, pp. 89–91, 2 figs. Shows a power saving of 23 per cent.

LUBRICATING OILS

Carbonization in Internal-Combustion Engines. The Carbonization of Lubricating Oils in Internal-Combustion Engines, Frederic H. Garner. Jl. Instn. Petroleum Technologists, vol. 7, no. 26, Apr. 1921, pp. 98–126 and (discussion and bibliography) pp. 126–148, 8 figs. Method of determining asphaltic resins in lubricating oils was devised by utilizing the selective absorbent power of animal charcoal. Results of experimental work on evaporation and carbonization of series of lubricating oils derived from Texas and Pennsylvania crudes.

Castor Oil. Castor Beans and Castor Oil, M. Riodl. So. African Jl. Ind., vol. 4, no. 6, July 1921, pp. 540–547. Discusses cultivation of the bean and use of castor oil as a lubricant.

Reclaimed. The Reclamation of Used Motor Oils, William F. Parish. Sci. Lubrication, vol. 1, no. 6, June 1921, pp. 5–7. Discusses the value of reclaimed oil and advocates its salvage.

Viscosity-Temperature Chart. A New Chart for Viscosity Temperature Relations. Lubrication, vol. 7, no. 6, June 1921, pp. 5–8, 2 figs. Presents chart, one of important features of which is that every known lubrication oil can be shown comparatively.

LUBRICATION

Steam-Cylinder. Steam cylinder Lubrication. Lubrication, vol. 7, no. 6, June 1921, pp. 1–4 and 9–13. Notes on what the oil must lubricate; how it can best be applied; conditions under which it must operate; selection of oils; and how to tell if lubrication is correct.

M

MACHINE GUNS

Dispersion. Long Range Small Arms Firing—IV, Glenn P. Wilhelm. Army Ordnance, vol. 2, no. 1, July-August 1921, pp. 31–35, 4 figs. Discusses dispersion, especially kinds of machine-gun dispersion.

Synchronizing with Airplane Propeller. Engineering Field of Aeronautics—XI, T. L. Sherman. Commonwealth Engr., vol. 8, no. 11, June 1, 1921, pp. 322–325, 3 figs. Discusses wave transmission as applied to secure synchronism of a machine gun with the propeller of an aeroplane engine.

MACHINE SHOPS

High- and Low-Bay Type. The High- and Low-Bay Type of Machine Shop, Fred H. Colvin. Am. Mach. vol. 55, no. 3, July 21, 1921, pp. 91–93, 7 figs. Wide, high bays, with low bays between, give light from both sides. Standard columns and shapes make rearrangement easy at any time.

MACHINERY

Foundation Bolts. Elements of Design for Foundation Bolts of Machines, Terrell Croft. Coal Age, vol. 20, nos. 2 and 3, July 14 and 21, 1921, pp. 45–51, 9 figs., and 95–99, 13 figs. Summary of available information concerning design of machinery foundations and holding-down bolts necessary. Devices to increase holding power of anchor bolts; relative value of neat cement, sulphur and lead.

MALLEABLE IRON

Structure. Explain the Structures of Malleable, W. R. Bean, W. H. Highriter and E. S. Davenport. Foundry, vol. 49, no. 14, July 15, 1921, pp. 557–564, 40 figs. Microscope reveals causes of many different effects found in fracture of malleable cast iron. Condition of carbon is said to be largely governed by composition and by anneal. Paper presented before Am. Foundrymen's Assn.

Sulphur in. Sulphur in Malleable Cast Iron, Lester C. Crome. Chem. & Met. Eng., vol. 25, no. 6, August 10, 1921, pp. 247–248. Discusses determination of sulphur in white cast iron by the evolution process.

MARINE STEAM TURBINES

Gearing. Marine Steam-Turbine Gearing, J. Hamilton Gibson. Trans. Inst. Mar. Engrs., session 1921–22, June 1921, pp. 115–126 and 127–143, 1 fig. on p. 144. Deals with essential elements of manufacture, erection and running.

MATERIALS

Storage. Principles of Storage. Iron Age, vol. 108, no. 4, July 28, 1921, pp. 194–196, 8 figs. Experience and practices of Pittsburgh railways summarized.

METAL SPRAYING

Schoop Process. Progress in Metal Coating, Schoop Process of Spraying Metals or Alloys (Les Progrès de la Métallisation, Procédé Schoop Par Pulverisation de Metaux ou Alliages Fondus), P. Nicolardot. Chimie & Industrie, vol. 5, no. 6, June 1921, pp. 619–635, 26 figs. Describes the Schoop process, apparatus and applications in industry.

METALLOGRAPHY

Foundry Uses. Use of Metallography in Metal Foundries (Anwendungen der Metallographie in der Metallgiesserei), Rudolf Stotz. Giesserei-Zeitung, vol. 18, nos. 13 and 14, July 5 and 12, 1921, pp. 207–211 and 215–220, 32 figs. Discusses internal structure of metals and alloys in relation to foundry practice. Address delivered before Assn. German Metal Foundrymen.

METALS

Annular Cracks. Annular Cracks, R. R. Clarke. Metal Industry (Lond.), vol. 19, no. 2, July 8, 1921, pp. 27–28, 2 figs. Discusses various theories for their formation.

Calorizing. Calorizing as a Protection for Metals, A. V. Farr. Forging & Heat-Treating, vol. 7, no. 7, July 1921, pp. 384–386, 4 figs. Also in Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 431–433. Recent developments. Characteristics of a good protective coat. Materials that can be calorized. Cost and various applications. (Abstract.) Paper read before Eng. Soc. West. Pa.

Protecting Metals by Calorizing (Les Méthodes de Protection des Métaux et la Calorisation), Léon Guillet. Revue de Métallurgie, vol. 18, no. 5, May 1921, pp. 283–289, 6 figs. Describes the three methods depending on (1) reaction of the metal itself, (2) adding another metal, and (3) non-metallic coating.

Properties at High Temperatures. Study of the Physical Properties of Metals at High Temperature. (Studio delle Proprieta Fisiche dei Metalli Alle Elevate Temperature Precedenti il Loro Intervallo di Plasticita). Il Forno Elettrico, vol. 3, no. 5, May 15, 1921, pp. 71–73. Particulars of experiments carried out and conclusions.

Scratches, Effect of. The Effects of Scratches in Materials, Ernest George Coker. Engineering, vol. 112, no. 2897, July 8, 1921, pp. 81–82. Effect of different kinds of scratches on stressed materials. Paper read before Instn. Civ. Engrs.

Viscosity. On the Determination of the Coefficient of Normal Viscosity of Metals, Kôtarô Honda and Seibei Konno. Lond., Edinburgh, & Dublin Philosophical Mag., vol. 42, no. 247, July 1921, pp. 115–123, 3 figs. Coefficients of twelve different metals are measured at room temperature, values ranging from 0.7×10^8 to 27×10^8. Annealing causes diminution of coefficient of viscosity; in carbon steels coefficient increases with content of carbon.

MICROMETERS

Screw. The Spreading of Micrometer Frames (Die Aufbiegung von Schraubenmikrometern), G. Berndt. Betrieb, vol. 3, no. 19, June 25, 1921, pp. 574–581, 12 figs. Results of experiments with a number of screw micrometers by different firms. A formula for calculation of semi-circular frames is developed. A table of permissible amounts of spreading of frames is presented and weights for rectangular cross-section frames are calculated.

MILLING MACHINES

Continuous. New 18-Inch Continuous Mill. Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 430–431, 4 figs. Recently completed by Whitaker-Glessner Co. at Portsmouth, Ohio. Consists of six stands of 18-in. roughing and finishing rolls together with two edging mills, located respectively in front of first and third roughing passes.

Whitaker-Glessner Continuous Mill. Iron Age, vol. 107, no. 26, June 30, 1921, pp. 1747–1749, 4 figs. For making sheet bars or billets. Includes edging rolls. Approach table with skewed V-groove rollers for centering blooms.

Universal. A New Universal Milling Machine. Eng. Production, vol. 3, no. 40, July 7, 1921, pp. 18–19, 2 figs. Details of latest motor-driven universal milling machine manufactured by J. Perkinson & Son, Shipley, England.

MOLDING MACHINES

Centrifugal. Centrifugal Molding Machine of E. O. Beardsley and W. F. Piper (Die Schleuderformmaschine von E. O. Beardsley and W. F. Piper. Stahl u. Eisen, vol. 41, no. 21, May 26, 1921, pp. 723–724, 1 fig. Refers to centrifugal molding machines described in same journal (Sept. 30, 1920) which are now being manufactured by the inventors in several forms, the most popular being the portable machine. Recent improvement.

French Practice. Mechanical Molding Practice (La Pratique de Moulage Mécanique), G. Pouplin. La Fonderie Moderne, no. 5, May 1921, pp. 128–137, 6 figs. Discusses various methods for molding grate bar and aluminum casings for motor cars.

Operation. Machine Molding (La Pratique de Moulage Mécanique). G. Pouplin. La Fonderie Moderne, no. 4, April 1921, pp. 92–102, 7 figs. Describes the operations in detail. (To be continued.)

MOLDING METHODS

Follow-Board Use. Accentuates Use of Follow Board Pat. Dwyer. Foundry, vol. 49, no. 15, August 1, 1921, pp. 585–590, 11 figs. Match plates extensively used in new foundry equipment.

Gating. Elevated, Midway, and Subway Gating, William H. Parry. Am. Mach., vol. 55, no. 6, Aug. 11, 1921, pp. 209–210, 8 figs. Using three-part flasks on two-part work to increase production. Arrangement of gates and runners. Abandoning horn gate.

Pipe Fittings. Large Elbow Made in Dry Sand Mold, James J. Zimmerman. Foundry, vol. 49, no. 15, August 1, 1921, pp. 607–610, 8 figs. Methods employed in the production of pipe fittings for 96-in. diameter exhaust line.

Sash Weights. How to Make Sash Weight Castings, J. H. Anderson. Foundry, vol. 49, no. 15, August 1, 1921, pp. 592–594, 5 figs. Shows how these castings can be produced rapidly and economically.

MOLYBDENUM STEEL

Motor Cars. Molybdenum Steel in the Motor Car. Sci. Am., vol. 125, no. 4, July 23, 1921, pp. 62–63, 4 figs. Notes on reducing weight in high-power cars by use of new steel alloys.

Physical Properties. The Value of Molybdenum Alloy Steels, G. W. Sargent. Trans. Am. Soc. Steel Treating, vol. 1, no. 10, July 1921, pp. 589–596 and (discussion) pp. 596–597, 5 figs. Notes on manufacture and physical properties.

MONEL METAL

Magnetic Properties. Monel Metal Has Definite Magnetic Properties, Charles W. Burrows. Elec. World, vol. 78, no. 3, July 16, 1921, pp. 115–116, 3 figs. Investigation shows magnetic characteristics considerably less than iron. Important property in loss of magnetism at temperature near 200 deg. fahr.

MOTOR-TRUCK TRANSPORTATION

Chicago. Motor Truck Haulage in Chicago. Elec. Ry. Jl., vol. 58, no. 4, July 23, 1921, pp. 133–135, 4 figs. North Shore line has receiving station close to Chicago Loop and hauls merchandise on trucks to rail terminal. Study shows service to be costly taken by itself, but valuable as business producer.

Development and Future. The Development and Future of Handling Freight by Motor Trucks. Jl. Engrs.' Club of Phila., vol. 38–6, no. 198, June 1921, pp. 225–240. Better Highways and Motor Transportation as an Aid to Production, F. W. Fenn. The Motor Truck and Legislation, R. A. Hauer. Motor Truck Operation in Southern Maryland, M. O. Eldridge. Discussions.

MOTOR TRUCKS

Cushioning in. Cushioning in Motor-Truck Design, Charles O. Guernsey. Jl. Soc. Automotive Engrs., vol. 9, no. 2, August 1921, pp. 143–147 and discussion pp. 147–150, 10 figs. Considers chassis stresses, cushion tires and wheels and elimination of vibration.

MUSKETS

Sights. Telescopic Musket Sights, H. K. Rutherford. Army Ordnance, vol. 2, no. 1, July-August 1921, pp. 23–30, 17 figs. Discusses ten different kinds of sights.

N

NICKEL STEEL

Deoxidizing. Method of Deoxidizing High-Nickel Steel, C. B. Callomon. Foundry, vol. 49, no. 15, August 1, 1921, pp. 590–591. Advocates use of pure manganese instead of aluminum.

O

OFFICE MANAGEMENT

Data Filing. Packard's Motor Transport Data Files, Dorsey W. Hyde, Jr. Filing & Office Management, vol. 6, no. 3, August 1921, pp. 71–73. Gives details of classification.

Government Departments. Office Management as Applied to Government Establishments, W. E. Mickey. Filing & Office Management, vol. 6. no. 3, August 1921, pp. 65–67, 2 figs. Outline of the work of the various departments.

OIL ENGINES

Crossley Solid-Injection. The Production of Power from Internal-combustion Engines, F. W. Burstall. Elecn., vol. 86, no. 2249, June 24, 1921, pp. 781–783, 2 figs. Details of the Crossley solid-injection heavy-oil engine of high-compression type, in which the charge is ignited by mixture itself at end of compression.

French. A New French Heavy Oil Engine, M. R. E. Mathot. Gas & Oil Power, vol. 16, no. 190, July 7, 1921, pp. 149–150, 1 fig. Describes new type built by Weyher & Richemond, Pantin, near Paris.

Marine. Some Observations on Marine Oil Engines, D. M. Shannon. Trans. Inst. Mar. Engrs., session 1921–22, June 1921, pp. 145–164 and (discussion) pp. 165–174, 15 figs. Deals with various types, including Diesel and hot-bulb engines. Diagrams from various types of piston engines.

OIL FUEL

Eyre System. Eyre System of Liquid Fuel Burning. Tramway & Ry. Wld., vol. 50, no. 3, July 14, 1921, pp. 9–11, 8 figs. This system is extremely simple and suitable for all kinds of furnace work and steam-raising purposes.

Mexican. The Production and Combustion of Mexican Fuel Oil—IV. J. M. Pettingell and J. R. Carlson. Combustion, vol. 5, no. 2, Aug. 1921, pp. 66–69, 5 figs. Fuel oil and coal comparison.

Production. Fuel Oil, W. A. Whyte. Steamship, vol. 33, no. 385, July 1921, pp. 6–12. Notes on origin, finding and refining of petroleum; statistics of output. Fire precautions and appliances for use on ships burning oils. Paper read before North-East Board of Engrs. & Shipbuilders.

OIL WELLS

Cementing. The Cementing of Oil Wells. Petroleum Times, vol. 6, no. 130, July 2, 1921, pp. 13–14, 1 fig. Details of the Halliburton cementing process.

Drilling. Drilling Oil Wells With the Diamond Drill, Frank A. Edson. Bul. Am. Assn. Petroleum Geol., vol. 5, no. 3, May-June 1921, pp. 386–393. Maintains that the diamond drill affords a means of obtaining much more accurate information and at no greater cost.

Study on Drilling and Behavior of Neighboring Wells, A. W. Ambrose. Oil Field Eng., vol. 23, no. 7, July 1921, pp. 86–88. (From U. S. Bur. of Mines, Bul. 195). Advocates the exchange of information, speaks of the necessity for testing drilling well and testing samples of information for oil.

Mud Injection. Introducing Mud-Laden Fluid Under High Pressures Into Porous Formations, H. J. Steiny. Eng. & Min. Jl., vol. 112, no. 5, July 30, 1921, pp. 182, 1 fig.

OILS

Animal, Hydrogenation of. Hydrogenation of Some Marine Animal Oils (Hydrogénation de quelques huiles d'animaux marins), H. Marcelet. Académie des Sciences, vol. 173, no. 2, July 11, 1921, pp. 104–107. Shows favorable results from experiments carried out.

Linseed. Improved Process of Refining Linseed Oil, Alexander Schwarcman. Chem. Age (N. Y.), vol. 29, no. 7, July 1921, pp. 280–282. Writer describes process developed by him and mechanical equipment required therefor.

Vegetable. Solvent Extraction in the Vegetable Oil Industry, J. H. Shrader. Chem. & Metallurgical Eng., vol. 25, no. 3, July 20, 1921, pp. 94–100, 6 figs. Stationary and rotary types of extractors; principal solvents; economic considerations; uses of products obtained.

OPEN-HEARTH FURNACES

Egler Blow-Torch Port. The Egler Blow-Torch Port for Open-Hearth Furnaces. Iron & Coal Trades Rev., vol. 102, no. 2782, June 24, 1921, pp. 846–847, 2 figs. Details of Egler furnace said to be equally adapted to all kinds of gas or liquid fuel and to powdered coal.

Improvements. Improvement in Open-Hearth Details, A. G. and A. F. Schumann. Iron Age, vol. 108, no. 5, Aug. 4, 1921, pp. 269–272, 8 figs. New arrangement of reversing furnace valves promotes economy. Burners for liquid fuel and tar. Results in operation.

Relation of Temperature to Output. Discussion on Open Hearth Practice, Henry Wm. Seldon. Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 422–423. Facts to be considered in relation to open-hearth furnace temperature to furnace output.

OXY-ACETYLENE WELDING

Refrigerating Apparatus. Oxy-Acetylene Welding of Refrigerating Apparatus, Fred E. Rogers. A.S.R.E. Jl., vol. 7, no. 6, May 1921, pp. 432–450 and (discussion) pp. 450–451, 27 figs. Discusses the importance of true forms, manipulation of torch and welding rod, reinforcement of welds, size of welding rods and tips, etc.

P

PARACHUTES

Types. Saving Life in Air Wrecks, T. Orde Lees. Aeronautical Jl., vol. 25, no. 127, July 1921, pp. 317–328 and (discussion) pp. 328–332. Discusses saving of passengers and crew by parachute. Different types of parachutes are described.

PEAT

Pulverized. Pulverized Peat Fuel a Success, C. L. Bohannan. Jl. Am. Peat Soc., vol. 14, no. 3, July 1921, pp. 19–25. It is claimed that use of pulverized fuel produces a great saving in both fuel and labor costs.

Russian Plants. Russian Machine-Cut Peat Plants (Russische Maschinentorfanlagen), A. Naumann. Fördertechnik u. Frachtverkehr, vol. 14, no. 4, Feb. 18, 1921, pp. 50–51. It is claimed that the Russian machine-cut peat plants are the most perfect of their kind in existence.

PIPE, CAST-IRON

Explosion. Explosion of a Cast-Iron Steel Pipe Engineering, vol. 112, no. 2898, July 15, 1921, p. 102. Results of investigation shows that explosion was due to improper overhauling of drain trap.

PIPE FITTINGS

Casting. Casting Large Pipe Fittings, James J. Zimmerman. Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 417–420, 9 figs. Scott Foundry, Reading, Pa., makes 96-in. elbows for 10,000-kw. installation for steel plant, in dry sand mold. Describes methods.

PIPE, WOOD-STAVE

Use of. Construction of Wood Pipe Lines (Der Bau hölzerner Rohrleitungen), Leopold Nosseck. Zeit. des Oesterr. Ingenieur- u. Architekten-Vereines, vol. 73, nos. 1–2 and 24–25, Jan. 14 and June 24, 1921, pp. 13–14 and 166–168, 5 figs. Summary of conditions favorable to use of and advantages of wood-stave pipe.

PISTONS

Machining. Machining Motor Pistons. Machy. (Lond.), vol. 18, no. 458, July 7, 1921, pp. 428–429, 3 figs. Successive steps and equipment employed in machining pistons for high-grade motor car.

PLANERS

Crank-Driven. Results Obtained with Crank-driven Planers. Machy. (Lond.), vol. 18, no. 458, July 7, 1921, pp. 415–419, 9 figs. Methods of operating machines possessing features of both planer and shaper.

PLATES

Reinforced-Concrete. Load Distribution in Reinforced-Concrete Plates Supported on Both Sides and under Concentrated Load Lastverteilung bei zweiseitig aufliegenden Eisenbetonplatten mit konzentrierter Belastung), W. Petry. Beton u. Eisen, vol. 20, no. 4–5, Mar. 7, 1921, pp. 60–62. Results of tests carried out by German Committee for Reinforced Concrete in the material-testing station of the Stuttgart Technical Academy.

Dundee, Scotland. Power Supply in Dundee. Elecn., vol. 87, no. 2252, July 15, 1921, pp. 70-76, 8 figs. Account of progress. Notes on supply conditions, coal and ash handling, boiler house, flues and economizers, feed pumps, generating plant, generators, switchgear, sub-stations, transmissions and distribution.

Generating Costs. Generating Costs in Stations of Medium Size, M. J. Idail. Elec. World, vol. 78, no. 4, July 23, 1921, pp. 169-170. Southern station burning Mexican fuel oil averages $1.37 cents per kw-hr.; another station with river washery coal averages $1.24.

Glasgow, Scotland. Dalmarnock Power Station, R. B. Mitchell. Elec. Ry. & Tramway Jl., vol. 44, no. 10, June 10, 1921, pp. 261-271, 26 figs. Describes Glasgow plant completed in 1920. Summary of important data concerning boilers, turbo-alternators condensing plant, motors driving auxiliaries, alternators, step-up transformers, switchgear, and other equipment.

POWER TRANSMISSION

Types of Drive. Progress and Problems of the Mechanical Transformation of Energy (Fortschritte und Probleme der mechanischen Energieumformung) K. Kutzbach. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 26, June 25, 1921, pp. 673-678, 21 figs. Deals with high-speed toothed-gear drive for ship turbines, stationary turbines, electric locomotives and hydroelectric plants; and gives examples of belt and rope drives, typical for trend of recent development.

PRESSES

Design. Designing Power Press Frames. Eng. Prod., vol. 3, no. 43, July 28, 1921, pp. 76-78, 2 figs. Data for use in determining the leading dimensions.

PULVERIZED COAL

Foundries. Powdered Coal Applied in Foundry, A. J. Grindle. Foundry, vol. 49, no. 15, August 1, 1921, pp. 617-618. Layout and operation of a powdered-coal installation.

German Steel Industry. Powdered Coal as Fuel for Boilers, F. Schulte. Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 447-452, 4 figs. Application in German steel industry. Translated from Glückauf, Apr. 30, 1921.

Properties. Powdered Fuel, Robert James. Proc. South Wales Inst. Engrs., vol. 37, no. 3, July 7, 1921, pp. 221-236. Continuation of the discussion of Robert James' paper.

Steam Generation. Pulverized Firing in Steam Generation, F. J. Crolius. Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 453-460. Discusses use of pulverized coal. Typical layout of successfully operated plant.

Steel Works. The Adaptability of Pulverized Coal Furnaces for Iron and Steel Works (Anwendbarkeit der Kohlenstaubfeuerung in Eisenhüttenwerken), G. Bulle. Stahl u. Eisen, vol. 41, no. 29, July 21, 1921, pp. 985-994, 6 figs. Advantages of firing with pulverized coal from technical and economic standpoint.

Trent Cleaning Process. Trent Process for Cleaning Powdered Coal, O. P. Hood. Iron Age, vol. 108, no. 6, Aug. 11, 1921, p. 323. Agitation method of producing an amalgam and eliminating ash from low-grade fuels.

PUMPING STATIONS

Cleveland. The Division Pumping Station at Cleveland, Ohio, J. N. H. Christman. Jl. Am. Water Wks. Assn., vol. 8, no. 4, July 1921, pp. 433-441. Particulars of construction and equipment.

PUMPS

Boiler-Feed. Water and Air Pumps for Small Deliveries with Eccentric Drive (Wasser-und Luftpumpe für geringe Fördermengen mit Antrieb durch Exzenter), H. Mitusch. Fördertechnik u. Frachtverkehr, vol. 14, no. 3, Feb 4, 1921, pp. 33-34, 5 figs. Description and illustrations demonstrating arrangement of pumps with eccentric drive for use where crank drive is inexpedient.

PUMPS, CENTRIFUGAL

Piston vs. Centrifugal Versus Piston Pumps (Kreiselpumpe oder Kolbenpumpe?) Alfred Schacht. Fördertechnik u. Frachtverkehr, vol. 14, no. 7, Apr. 1, 1921, pp. 79-80, 1 fig. Cost of installation of centrifugal pump is said to be about half that of steam piston pump, and foundations can be easily and cheaply constructed. Condensation water of turbine is free of oil and can be directly reused for boiler feed.

Reciprocating Pumping Engines vs. Comparison between Reciprocating Pumping Engines and Turbo-driven Centrifugal Pumps, Hugh Lupton. Engineering, vol. 112, no. 2897, July 8, 1921, pp. 74-76. Includes tables showing consumptions and costs of triple-expansion pumping engines and steam turbine-driven centrifugal pumps. Paper read before Instn. Civ. Engrs.

PUNCHES

Design. The Design and Construction of Press Tools—X. Eng. Production, vol. 3, no. 42, July 21, 1921, pp. 56-58, 6 figs. Considers various kinds of punches and dies. (Concluded.)

PYROMETERS

Equipment for. Some Essentials of Modern Pyrometer Equipment, H. G. Hall. Can. Machy., vol. 26, no. 3, July 21, 1921, pp. 38-40, 4 figs. Discusses simplicity of design, cost of thermocouple upkeep, etc.

R

RADIOMETALLOGRAPHY

Spectral Analysis of Metals. Radiometallography (La Radiométallographie), E. Dieudonné. Revue Universelle des Mines, vol. 9, no. 6, June 15, 1921, pp. 557-566, 8 figs. Concludes that by it the spectral analysis of metals has been made possible.

RAILS

Damage Due to Deceleration. Damage to Tyres and Rails Caused by Brakes or Slipping Wheels, Christer P. Sandberg. Engineering, vol. 112, no. 2897, July 8, 1921, pp. 82-84, 8 figs. Two examples of rail failure are given which are said to be typical of many others for which no adequate explanation has been found. Paper read before Instn. Civ. Engrs.

Failures. Split-Head Rail Failure Shows Rupture, James E. Howard. Iron Age, vol. 108, no. 7, Aug. 18, 1921, pp. 393-395, 7 figs. Differs from a piped rail and is often more easily discovered by outcropping at side. (Abstract.) Report of Interstate Commerce Commission.

Fissures. A New Theory of Fissure Formation (Eine neue Theorie der Riffelbildung), A. Wichert. Verkehrstechnik, vol. 38, nos. 9 and 11, Mar. 25 and Apr. 15, 1921, pp. 109-113 and 140-143, 7 figs. New theory of fissuring is developed and means of preventing it described. Details of apparatus for investigation of formation of fissure designed by author and built by Greater Berlin Street Railway, tests with which are to be carried out by Brown, Boveri & Cie., Mannheim.

Specifications. A New Rail Specification Proposed, Robert W. Hunt. Iron Age, vol. 108, no. 5, Aug. 4, 1921, pp. 262-263. Provides for rolling tie plates from top of each ingot. Treatment in soaking pits. Lenient as to cold straightening.

New Specification for Rails, Robert W. Hunt. Ry. Age, vol. 71, no. 6, August 6, 1921, pp. 255-256. New specifications to compose difference between existing rail-makers and users.

Welding. Welding of Rails by Aluminothermic Processes, (La soudure des rails de tramways par les procédés aluminothermiques), M. Guiffart. L'Industrie des Tramways, vol. 15, no. 171-172, March-April 1921, pp. 41-47, 9 figs. Practice of French General Company of Tramways.

RAILWAY ELECTRIFICATION

Brazil. Electrification of the Paulista Railway of Brazil, W. D. Bearce. Ry. Age, vol. 71, no. 2, July 9, 1921, pp. 80-83, 5 figs. Fuel scarcity forces the adoption of electric motive power on Brazilian wide-gage line.

Switzerland. The St. Gothard Electrification. Elec. Ry. & Tramway Jl., vol. 45, no. 1086, July 8, 1921, pp. 17-20, 6 figs. Has adopted single-phase system, 15 periods, at 7,500-15,000 volts on the contact line. Reasons for this choice are discussed.

RAILWAY OPERATION

Demountable Car Bodies. Speeding Up Terminal Operations. Ry. Gaz., vol. 35, no. 5, July 22, 1921, pp. 218, 8 figs. Describes the use of demountable bodies in conjunction with motor chassis to speed up the handling of traffic.

Heavy-Tonnage. Heavy Tonnage Train Handling Demonstrations on Virginian. R. R. Herald, vol 25, no. 8, July 1921, pp. 23-27, 4 figs. Account of series of heavy-tonnage train-handling demonstrations conducted on Virginian R. R. under auspices of Westinghouse Air Brake Co., which successfully illustrated feasibility of handling trains approximating 16,000 tons gross behind locomotive, even when undertaking involves long descending mountain grades.

Locomotive Fuel-Oil Stations. Design and Operation of Locomotive Fuel Oil Stations. Eng. News-Rec., vol. 87, no. 5, Aug. 4, 1921, pp. 183-187, 9 figs. Tank cars discharge into track troughs; storage and service tanks; gravity of pumped supply to engines; oil columns; fire protection.

Train Control. Problems of Automatic Train Control. Ry. Gaz., vol. 35, no. 3, July 15, 1921, pp. 124-125. Discusses questions in connection with the prevention of accidents.

The Train Control System of the Midland Railway. Ry. Gaz., vol. 35, no. 2, July 8, 1921, pp. 45-97, 72 figs. partly on supp. plates. Comprehensive review of successful scheme of traffic in which all train-operating arrangements are centralized. Outstanding feature of scheme is said to be its simplicity. Includes figures indicating running efficiency secured by means of control system.

RAILWAY SHOPS

Power and Light for. Electric Power and Light for Railroad Shops, J. E. Gardner. Ry. Mech. Engr., vol. 95, no. 8, August 1921, pp. 515-518, 1 fig. Trend of development and standards adopted in the power and lighting field.

RAILWAY SIGNALING.

Alternating-Current. Principles of Alternating Current Signaling, J. S. Holliday. Ry. Signal Engr., vol. 14, no. 7, July 1921, pp. 267-269, 3 figs. Vector combinations and solutions of resistances of impedances. (Continuation of serial.)

Maintenance of A. C. Signal Apparatus, L. F. Vieillard. Ry. Signal Engr., vol. 14, no. 8, August 1921, pp. 229-302, 3 figs. Discusses relays, impedance bonds, resistances and reactances, transformers, etc. (To be continued.)

Farm-Lighting Unit. Farm Lighting Units for Signal Operation, F. H. Bagley. Ry. Signal Engr. system for charging storage batteries at central locations in territory where alternating current is not available.

Floating Battery. A. C. Floating Battery for Railway Signaling. Ry. Signal Engr., vol. 14, no. 8, August 1921, pp. 303-306, 6 figs. Comparison of this new system with straight a.c. and d.c. signaling and points to be considered in estimates.

New Signals and Interlockers. New Signals and Interlockers on the P. & R., B. V. Strickland. Ry. Signal Engr., vol. 14, no. 7, July 1921, pp. 256-261, 10 figs. Details of extensive improvements and additions to signaling system on New York branch of Phila. & Reading road. Notes on pole line construction, power supply, signal lighting, automatic block signaling, etc.

Position-Light Signals. The Development of Position-Light Signals, A. H. Rudd. Ry. Signal Engr., vol. 14, no. 7, July 1921, pp. 264-266, 1 fig. Latest design of Pennsylvania Railroad is said to reduce cost of operation and maintenance and promote simplicity and safety.

RAILWAY SWITCHES

Low-Voltage Machines. Switch Operation by Low-Voltage Machines, C. C. Anthony. Ry. Signal Engr., vol. 14, no. 8, August 1921, pp. 313-315, 1 fig. Discusses where these machines are best employed and their advantages.

RAILWAY TIES

Hollow Steel. Hollow Steel Ties (Die eiserne Hohlschwelle und die Wirtschaftlichkeit der Bahnunterhaltung), A. Birk. Verkehrstechnik, vol. 38, no. 12, Apr. 25, 1921, pp. 154-156, 6 figs. Describes R. Scheibe's hollow steel ties and compares their elastic properties and weights with those of other ties. Results of tests.

RAILWAY TRACK

Ashpits. Locomotive Ash-Pit and Coaling Station at Communipaw, New Jersey. Engineering, vol. 112, no. 2898, July 15, 1921, pp. 125-127, 8 figs. The two double submerged pits consist of rectangular reinforced-concrete tanks with piling foundations. Coaling station consists of reinforced-concrete structure spanning eight tracks to any of which any of three kinds of coal can be delivered.

REFRACTORIES

Carborundum. Carborundum Refractories in Heat Treating Furnaces, M. L. Hartman. Trans. Am. Soc. Steel Treating, vol. 1, no. 10, July 1921, pp. 601-603. Points out success resulting from adoption of carborundum refractories in various heat-treating furnaces.

Hardness when Heated. Arrangement For Testing the Hardness of Refractory Materials At High Temperatures (Sur un dispositif pour les essais de dureté des matériaux refractaires a haute temperature), Etienne Rengade & Edmond Desvignes. Comptes rendus de l'Académie des Sciences, vol. 173, no. 3, July 18, 1921, pp. 134-137, 1 fig. Description of a new apparatus superseding the Seger cone.

Rotary Cement Kilns. Refractories for Rotary Cement Kilns, Raymond M. Howe. Cement, Mill & Quarry, vol. 19, no. 1, July 5, 1921, pp. 35-36. Service in clinker zone is said to tax refractory materials. Effect of high temperature and changes in temperature. Other materials. Paper read before Portland Cement Assn.

REFRIGERATING MACHINES

Ammonia. Investigations of an Ammonia Refrigerating Machine (Untersuchungen an einer Ammoniak-Kältemaschine), Walther Fischer. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 27, July 2, 1921, pp. 720-723, 7 figs. Deals especially with influence of cooling water jacket on compressor.

Compression. The Compression Refrigerating Machine, Gardner T. Voorhees. Ice & Refrigeration, vol. 61, no. 1, July 1921, p. 23. Gage pressure.

REFRIGERATING PLANTS

Propellers for Brine Agitation. Modern Propeller Design for Brine Agitation and Circulation, E. A Burrows. Ice & Refrigeration, vol. 61, no. 1, July 1921, pp. 18-19, 10 figs.

RESEARCH

University. The University and Research, Vernon Kellogg. Chem. Age (N. Y.), vol. 29, no. 7, July 1921, pp. 274-276. Notes on work of Nat. Research Council, and conditions of university research. Paper read at University of Minn.

RIVETED JOINTS

Design. Principles of Riveted Joint Design, William C. Strott. Boiler Maker, vol. 21, no. 7, July 1921, pp. 191-193 and 212, 6 figs. Discusses types of plate and rivet failures, joint efficiency and calculations involved in determining strength of given riveted seam. (To be continued.)

RIVETING

Gas Rivet Heating. Experience with Gas Rivet Heating in the Pacific Coast, Letson Balliet. Eng. News-Rec., vol. 87, no. 1, July 7, 1921, pp. 21-22. Shipyard results show better rivets and saving of time and cost. Possibilities for structural work.

ROLLING MILLS

Chilled Rolls. Chilled Rolls for Rolling Mills (Cylindres de Laminoirs en Fonte trempée), Christian Kluytmans. La Fonderie Moderne, no. 4, April 1921, pp. 81-83. Discusses composition, silicon and other content, and tempering.

Modern Practice. Principles of Modern Rolling Practice, E. Cotel. Iron Age, vol. 108, no. 7, Aug. 18, 1921, pp. 396–399, 6 figs. Discussion of great power required for finishing passes. Phenomenon of speed gain (bar acceleration) in rolling. Translated from Montanistische Rundschau.

Roll Design. The Logic of Roll Design, W. H. Melaney, Part IV. Blast Furnace & Steel Plant, vol. 9, no. 8, August 1921, pp. 477–478, 1 fig. Discusses maximum draft of each pass and minimum diameter of roll.

Roll Making. How Steel Mill Rolls Are Made—I, H. E. Diller. Foundry, vol. 49, no. 15, August 1, 1921, pp. 595–601, 10 figs. Description and illustration of process.

Scullin Steel Co. Steel Rolling Mills of the Scullin Steel Company at St. Louis, Mo. (Les Laminoirs de l'Aciérie de la Scullin Steel Company à Saint-Louis, Missouri, E.-U.). Le Génie Civil, vol. 79, no. 1, July 2, 1921, pp. 1–5, 7 figs. Detailed description of plant and equipment.

ROOF TRUSSES

Design. Basic Principles for the Design of Arched Roof Trusses without Tie Rods (Entwurfsgrundlagen für zweistielige Bogenhallenbinder ohne Zugband), Otto Fröhlich. Beton u. Eisen, vol. 20, no. 2–3, Feb. 4, 1921, pp. 34–38, 7 figs. Tables and calculations supplementing those for arched roof trusses with tie rod developed by author and published in same journal (nos. 9–10, 1919).

ROPE DRIVE

Grünig Pulley. The Grünig Single-Groove Rope Driving Pulleys (Die einrillige Seiltreibscheibe nach dem Patente des Ing. Albert Grünig), Gustav Ryba. Montanistische Rundschau, vol. 13, nos. 11, 12 and 13, June 1, 16 and July 1, 1921, pp. 203–206, 225–228 and 247–249, 10 figs. Points out disadvantages of multiple driving pulleys and describes principles and construction of Grünig's patented single-groove pulley.

S

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SEAPLANES

Types. Hydroplanes (Les Appareils Marins d'Aviation), Guitton. L'Aéronautique, vol. 3, no. 25, June 1921, pp. 229–231, 1 fig. Describes the Bréguet Caudron, Savoia and Farman types.

SEMI-DIESEL ENGINES

Small Central Stations. Semi-Diesel Engines in Small Central Stations, W. S. Barnes. Power, vol. 54, no. 3, July 19, 1921, pp. 96–97, 2 figs. Describes 250-hp. engine direct-connected to an alternator. Typical log sheet covering 24-hr. period of operation shows remarkably high fuel economy at varying loads as well as over-all economy.

SHAFTS

Critical Speeds. On the Critical Velocity of Shafts (Sulle Velocita Critiche Degli Alberi), Pietro E. Brunelli. L'Industria, vol. 35, no. 12, June 30, 1921, pp. 269–272, 4 figs. Mathematical calculations for various given conditions.

Large, Straightening. Straightening a Large Shaft by the Heat Process, Frank G. Frost. Proc. La. Eng. Soc., vol. 7, no. 2, Apr. 1921, pp. 85–91, 2 figs. Details of straightening a shaft of a vertical Curtis turbo-generator in a New Orleans generating station.

SHEARS

Heavy. Heavy Shears Without Flywheel (Schwere Blechschere ohne Schwungrad). Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 28, July 9, 1921, pp. 744–746, 6 figs. Details of shears built by Thyssen & Co. Corp. Machine Works, Mulheim, cutting plates up to 45 mm. thick and 3000 mm. wide out of steel with tensile strength of 700 kg. per sq. mm. Advantages over shears with flywheel.

SLAG

Blast-Furnace. Color Classification of Blast Furnace Slags, Wallace G. Imhoff. Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 433–434. Scientific investigation on nature of slag itself; color classification of slags of value to blast-furnace men. (To be continued.)

SPRINGS

Flat. Design of Flat Springs, Joseph Kaye Wood. Am. Mach., vol. 55, no. 2, July 14, 1921, pp. 46–49, 5 figs. Importance of "spring criterion." Derivation of formulas. Triangular-shaped flat springs. Work and resilience in cantilever springs.

Helical. A Chart for the Design of Helical Wire Springs, R. Brooks. Engineering, vol. 112, no. 2900, July 29, 1921, pp. 173–175, 9 figs. Expressions are developed on which diagrams are built up, and from these the complete proportions of a spring to meet any required specification can be determined with practically no calculation.

STANDARDIZATION

Holland. Standardization in Holland (Normung in Holland), Ernst Hijmans. Betrieb, vol. 3, no. 19, June 25, 1921, pp. 582–595, 12 figs. Discussion of fundamental principles underlying standardization in Holland. Examples of standard sheets.

German N.D.I. Reports. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 19, June 25, 1921, pp. 283–292, 16 figs. Proposals of Board of Directors for studs with journal ends; screw-end pins; set screws with various kinds of points; hexagonal cap screws, etc. Proposed new standards for round-head, flat and oval-head countersunk head machine screws with rolled threads.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 17, May 25, 1921, pp. 247–255, 12 figs. Proposal of Board of Directors for drawings; shank and sleeve tapers; chamfering and grooving; 45-deg. Y-branches, offsets and double Y-branches; basement sink-water traps. Proposed standards for drawings for helical, spiral and laminated springs; hoisting chains, both calibrated and uncalibrated.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 18, June 10, 1921, pp. 259–266, 7 figs. Proposal of Board of Directors for universal joints and shafts therefor. Proposed new standards for indicator cocks; metal screw inserts for insulated handles; solid insulated handles and knobs.

STEAM-ELECTRIC PLANTS

Fuel Economy. Cutting Coal Consumption a Third. Elec. Ry. Jl., vol. 58, no. 7, August 13, 1921, pp. 232–237, 10 figs. Describes improvements made in the power plant of Wilmington and Philadelphia Traction Co.

STEAM POWER PLANTS

Candy Factory. Power for Candy Making. Power Plant Eng., vol. 25, no. 15, August 1, 1921, pp. 743–747, 6 figs. Robt. A. Johnston Co.'s plant in Milwaukee. Installations of power-generating, refrigerating and air-conditioning equipment.

Modern Type. New Plant of the Continental Motors Corporation. Power Plant Eng., vol. 25, no. 16, August 15, 1921, pp. 789–796, 13 figs. Discusses coal- and ash-handling equipment, the boiler room, turbine room, auxiliaries and instruments.

STEAM TRAPS

Sugar Factories. Meditations on Trapology—III, J. O. Frazier. Int. Sugar Jl., vol. 23, no. 271, July 1921, pp. 382–385, 1 fig. The role of the steam trap in the sugar factory. (To be continued.)

STEAM TURBINES

Critical Speeds. The Calculation of Critical Speeds. Engineering, vol. 112, no. 2896, July 1, 1921, pp. 1–2, 3 figs. Discusses Bauman's rule for critical speed of turbine rotors.

High-Capacity. Steam Turbines for Limit Performances (Die Dampfturbinen für Grenzleistungen), A. Loschge. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 28, July 9, 1921, pp. 739–744, 10 figs. Development of the limit-performance turbine; influence of low-pressure blading on limit output. Calculation of strength of blades; limits of maximum capacity. Different construction types. Significance of super-critical velocity of steam.

Modern Types. Recent Advances in Steam Turbine Design, Gerald Stoney. Elecn., vol. 86, no. 2249, June 24, 1921, pp. 774–780, 14 figs. Details of various modern types. Notes on high-vacuum difficulties; disadvantages of higher blade speeds; effects of high steam temperature; bending troubles; blading material; advantages of Monel metal; etc.

STEEL

Artificial Seasoning. Artificial Seasoning of Steels, H. J. French. Chem. & Metallurgical Eng., vol. 25, no. 4, July 27, 1921, pp. 155–158. Review of available data on length changes and spontaneous generation of heat in hardened steels, together with results of preliminary experiments on artificial seasoning by different methods of several types of steels used for making limit gages.

Cold-Drawn. Production and Uses of Cold-Drawn-Steel, C. E. Bregenzer. Iron Age, vol. 108, no. 3, July 21, 1921, pp. 135–136, 1 fig. Annual output estimated at 900,000 tons. Automobile field largest consumer.

Motor-Valve. Steels for Internal-Combustion Motor Valves—II, G. Gabriel. Automotive Mfr., vol. 43, no. 3, June 1921, pp. 16–17 and 26–27. Details of various steels tested and results obtained. Enumeration of desirable and undesirable properties. Kinds of steel recommended.

Low-Carbon, Forging Tests with. Forging Tests with Low-Carbon Steel (Schmiedeversuche an Flusseisen), Paul Junkers. Stahl u. Eisen, vol. 41, no. 20, May 19, 1921, pp. 677–687, 23 figs. Results of tests with two grades of low-carbon steel containing 0.13 and 0.50 per cent carbon respectively, carried out for purpose of determining influence of reduction of cross-section and of forging temperature on mechanical properties and structure; also resistance of iron to deformations at different temperatures.

Nitrogen in. An Occurrence of Nitrogen in Steel, A. A. Blue. Iron Age, vol. 108, no. 1, July 7, 1921, pp. 1–5, 20 figs. Effect of gases on a light forging left accidentally in a furnace flue. Critical analysis of resulting structures.

Overstrain. Effect of Overstrain on the Elastic Properties of Steel. Iron & Coal Trades Rev., vol. 103, no. 2785, July 15, 1921, pp. 73. (From R. D. Report No. 45, Research Dept. at Woolwich.) Gives a summary of tests carried out with overstrained steels.

Pickling, Effect of. Embrittling Effect of Pickling Upon Carbon Steel, C. J. Morrison. Iron Age, vol. 108, no. 6, Aug. 11, 1921, pp. 334–335, 3 figs. Study of grain sizes shows that pickling increases width of junction lines between grains.

Properties and Mibrostructure. Properties and Miscrostructure of Heat Treated Nonmagnetic, Flame, Acids add Rust Resisting Steel, Charles M. Johnson. Trans. Am. Soc. Steel Treating vol. 1, no. 10, July 1921, pp. 554–575, 47 figs. Describes certain unusual properties of steel produced as result of author's study of steels. Photomicrographs.

Properties at High Temperatures. Investigation of the Mechanical Properties of Steels at High Temperatures (Recherches expérimentales sur les propriétés mécaniques des aciers aux températures elevées), Eugene Dupuy. Révue de Métallurgie, vol. 18, no. 6, June 1921, pp. 331–365, 39 figs. Detailed study of fracture and elongation, giving experimental results.

Specifications. Proposed Revised Specifications for Steel Products. Blast Furnace & Steel Plant, vol. 9, no. 8, August 1921, pp. 498–505. Abstract of recent report of committee of American Society for Testing Materials covering steel rails, steel pipe, boiler and superheater tubes.

Tool. The Oxidation of Carbon Tool Steel on Heating in Air, Howard Scott. Chem. & Metallurgical Eng., vol. 25, no. 2, July 13, 1921, pp. 72–74, 9 figs. Results of experiments show that below 850 deg. cent. and for period up to five hours there is no appreciable decarbonization—that is, scaling at least keeps space with decarbonization.

[See also MOLYBDENUM STEELS; NICKEL STEEL; STEEL, HIGH-SPEED; STRUCTURAL STEEL.]

STEEL CASTINGS

Centrifugally Cast. Tests of Centrifugally Cast Steel, George K. Burgess. Techn. Papers Bur. Stand., no. 192, 22 pp., 9 figs. Six castings were examined as to their physical and chemical properties, showing the possibility of substituting heat treatment for forging in this type of casting.

Green-Sand. Steel Castings Made in Green Sand, W. H. Roesner. Foundry, vol. 49, no. 14, July 15, 1921, pp. 552–554, 5 figs. When proper precautions are observed steel castings poured in this medium are said to present as pleasing an appearance as any gray iron or malleable castings.

STEEL, HEAT TREATMENT OF

Factors Governing. Factors Governing the Production of Heated Products, J. A. Brown. Trans. Am. Soc. Steel Treating, vol. 1, no. 10, July 1921, pp. 575–587. Summary of factors to be considered.

STEEL, HIGH-SPEED

Manufacture. The Manufacture of High Speed Steel, Felix Kremp. Official Proc. Central Ry. Club, vol. 29, no. 3, May 1921, pp. 1042–1046 and (discussion) pp. 1046–1051. Details of manufacture.

STEEL WORKS

England. The New Darnall Works of Messrs. Davy Brothers, Limited. Iron & Coal Trades Rev., vol. 102, no. 2782, June 24, 1921, pp. 841–843, 5 figs. Details of new works for manufacture of steelworks plant and boilers, the Davy patent high-speed forging press, modern rolling-mill plant, and accessories.

Power Plant for. Modern Steel Works Power Plant, W. N. Flannigan, Part III. Blast Furnace & Steel Plant, vol. 9, no. 8, August 1921, pp. 510–514. Considers the questions of efficiency and possibilities of saving.

STRUCTURAL STEEL

Plant. Design of Structural Steel Plant of 5000-Ton Capacity, W. D. Coulter. Can. Engr., vol. 41, nos. 2 and 3, July 14 and 21, 1921, pp. 7 and 11 and 9–10, 5 figs. Layout of plant and buildings; types of buildings and equipment.

SUPERHEATERS

Marine and Locomotive. Superheaters and Fuel Economy—XII. Machy. Market, no. 1078, July 1, 1921, pp. 21–22, 3 figs. Marine and locomotive superheaters.

Performance. Superheaters and Superheat, A. D. Pratt. Mech. Wld., vol. 70, no. 1803, July 22, 1921, pp. 61–63. Discusses safety-valve equipment, superheater performance and variable combustion conditions.

SWAGING MACHINES

Band-Saw. Swaging and Side-Dressing Machine for Band Saws. Engineering, vol. 112, no. 2900, July 29, 1921, pp. 186 and 188, 9 figs. Machine constructed by A. Ransome & Co., Ltd., Newark-on-Trent, England, can deal with saws from 3½ in. to 8 in. wide and with teeth from 1¼ in. to 2½ in. pitch. It is entirely automatic in operation and works at rate of 20 teeth a minute.

T

TAR OILS

Low-Temperature. Uses for Low-Temperature Tar Oils, F. P. Coffin. Gas Age-Rec., vol. 48, no. 3, August 6, 1921, pp. 97–100, 5 figs. Considers creosote and light motor fuel oils.

TEMPERATURE MEASUREMENT

Instruments for. The Measurement of Temperature—XII, P. Field Foster. Mech. World, vol. 70, no. 1801, July 8, 1921, pp. 32–33, 6 figs. Details of Carpenter-Stansfield deflection potentiometer; and thermocouple indicator made by Foster Instrument Co. Describes several industrial applications of thermocouple pyrometers and methods of mounting. (Continuation of serial.)

TESTING MACHINES

Bar. Testing Machine Helps, R. W. Allard. Iron

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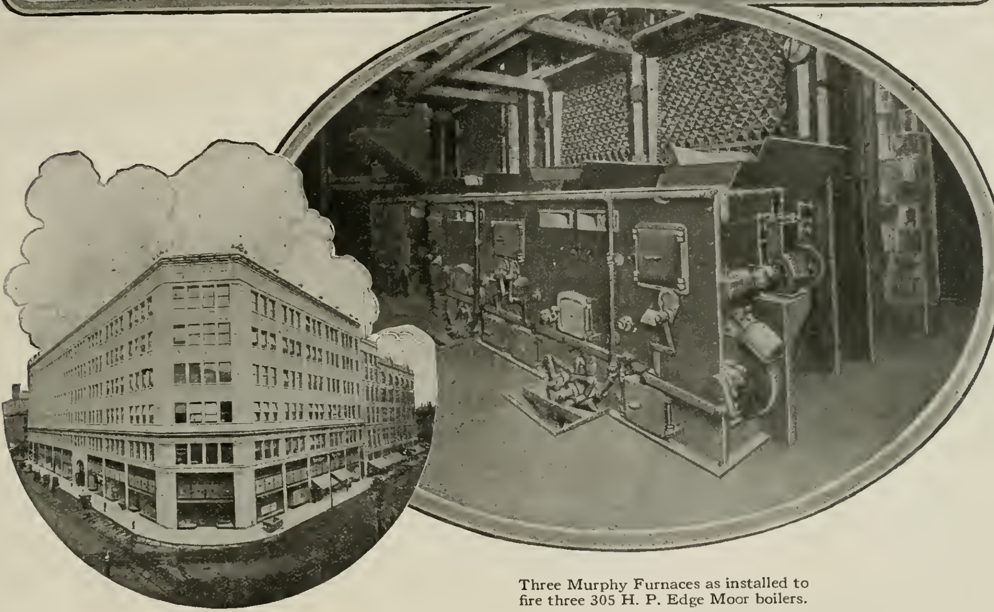

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ENGINEERING INDEX (Continued)

Age, vol. 108, no. 2, July 14, 1921, p. 87, 1 fig. Compiling table to translate pounds on test bar into pounds per square inch.

Brinell Hardness. The Brinell Test. Machy. (Lond.), vol. 18, no. 459, July 14, 1921, pp. 459–461, 3 figs. Describes two new machines, a power-operated hardness and a small ball hardness testing machine.

The Brinell Testing Machine. Some of Its Uses, Alfred Herbert. Can. Machy., vol. 26, no. 1, July 7, 1921, pp. 75 and 76. Points out advantage of its use for very soft steels, case-hardening steels, non-ferrous alloys, etc.

TEXTILE INDUSTRY

Felt-Manufacturing Machinery. True or Pressed Felt Manufacturing, J. A. Butler. Textile World, vol. 60, no. 3, July 16, 1921, pp. 27–29, 3 figs. Particulars of machines and processes employed.

Winding and Warping Machinery. New Winding and Warping Machinery. Textile World, vol. 60, no. 3, July 16, 1921, pp. 33 and 59, 5 figs. Yarn wound into large cheeses; warping speed 500 to 600 yards per minute. Automatic features.

TEXTILE MILLS

Steam Plant. The Hamilton Plant of the Canadian Cottons Ltd., T. H. Fenner. Power House, vol. 14, no. 14, July 20, 1921, pp. 21–25, 7 figs. Steam plant installed to supply steam for process work and heating.

Ventilation. The Ventilation and Humidification of Textile Factories, H. N. Leask. Engineering, vol. 112, no. 2900, July 29, 1921, pp. 202–204, 2 figs. Describes apparatus designed by A. B. Cleworth to meet all requirements of constancy of humidity and ventilation, etc. Presents chart showing average monthly temperatures in weaving shed. Paper read before Rochdale Cotton Spinners' Mutual Improvement Soc.

THERMIT WELDING

Pipe Joints. Thermit Welded Pipe Joints, R. L. Browne. A.S.R.E. Jl., vol. 7, no. 6, May 1921, pp. 452–457 and (discussion) pp. 457–459, 4 figs. Gives results of tensile and bursting tests, and vibration tests.

THERMODYNAMICS

Definition. Critical Discussion of the Traditional Definition of Thermodynamics (Kritische Betrachtungen zur traditionellen Darstellung der Thermodynamik), M. Born. Physikalische Zeit., vol. 22, nos. 7, 8 and 9, Apr. 1, 15 and May 1, 1921, pp. 218–224, 249–254 and 282–286, 3 figs. Deals with work by C. Carathéodory entitled Investigations of the Fundamental Principles of Thermodynamics, published in Math. Annalen (vol. 61, p. 355, 1909), of which, author claims, too little is known among physicists. Points out importance of work for explaining fundamental conceptions and as a basis for instruction.

TIDAL POWER

France. Project For Utilizing the Tides in the Bay of Rothéneuf [Project of Utilisation des Marées dans la Baie de Rotheneuf (Ille-et-Vilaine)], Ch. Dantin. Le Génie Civil, vol. 79, no. 5, July 30, 1921, pp. 102–106, 9 figs. Discusses tide conditions and proposed turbo-alternator equipment, cost of power, etc.

Utilization. Utilizing the Power of the Tides (Utilisation de l'Énergie des Marées), M. Boisnier. Annales des Ponts et Chaussées, vol. 62, 11th Series, May-June 1921—III, pp. 297–396, 13 figs. Discusses means and methods of accumulating and using the power, also in connection with railway electrification.

Industrial Use of the Power of Tides (L'Utilisation Industrielle de la Force des Marées), Henri Fischer. Bulletin de la Société Industrielle de Mulhouse, vol. 87, no. 3, Mar. 1921, pp. 169–181, 3 figs. Describes the Parisot system.

TIMBER

Waste Elimination. Industrial Timber Research Abroad and In South Africa, Nils B. Eckbo. So. African Jl. Ind., vol. 4, no. 6, July 1921, pp. 534–539, 6 figs. Concentrates on elimination of wastes and improved utilization of forest products.

TIME STUDY

Watch for. Time Study Watch That Records Number of Operations Performed in One Hour. Coal Age, vol. 20, no. 2, July 14, 1921, p. 52, 1 fig. Describes new duration time-study watch for timing, analysis and observation of from one to ten operations up to including five minutes of duration.

TIRES, RUBBER

Durability. Determining Factors for the Life of a Pneumatic Tire, William G. Nelson. Chem. & Metallurgical Eng., vol. 25, no. 4, July 27, 1921, pp. 153–154. Discusses five factors, namely, rubber and compounding materials, fabric, construction, vulcanization and usage. Causes for premature failures of tires.

Fabric for. A Brief Analysis of Tire Fabric Manufacture, H. R. Whitehead. India Rubber World, vol. 64, no. 5, August 1, 1921, pp. 814–816, 10 figs. Discusses picking, carding, combing, drawing, slubbing, warping and twisting, weaving.

Pneumatic. Dynamic Balance and Construction of the Pneumatic Tire, William Roberts. India Rubber World, vol. 64, no. 5, August 1, 1921, pp. 811–813, 9 figs. Considers variables in tire construction, proper bead location, assembling threads and gives a formula for figuring weight of cured and uncured thread.

The Determining Factors for the Life of a Pneumatic Tire, William G. Nelson. India Rubber World, vol. 64, no. 5, August 1, 1921, pp. 806–808. Considers the five factors, rubber and compounding materials, fabric, construction, vulcanization and usage.

TOOLROOMS

Puget Sound Navy Yard. Caring for Tools at Puget Sound Navy Yard. Am. Mach., vol. 55, no. 3, July 21, 1921, pp. 94–96, 7 figs. Central tool-grinding room. Novel system of sliding racks for storing milling cutters. Cleansing and lubricating pneumatic tools.

TRACTORS

Caterpillar. Tractors in the Oil Fields, Earle W. Gage. Oil Field Eng., vol. 23, no. 7, July 1921, pp. 66, 1 fig. Gives particulars of successful application of caterpillar type of tractor.

Lubrication. Tractor Lubrication, J. W. Stack. Part II. Sci. Lubrication, vol. 1, no. 6, June 1921, pp. 9–14, 12 figs. Discusses lubrication as applied to internal-combustion-motor-propelled units. (Concluded.)

TRAILERS

Clay-Products Industry. Use of Trailer Saves Motive Power, Gilbert I. Stodola. Brick & Clay Rec., vol. 59, no. 1, July 12, 1921, pp. 35–38, 6 figs. Application of trailer and semi-trailer in clay-products industry for distribution of clay ware.

TRUSSES

Stress Determination. Theory of Structures, Ernest W. Dibley. Commonwealth Engr., vol. 8, no. 11, June 1, 1921, pp. 328–329, 9 figs. Describes a method for determining by inspection the nature of stresses in the members of trusses for dead and uniformly distributed live loads.

TUBES

Seamless. On the Manufacture of Seamless Tubes—IV, Karl Gruber. Blast Furnace and Steel Plant, vol. 9, no. 7, July 1921, pp. 442–444, 6 figs. Seamless tube rolling in Germany, with special consideration of Mannesman pilgrim-step rolling mill.

U

U. S. BUREAU OF STANDARDS

War Work. War Work of the Bureau of Standards, U. S. Dept. of Commerce Bur. of Standards, no. 46, Apr. 1, 1921, 299 pp., 35 figs. Short descriptions of more important work carried on during war which was of direct service to military forces. Deals with aeronautic instruments and power plants; aircraft construction, materials, etc.; chemical investigations; coke-oven investigations; concrete ships; electric batteries; electric tractors and trucks; precision gages; illuminating engineering; invisible signaling; magnetic investigations; metallurgical investigations; natural-gas investigations; optical glass and instruments; protective coatings; radio communication; radium; rubber; searchlights; sound-ranging apparatus; wheels; X-rays, etc.

V

VIBRATION

Measurement. Measurement of Vibration of the 660-ft. Wireless Telegraph Station Tower at Haranomachi, F. Omori. Engineering, vol. 112, no. 2900, July 29, 1921, pp. 196–199, 13 figs. Results of measurement of movement of tower caused by winds carried on during course and after completion of construction on five different occasions.

VISCOSITY

Effect on Orifice Flows. The Effect of Viscosity on Orifice Flows, W. N. Bond. Physical Soc. Lond. Proc., vol. 33, part 4, June 15, 1921, pp. 225–230, 2 figs. Results of determinations are plotted in manner which combines both purely viscous and purely turbulent flows in one graph. It is shown that effect of slight viscosity is to increase coefficient of discharge.

W

WAGES

Incentive vs. Production Basis. Incentive or Production Basis of Wage Payment—I and II, Henry Farquhar. Am. Mach., vol. 55, nos. 5 and 7, Aug. 4 and 18, 1921, pp. 169–172 and 275–277, 1 fig. Aug. 4: Constructive preparation necessary; effect of working conditions on mental attitude; elements of scientific management; determining standard production time. Aug. 18: Reward for standard accomplishment; variations in types of incentive; aristocracy of skilled labor; individual and group reward.

Wage-Level Formula. Past and Future Wage Levels, Halbert P. Gillette. Eng. & Contracting, vol. 56, no. 5, August 3, 1921, pp. 97–101, 2 figs. Develops a wage-level formula for which he concludes that during the past 30 years the per capita bank deposits have increased twice as rapidly as per capita money.

WAR DEVASTATION

Metallurgical Works, France. Destruction of the Works of the Compagnie Métallurgique Franco-Belge at Mortagne (La Destruction des Usines de la Compagnie Métallurgique Franco-Belge de Mortagne), Marchal. Révue de Métallurgie, vol. 18, no. 5, May 1921, pp. 261–263, 4 figs.

Destruction of French Metallurgical Works by the Germans During the War (Les déprédations et destructions commises par les Allemands aux Usines de Givet de la Compagnie francaise des Métaux pendant la guerre de 1914–18), A. Mercier des Rochettes. Révue de Métallurgie, vol. 18, no. 5, May 1921, pp. 247–259, 17 figs.

WASTE HEAT

Utilization. The Utilization of Waste Heat in Gasworks, George E. Stewart. Engineering, vol. 112, no. 2897, July 8, 1921, pp. 77–78. Notes on carbonization, water gas manufacture, and waste heat boilers. Paper read before Instn. Civ. Engrs.

WATER

Viscosity. Viscosity of Water at Low Rates of Shear, Albert Griffiths. Physical Soc. Lond. Proc., vol. 33, part 4, June 15, 1921, pp. 231–242, 4 figs. Determination by method in which water is forced along glass capillary tubes of about 1.5 to 2 mm. bore at rates of flow varying from 1 liter in two years to 1 liter in 24 years.

WATER POWER

Canada. Available Water Power in Canada. Can. Engr., vol. 41, no. 1, July 7, 1921, p. 1. Figures recently compiled by Dominion water-power branch.

Development. Water Power Development, W. E. Williams. Beama, vol. 9, no. 1, July 1921, pp. 19–24, 7 figs. Notes on survey of a catchment area; artificial reservoirs; and linking up of hydroelectric stations.

Germany. The Development of German Water Powers (Der Ausbau unsrer Wasserkräfte). Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 26, June 25, 1921, pp. 687–697, 3 figs. Notes on developments in Bavaria, Southwest Germany, Harz and Silesia. Water power in France.

Montana. Hydro-Electric Possibilities in Montana, E. W. Kramer. Elec. World, vol. 78, no. 3, July 16, 1921, pp. 111–115, 5 figs. Total water power available placed at approximately 1,000,000 hp., of which 225,000 hp. has been developed. Study of four principal watersheds showing possible developments of over 10,000 hp.

Rhone River. Utilization of the Water Power of the Rhône (L'aménagement des forces motrices du Rhône), L.-D. Fourcault. L'Electricien, vol. 52, no. 1280, July 15, 1921, pp. 313–314, 1 fig. Details of project recently adopted.

Undeveloped. Probable Water-Power Developments. Elec. World, vol. 78, no. 5, July 30, 1921, pp. 219, 6 figs. Tabulation of the undeveloped water powers of over 10,000 hp. by drainage basins.

Utilization. Contribution to the Study of the Determination of the Hydraulic System of a Basin in Terms of Its Rainfall. (Contribution à l'étude du ruissellement et à la détermination du régime hydraulique d'un bassin en fonction de sa pluviosité), Aimé Coutagne. Revue Générale De L'Electricité, vol. 9, no. 25, June 18, 1921, pp. 885–893, 5 figs. Technical study. Application of conclusions derived from central region of France. (To be continued.)

The Employment of Water Power in the Development of the Mineral Industry, John Evans. Engineering, vol. 112, no. 2897, July 8, 1921, p. 76. Past developments and future possibilities. Paper read before Instn. Civ. Engrs.

WATER SOFTENING

Cold Lime-Soda Process. Water Softening by the Cold Lime-Soda Process, George C. Cook. Power, vol. 54, no. 3, July 19, 1921, pp. 92–94. How boiler priming and scale formation may be prevented by simple chemical treatment. How to conduct tests for causticity and alkalinity in feedwater.

WATER TANKS

Elevated. Auxiliary Equipment for Elevated Water Tanks, Charles L. Hubbard. Power Plant Eng., vol. 25, no. 14, July 15, 1921, pp. 703–706, 8 figs. Methods employed to prevent the freezing of water tanks and riser.

WELDING

See AUTOGENOUS WELDING; ELECTRIC WELDING; ELECTRIC WELDING, ARC; FUSION WELDING; OXY-ACETYLENE WELDING; THERMIT WELDING.

WELFARE WORK

Employees' Mutual Benefit Associations. Mutual Benefit Associations in Industry, Frederick A. Anderson. Power Plant Eng., vol. 25, no. 16, August 15, 1921, pp. 798–802, 3 figs. Outlines the principles on which such an organization should be organized.

WIND TUNNELS

Compressed Air for. A New Type of Wind Tunnel Max Munk. Aviation, vol. 11, no. 6, August 8, 1921, pp. 162–163. (Abstract from N.A.C.A. Technical Note No. 60.) Discusses the use of compressed air in wind tunnels, its advantages and difficulties.

WINDING ENGINES

Graphical Dynamics. The Graphical Dynamics of a Winding Engine—I, Charles D. Mottram. Colliery Guardian, vol. 121, no. 3155, June 17, 1921, pp. 1733–1734, 8 figs., and vol. 122, no. 3157, July 1, 1921, p. 30, 3 figs. Apportionment of external losses in a large steam winding engine at Yorkshire Main Colliery, Doncaster. Determination of hp. developed in raising load only; hp. expended in wind resistance.

Modern. Modern Winding Engines—IX, M. Corliss. Mech. World, vol. 70, no. 1801, July 8, 1921, pp. 29–30. Brake gears. (Continuation of serial.)

MECHANICAL ENGINEERING

Volume 43 November, 1921 Number 11

Steam-Condensing Plants

A Detailed Consideration of the Fixed and Operating Charges in Surface-Condenser Installations, and Description of a New Type of High-Efficiency Condenser

By PAUL A. BANCEL,[1] NEW YORK, N. Y.

THE heart of a power plant lies in the boiler room, and the most important aspect of the condensing plant is in its relation to boiler-room costs. The choice of a condenser may be said to rest largely on its influence in reducing boiler-room charges. As indicated in Fig. 1, it would pay to run condensing if coal cost nothing; and pay even more, if the boiler feed was poor or expensive, to install the costliest of condensers—the surface type. With pure feedwater there is less fuel loss and boiler-maintenance charges, and, what is of still greater importance, boilers may be driven at higher ratings with consequent further reductions in first costs and fixed charges.

The designer of a power house is in a quandary—flying from boiler evils to condenser evils, and often with hesitancy as to which are the less serious. The problem is one of balancing fixed and operating charges in the boiler room against similar charges in the condensing plant.

Fixed Charges

The fixed charges against a surface-condensing plant depend on—

a Vacuum desired, which influences the size and cost of the equipment

b Cost of tube replacement, which depends on amount of tube surface in any particular design and life of the tubes as influenced by water conditions and condenser design

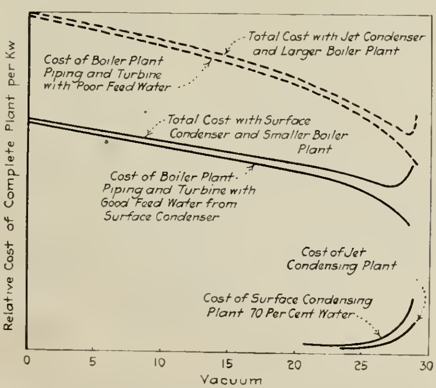

Fig. 1 Relative First Cost of Steam Power Plant at Different Vacuums

c Power for the auxiliaries, which increases if the cost and fixed charges are reduced.

Vacuum. In Fig. 2 the curve 0-0-0 shows the absolute back pressures at the turbine exhaust which might be expected from a cycle of water temperatures and a certain investment in condenser. Frequently the design of the turbine is such and the water temperatures in the winter are so low that for certain winter periods a vacuum is obtained which is better than can be utilized by the turbine. On the other hand, the temperature of the available water supply for three to six months of the summer is 60 to 80 deg., so that the vacuums obtainable are lower than are desirable for maximum turbine economy. Area *C* in Fig. 2 indicates the range of vacuums by investing more or less money.

As will be seen later, extensive calculations in regard to best investment are apt to be misleading because of the reduction in vacuum which so often occurs due to fouling of the tubes. In such instances all other questions become subordinate to that of maintaining high vacuum continuously, under actual operating conditions. In other cases the decision must rest on the relation

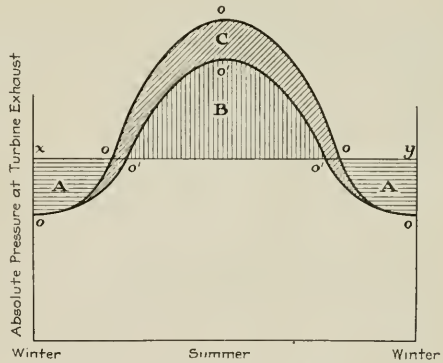

Fig. 2 Cycle of Absolute Back Pressure of Year

Line *x*–*y* represent highest vacuum or lowest desirable exhaust pressure. Areas *A*,*A* represent waste in winter due to excessive vacuum and areas *B* and *C* waste in summer due to warm water and insufficient vacuum. Area *C* indicates improvement possible by investing more money.

of load factor, months of the year having hot water and the fixed charges and operating charges at different vacuums.

Cost of Tube Replacement. This can be set up as a yearly depreciation reserve. The life of a condensing plant might be 20 years, whereas the tube life might be only five. On a 10,000-kw. turbine this might necessitate the purchase every five years of tubes costing about $10,000. Thus in determining the best vacuum the item of tube renewals may have a preponderating influence. Furthermore, as between two condensers for the same vacuum, one of which requires less tubes than the other, it is manifest that the fewer the tubes the less the fixed charges.

Similarly, the longer the tube life the smaller the fixed charges and cost of power. In one plant the tube life might be five years and in others a great deal more or a great deal less. Tube life depends on the character of the water supply, on the chemical, physical and metallographic properties of the tubes (crystalline structure) and it also depends on the design of the condenser. The latest report of the Corrosion Committee of the Institute of Metals, London, summarizes the types of condenser-tube corrosion, principally general thinning, pitting and apparent dezincification. The fourth and fifth reports of this Corrosion Committee are exhaustive studies of the subject, and among other causes

[1] Ingersoll-Rand Company, New York, N. Y., Jun. Am.Soc.M.E.

Presented at a meeting of the Baltimore Section of The American Society of Mechanical Engineers, May 16, 1921. Slightly abridged.

emphasize the effect on corrosion of low velocity and high temperature.[1]

Velocity has a direct effect on corrosion. Low velocity allows the deposit of foreign matter in the tubes which forms obstructions around which the products of corrosion accumulate in concentrated form, with the resultant pitting. High water velocity keeps the tubes clean and eliminates this form of corrosion.

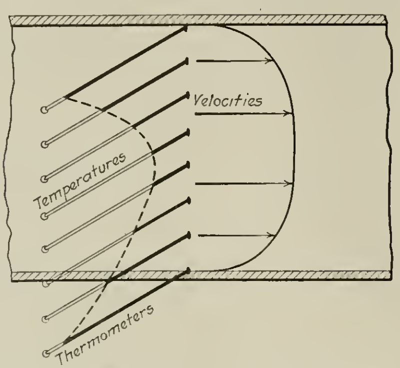

Fig. 3 Influence of Water Velocity and Tube Diameter on Temperature Distribution

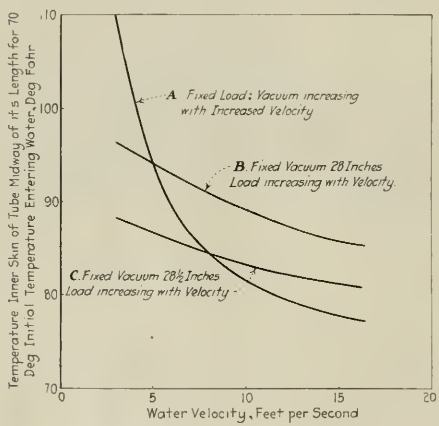

Fig. 4 Relation of Skin Temperature to Water Velocity at Different Loads and Vacuums

High temperature accelerates corrosion of all types and so seriously that a temperature of 95 deg. fahr. is recommended as the maximum. There are three ways of reducing temperatures in order to alleviate corrosion: by increasing the water quantity, thus decreasing the overall rise; second, by eliminating hot spots and local overheating of tubes; third, by increasing water velocity or decreasing tube size, thus decreasing the skin temperature at the tube wall. The first of these needs no comment. As to the second, it is well known that faulty steam distribution causes excessive heating of the water in some tubes counterbalanced by practically no heating of other tubes. Thus in condensers in which the steam distribution is obtained by lanes, the tubes in the path of the steam heat the water rapidly, but they short-circuit the tubes within the banks. The short-circuited tubes are not only wasted surface, but are the cause of the excessive temperatures in the exposed tubes, which consequently corrode rapidly.

The third method of reducing temperature, higher velocity and smaller tube size, may need explanation. It is well known that more heat is transferred for a fixed area of tube surface and fixed conditions of steam temperature and water temperature, if water velocity is increased or tube diameter reduced. The tube acts as though a colder water supply were being used, and this is exactly what is happening because the water at the walls is really colder. The metal is therefore colder and can abstract more heat in the same time from steam at the same temperature.

The flow of water in a tube is accompanied by cross-currents and whirls which convey the heat from the walls into the body of the water. In Fig. 3, if thermometers were placed as indicated the temperature readings would follow a curve as shown. Increased velocity reduces the temperature at the walls, making the curve flatter. Similarly, using a smaller tube reduces the temperature at the walls and makes the temperature gradient flatter. The inner skin temperature may be approximated from

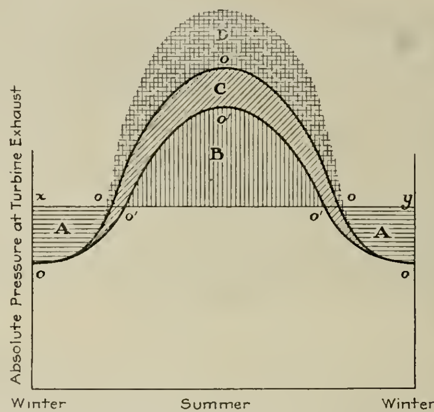

Fig. 5 Cycle of Absolute Back Pressures at Different Seasons
Area D shows increased back pressure or loss of vacuum due to fouling.

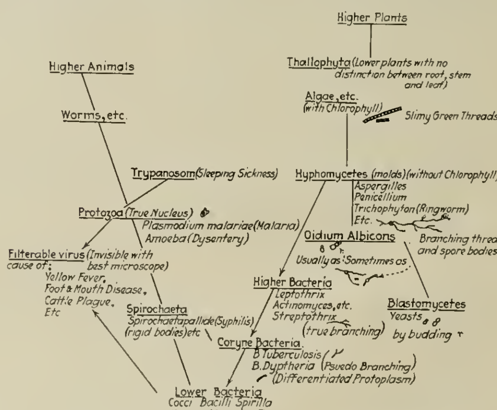

Fig. 6 Forms of Life in Condenser-Tube Slime

various experimental results on heat transmission and curves obtained as in Fig. 4, which shows the relation between the water velocity and this inner skin temperature for conditions of constant load (Curve A) and constant vacuum (Curves B and C). In all cases increasing the velocity reduces this temperature.

In a condenser with proper distribution to avoid hot spots, and with suitable velocity and tube diameter to further reduce skin temperature and prevent foreign deposits, a markedly longer life of tubes will be obtained. As will be seen, too, these features of design result in small initial surface requirements, so that there is a twofold reduction in the fixed charges to take care of replacements.

[1] Jour. Inst. of Metals, vol. 23, p. 76.

Operating Charges

The principal operating charges on a condensing plant may be grouped as follows:

a Reduction of condensate temperature below steam temperature and consequent loss of coal

b Power for operating the auxiliaries

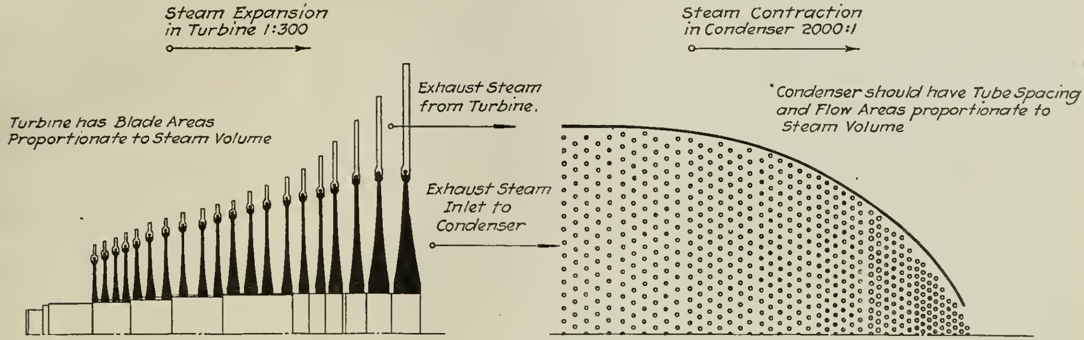

Fig. 7 Comparison of Steam Flow in Turbine and Correctly Designed Condenser

c Reduction of vacuum and increased coal consumption due to scaling and sliming of the tubes

d Cost and time lost to clean the tubes and cost and time lost due to tube failure and consequent pollution of the boiler feed.

Reduction or Depression in Condensate Temperature below steam temperature depends on condenser design and temperature of circulating water, being less with warm water and greater with

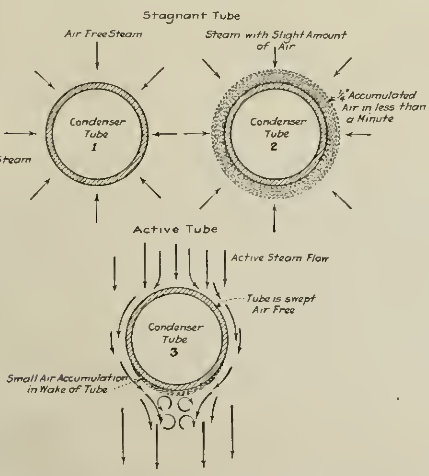

Fig. 8 Importance of Steam Velocity in Preventing Stratification of Air around a Condenser Tube

Stagnant Tube: Condition when steam flow is produced by avidity of tube itself for condensing steam.

Active Tube: Condition when there is active steam flow to sweep tube free of air.

cold water. The water of condensation must fall over successive rows of tubes to reach the bottom and if the steam is not drawn down to the bottom of the condenser, the water will be gradually cooled. The colder the water and higher the vacuum the greater the proportion of idle surface and the colder the condensate. Even in those condensers, in which numerous short-circuiting lanes are provided for the express purpose of securing penetration of the steam, there is a depression of condensate temperature of 5 to 10 deg. in summer and 10 to 20 deg. in winter. Eleven degrees loss of condensate temperature represents 1 per cent loss of efficiency and is equivalent to 300 kw. on a 30,000-kw. machine. In some plants this loss is largely overcome by the installation of preheaters.

Power for Operating the Auxiliaries has already been considered in a sense in the discussion of fixed charges, since the power required for any vacuum is partly dependent on the investment, and may

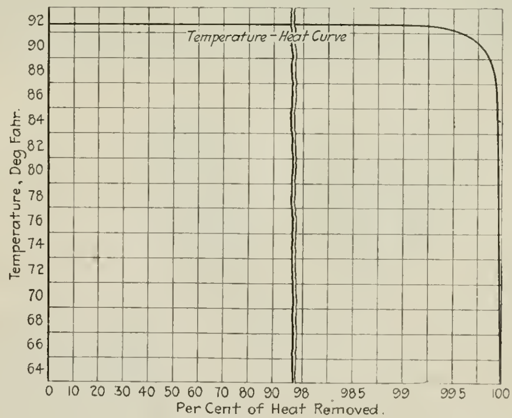

Fig. 9 Relation between Percentage of Heat Removed from a Mixture of Steam and Air and Temperature of the Mixture

Note scale is magnified 40 times at right-hand section of chart for the assumed mixture which is a fair average in high-vacuum condensers; the temperature starts to fall at 99 per cent.

be decreased by increasing the investment and fixed charges. No distinction should be made between the power required for driving condenser auxiliaries and the main power output of the plant, even where the auxiliaries are steam-driven and exhaust to a feed heater. The auxiliary power is a direct charge against the main unit output.

The principal item of power consumption lies in the circulating pump, and this unit is often arranged for variable-speed drive or else is divided into two smaller units, so that with cold water or light load the operating charge may be reduced by slowing down or by shutting down one pump. As shown in Fig. 2, an excessive vacuum is obtainable in the winter and the waste of fixed charges can be partially offset by saving on the circulating-pump power.

The best balance of circulating-pump power in the summer time for conditions of maximum water temperature and full load must be settled after consideration of all the aspects of the problem. By proportioning the condenser for low water velocities the head on the circulating pump may be made low, and the quantity of water used very low with small power requirement for driving the pump. This saving, however, may be counterbalanced by

excessive fixed charges distributed over a relatively small part of the year. Thus suppose the investment were increased $5,000 on a 10,000-kw. unit, and the circulating-pump power reduced by 50 kw. The added fixed charges including tube renewals might be $1000 per year, and if this be charged against the summer months, the rate might be 50 cents to several dollars per hour depending on the number of hours. This would offset 50 kw. For this reason many plants use two pumps in the summer, working under relatively high heads of 30 to 40 ft.

Low pump power with low water velocities may be offset also by increased operating charges due to low vacuum resulting from fouling. Fig. 5 is similar to Fig. 2, except that a shaded portion *D* has been added to indicate the range of vacuum in the summer time under actual conditions of fouling of condenser tubes. As much as an inch of vacuum is lost in a week in some cases, and in one extreme instance there is a loss of an inch in two days. It is unfortunate that the loss by fouling is most severe in the summer when it is most difficult to obtain high vacuum. As a reduction of only $^1/_4$ in. in vacuum represents a loss of $1^1/_2$ to 2 per cent of turbine economy, which may be equivalent to all the auxiliary power, it is readily seen how easily all calculations of exact balance between fixed charges against the condenser and operating charges against the auxiliaries may be disrupted.

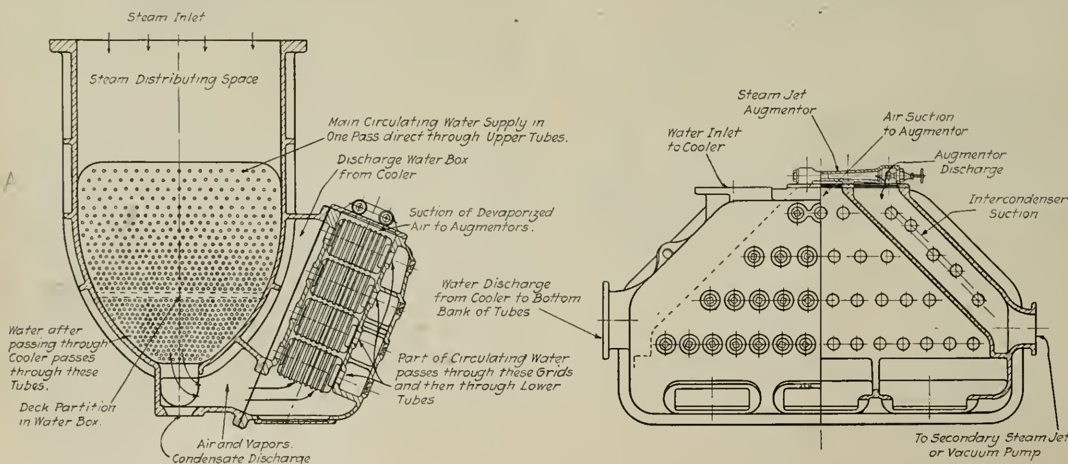

Fig. 10 Cross-Section through Main Condenser and Cooler of Ingersoll-Rand Surface Condenser

Reduction in Vacuum Due to Tube Fouling. The foreign matter that accumulates in condenser tubes may be divided into three classes:

a Mechanical deposits, silt and mud
b Scales deposited out of solution
c Slimes or organic growths.

The first of these is of minor influence in reducing vacuum unless water velocities are low indeed. The ability of a stream of water to carry solid substances in suspension increases rapidly with increase of the velocity. However, foreign matter such as silt, may be deposited in slime coatings which form a more adherent surface than a clean condenser tube.

The second form of deposits is common with salt water and hard waters carrying scale-forming salts, familiar in impure boiler feedwater. In many cases with cooling towers or spray ponds the source of make-up is a relatively hard water and causes deposits of sludge and scales in the condenser tubes. The commonest ingredients of such water are calcium and magnesium carbonate which are soluble in the presence of carbon dioxide. Heating the water drives off the CO_2 and precipitates the carbonates.

The influence of uniform steam distribution, smaller tube size and high water velocity on reducing skin temperatures has already been shown. It is also probable that high velocity has a mechanical effect in reducing the rapidity of such scale formations. In sugar evaporators it is commonly found that the tubes which work actively and therefore contain rapidly rising currents of mixed vapor and juice, scale the least; whereas tubes doing less evaporation foul more heavily.

Where extremely hard waters are encountered it is desirable not only to keep down the temperatures by observing the principles of high skin velocity and activity, but also by using larger quantities of water and smaller overall temperature rise. In this way it is possible as between two condensing plants to reduce the maximum temperature rise of the skin of water in the hottest tubes, 10 or 20 deg., or even more.

Slimes or organic growths are the third form of deposits. Fouling of this character is most severe in the summer time, and is also most severe in hot portions of a condenser with improper steam distribution. Thus, in a condenser with lanes, the tubes in the lanes will be found coated with a thick, heavy slime in a short time, whereas tubes in the short-circuited regions will be but slightly fouled. It is probable that these slimes are organic growths occurring under the ideal conditions of warmth and stagnation existing at the inner skin of the tube. A typical sample of condenser-tube slime was taken a short time ago by the author and given to a bacteriologist for analysis. A large number of hyphomycetes were demonstrated. This form of life is classified between bacteria and plants, as shown in Fig. 6. The hyphomycetes grow rapidly as long microscopic threads (Mycelia), which branch rapidly, forming a dense interlacing network in which all other organic and inorganic elements are caught. They grow better in an acid than an alkaline medium. The hyphomycetes are familiar to us as molds and fungi and are a form of life just below the algæ, which are the green slimes frequently seen in stagnant pools. The algæ contain chlorophyl and require light for their growth, whereas the hyphomycetes grow in the dark. The conditions for rapid growth are moisture, stagnation and a fair warmth. The optimum temperature is between 20 and 40 deg. cent. (68–104 deg. fahr.); when spores are formed they are more resistant to higher temperatures.

There are cases on record of two condensers side by side, one with low velocity the other with high velocity, in which the latter remains cleaner for longer periods. Similarly it is well known that condensers do not lose as much vacuum or have to be cleaned as frequently in the winter as in the summer, and also that those parts of the condenser that are hot foul more rapidly than those where the water is not heated. In one instance a condenser is so large that it is cleaned only part at a time, and when this practice was initiated the operating force found that cleaning the two lower quarters and one upper quarter improved the vacuum very slightly, whereas cleaning the last quarter which was exposed to

the full activity of the steam brought the vacuum back to normal. In this section, the tubes exposed to steam are so heavily fouled that two men are needed sometimes to push the brushes through. The same arrangement of tubes top revent local overheating, and the use of high water velocities to reduce inner skin temperatures and increase the activity and counteract stagnation along the inner wall of the tube, may be expected, therefore, to reduce and eliminate the formation of organic slimes. Corrosion, scaling and sliming can all be reduced by correct proportion of a condenser for high activity of water flow and turbulence at the tube wall and uniform steam distribution, factors which in addition permit of a large reduction in the amount of tube surface.

Fouling adds to the operating charges in another way, as there may be a large labor cost for cleaning. The time loss with a unit out of service is also a considerable item of cost. The charges due to failure of tubes by splitting and corrosion are of a similar nature. The pollution of the condensate and consequent scaling of the boilers from either impure condensate or from raw feedwater adds to the operating charge in the boiler room. The loss of time on the complete power-generating unit required to shut down, locate, and plug the leaking tube adds to the turbine-room operating charges.

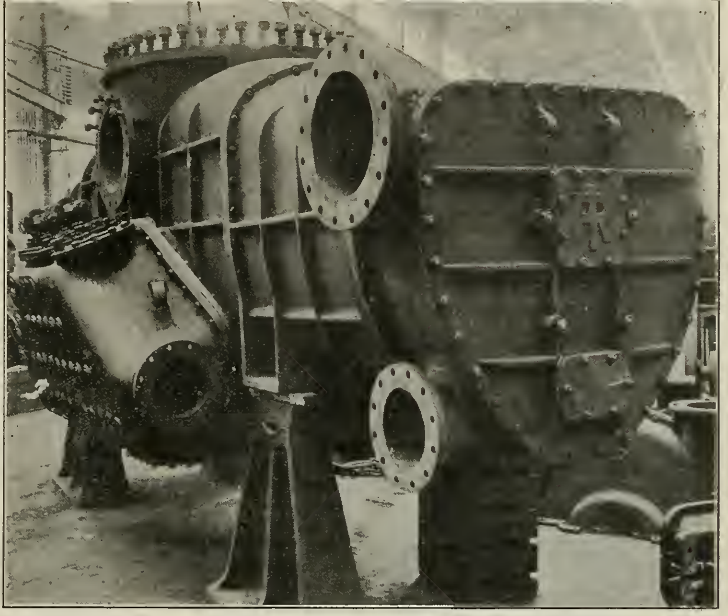

Fig. 12 Ingersoll-Rand Surface Condenser from Inlet Water-Box End
At the left is the cooler, mounted on shell.

Clogging of Tubes. One other loss adding to operating charge is that caused by clogging of tubes by accumulation of miscellaneous solid substances against the tube sheet. This applies only to plants using natural water supplies. With spray ponds the nozzles clog long before the condenser tubes. Clogging can be reduced by proper screening, and the use of flush, well-rounded tube inlets and high water velocities. Low velocities are wanted in the screens, but high velocities and clear inlets into the tubes. The influence of velocity is clearly shown by the tendency in two-pass condensers for the tubes of the return pass to clog with solid matter which originally came through the first pass. This clogging is most noticeable toward the top (where the water is needed most) and is due no doubt to the slow velocities at the top of the return box, which is at the top of the siphon and acts as a skimming tank.

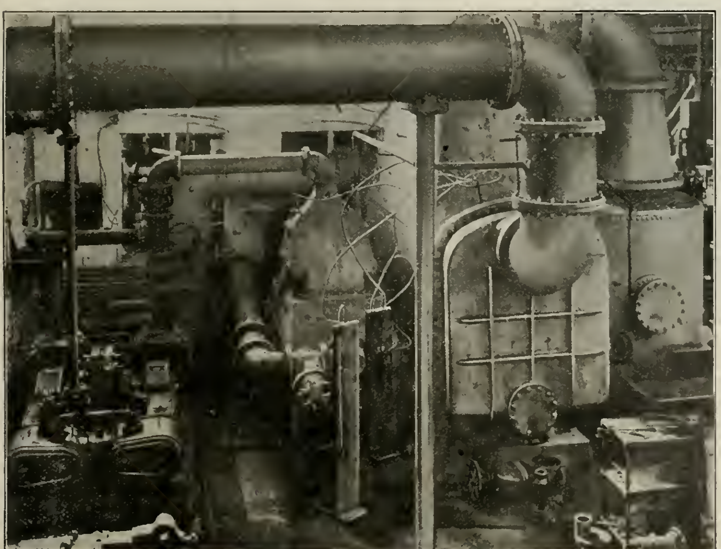

Fig. 11 Large Experimental Surface-Condenser Plant at Works of the Ingersoll-Rand Co., Phillipsburg, N. J.

Condenser Design

The design of a surface condenser to conform with the requirements which have been outlined, lies in the proper application of certain well-known principles. The first of these is to keep all of the tubes uniformly hot on the steam side so that the minimum number will be needed because none is wasted. To accomplish this the steam must be free to flow to all the tubes and over all the tubes, with slight loss of pressure and temperature, the condenser being arranged in stages, much as is a turbine, with large flow areas at the exhaust entrance and great distances between rows to avoid sharp bends and pressure loss. Fig. 7 illustrates the analogy.

Of equal importance in keeping all tubes hot is the proper staging to maintain velocities that will sweep the air ahead in the current of steam and the arrangement of tubes in staggered rows so that none is shielded or pocketed. Air left on a tube after condensation would otherwise stratify in a thick layer in a few seconds. With rapid steam velocities as shown in Fig. 8, all of the tube is hot because the air is continually carried away in the current of steam. Experiment has shown that this current is most active in producing heat transfer in front of the tube; the side about 90 per cent active, and the back about 75

per cent. This indicates the importance of a staggered tube arrangement so that the front of each tube is presented to the steam flow.

The steam velocities must be sustained throughout the depth of the condenser, which not only requires proper tube spacing but a shell of decreasing width—that is, a wedge- or heart-shaped shell terminating in a narrow, slot-shaped outlet. In this respect also the condenser is analogous to the turbine, Fig. 7, which has both changing blade height and changing wheel diameters.[1]

If the foregoing conditions are maintained, the mixture of steam and air is kept homogeneous and the temperature does not fall until a surprisingly large percentage of steam has been abstracted and the process almost completed. Fig. 9 shows the relation between percentage of heat removed from an average steam-air mixture such as would enter a condenser, and the temperature of the mixture. Starting with approximately 92 deg. temperature there is no perceptible fall of temperature due to increasing air richness until over 99 per cent of the heat has been abstracted and over 99 per cent of the steam condensed. Thereafter the temperature falls with a marked knee in the curve, the exact position and shape of which depend on the proportion of air to steam in the original mixture.

This process is *no longer rapid condensation but a matter of devaporization*, to reduce vapor temperature and pressure and increase partial air pressure so that the air may be removed by a vacuum pump. It is best carried out in a chamber external to the main condenser forming a devaporizer or cooler. Figs. 10, 11, and 12 illustrate such an arrangement in which the flow of hot vapors and air taken from the bottom of the main condensing chamber are turned upward into a cooler from which the concentrated air is finally removed at the top. It will be noticed that

Fig. 13 Showing Grids as Meshed when Assembled in Condenser Cooler

this cooler is also of wedge shape, decreasing in area as the outlet is approached. The air is withdrawn by steam-jet augmenters which discharge into an intercondenser section forming part of the cooler. The air at reduced vacuum is then withdrawn and compressed to atmosphere by secondary steam jets or a small reciprocating pump. In one case a single small pump is used as a secondary for two condensers, steam-jet secondaries being installed as stand-bys.

[1] Wedge-shaped shells have been in use for many years with Weir's marine condenser. The earliest record of this type of shell known to the author is that of its use 33 years ago by another English manufacturer.

The work of devaporization is done by cast-iron grids with fins, meshed together as illustrated in Fig. 13. Cold circulating water flows through the cores of the grids with only slight rise in temperature and then passes through the bottom group of tubes in the condenser (Fig. 10).

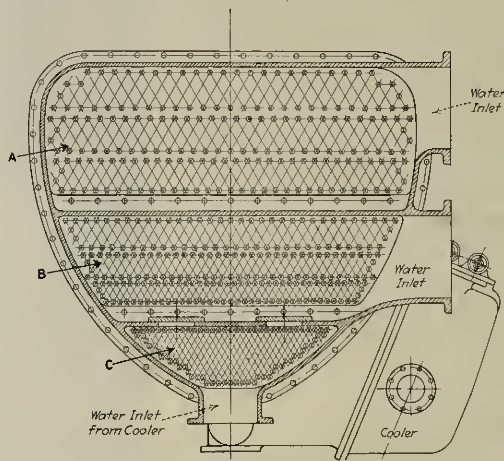

Fig. 14 Water Box with Two Injection Nozzles on I.-R. Surface Condenser

Both nozzles are used in summer, the upper one only in winter, thus obtaining high water velocity even with reduced water quantities and concentrating condensing action in top of condenser.

A large experimental plant, for capacities up to 70,000 lb. per hour was built at the Phillipsburg works of the Ingersoll-Rand Company to investigate these departures in design. The photograph reproduced in Fig. 11 illustrates the complete plant. By the use of electrical thermometers the performance of each row of tubes was determined and from that the efficiency of the tubes under all conditions of loads, vacuum and air leakage and in different parts of the condenser. A sliding or "trombone" thermometer of the electrical resistance type in the discharge water box was arranged so that it could be shifted to any position desired. Decks were fitted in the box which could be shifted to vary the water distribution so that a wide range of conditions of water circulation were obtained. It was found that high efficiency was obtained down to the last row of tubes of the condenser so long as certain critical conditions of vapor velocity were maintained. The condenser was hot throughout its depth and the condensate water at practically steam temperature. The hydrodynamic loss or pressure drop was also studied by the use of water manometers, from which the important relations of pressure loss, steam velocities, tube spacings, and number of rows were determined.

Depending on the air leakage, the cooler devaporizes and cools the air down as close to the temperature of the cold circulating water as one degree, thus giving complete countercurrent action. A study of these temperatures was made by electrical thermometers located at successive points as shown. As is well known from Dalton's law, the amount of air contained in a homogeneous flowing mixture of steam and air depends on the partial air pressure, which in turn depends on the temperature and corresponding partial vapor pressure, so that complete countercurrent action gives maximum withdrawal capacity of the vacuum pump and protection against excessive reduction of vacuum due to heavy air leakage.

It is evident that with the cooler taking care of the process at the knee of the curve and the main condenser hot and active throughout its depth, water cannot pass through great groups of tubes without heating, and therefore the entire bulk of the circulating water can be heated with only one passage through the tubes instead of multiple passes. The circulating water may be pumped, therefore, at low head and power consumption, with high average rate of condensation since none of the tubes is wasted, or

(Continued on page 758)

Fuel Saving in Modern Gas Producers and Industrial Furnaces

By W. B. Chapman,[1] New York, N. Y.

This paper calls attention to the wastes of fuel in the industries using gas producers and producer-gas furnaces. Both of these problems are in the field of combustion engineering.

The progress made in the last twenty-five years in gas-producer construction is emphasized by the descriptions of leading mechanical producers now in the market, together with an indication of their fuel-saving possibilities.

Attention is called to the savings made possible by using suitable accessories in the gas house.

To illustrate the possible savings in furnace operation a description is given of a distinctive type of recuperative furnace. The extension of the use of such a furnace to pulverized coal and oil would, the author states, result in similar savings.

There are about 10,000 gas producers in the United States. With the exception of the modern mechanical producer, most of these are "sick" and badly in need of a "gas doctor," and the furnaces they supply are in an equally bad way.

The producers in use are divided approximately as follows: 6500

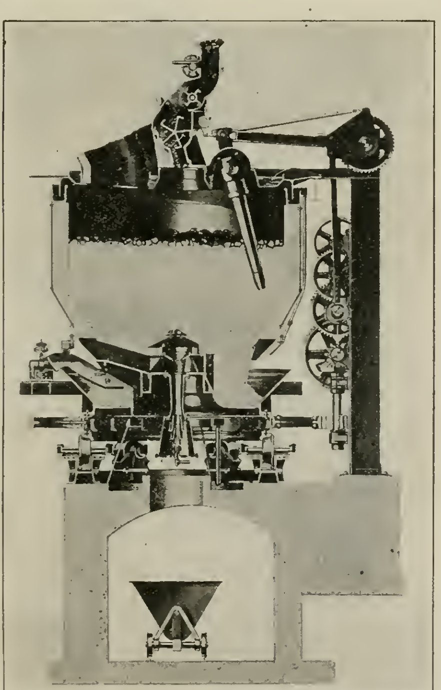

Fig. 1 Hughes Producer

in the steel industries; 1500 in the glass industries; 500 in the chemical industries; and 1500 in miscellaneous industries. Under "miscellaneous" are included the ceramic industries, lime burning and about 200 gas producers used for power.

Engineers have given much attention to the engine room, some to the boiler room, a little to industrial furnaces, and least of all to the making of raw producer gas. Hence the backward condition of the gas house.

No definite data have been compiled by the Government on the amount of coal used in gas producers, but with the assistance of such figures as are available it is estimated roughly that in the steel industries about 15,000,000 tons of bituminous coal are transformed annually into raw producer gas for use, and in the glass industries about 2,000,000 tons.

In the steel industries about the same amount of coal is used for making gas to heat furnaces as for making steam. In glass making three-fourths of all the fuel is used in gas producers. But wherever producer gas is used it is apt to be the most backward part of the business. A given amount of time and money, if spent on improving conditions in the gas house, will usually bring larger returns than in any other department. In most industries requiring large heating operations more trouble arises in that department than in any other part of the business.

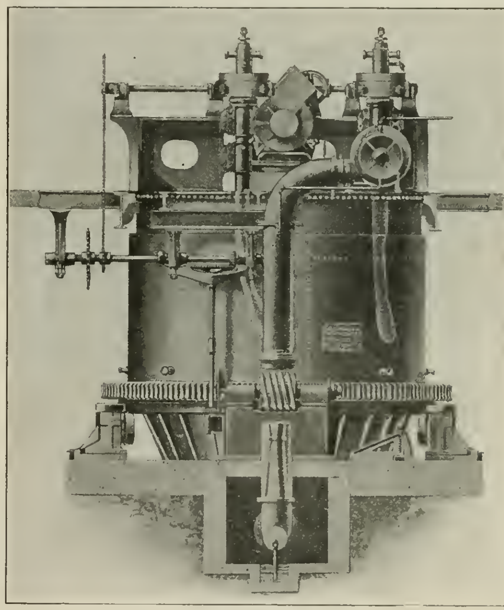

Fig 2 R. D. Wood Producer

Much progress has been made in the past 25 years in gas-producer construction. It started with the excellent work of W. B. Hughes. Progress in furnace construction, however, has lagged. The chief incentive to improvement of both producer and furnace has been high-priced labor, and the few advances made in furnace construction have been confined mostly to certain labor-saving features. Now the situation has changed; fuel saving has been put on a par with labor saving, and interest is being noted all along the line.

The Producer-Gas Process

In making producer gas there are three steps or operations: (1) Feeding the fuel; (2) agitating the fire; and (3) removing the ashes. Progress in producer construction has centered on various ways of performing these three operations automatically.

Automatic Coal Feeding, if continuous and uniform, will increase the B.t.u. in the gas about 10 per cent and will improve its uni-

[1] President, Chapman Engineering Company. Mem.Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. The paper is here printed in abstract form. All papers are subject to revision.

formity to such an extent that it can be burned in the furnace with a 10 per cent improvement in economy. However, the labor saving due to automatic feeding is slight, and should not be confused with the labor saved by the use of coal-handling equipment and overhead bins, always a good investment for installations of more than one producer.

Automatic Agitation, if suited to the kind of coal used, will increase the B.t.u. from 10 to 20 per cent (depending largely upon the zeal and skill with which it was formerly hand-poked) and the uniformity thus obtained will cause a corresponding saving in utilizing the gas in the furnace. The combined effect of automatic

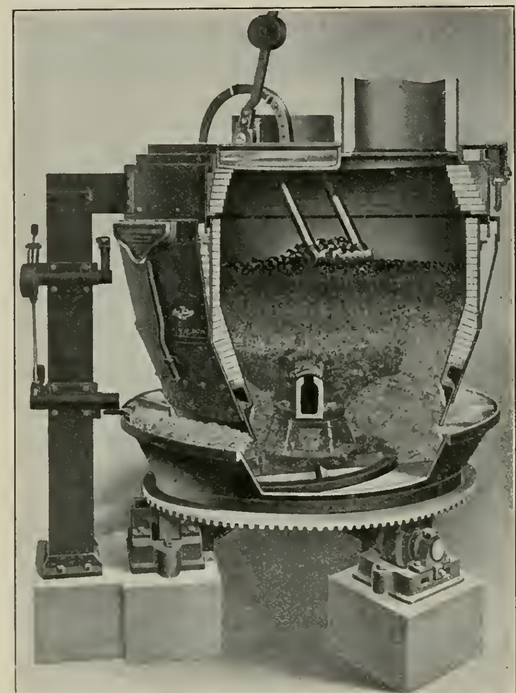

Fig. 3 Morgan Producer

feeding and automatic agitation usually makes possible a saving of 25 per cent of the fuel required for a given operation.

Automatic Ash Removal is of two kinds—intermittent and continuous discharge. The intermittent type removes the ashes once or twice in 24 hours. It is open to the objection that during the ash-removal period the fire is badly disorganized and a poor quality of gas is made for possibly half an hour. The continuous type of ash removal is entirely free from this objection. In Europe the continuous type is much in favor, although but few have been installed in this country.

The saving caused by mechanical ash removal depends largely upon the kind of device used. If the ashes are removed intermittently, and if no effective agitation accompanies the ash removal, the saving will be limited to the two or three hours' time required daily for the ash men to shovel the ashes out by hand. If, on the other hand, the ash removal is continuous and is accompanied by suitable agitation of the entire ash bed and lower portion of the fire bed, there will be a considerable saving in the labor required both for manipulating the fire and for cleaning clinkers off the walls. Moreover, the continuous type of ash removal, accompanied by ash agitation, will increase the capacity of the producer about 50 per cent and will save some fuel on account of the improvement in the quality and uniformity of the gas. Unfortunately the continuous type of ash remover, combining with effective agitation, is little known in this country, although it is the common type in use throughout Europe.

Types of Producers

Bearing in mind the foregoing three steps in making producer gas, let us now consider the types of producers in most common use in America, the Hughes, the R. D. Wood,[1] the Morgan and the Chapman. Each is an excellent machine.

To Mr. Hughes, then chief engineer of the Pencoyd Iron Works, is accorded the credit for having installed at that plant in 1897 the first successful mechanical producer in America. This machine is still in operation. As will be seen from Fig. 1, the chief feature consists in a vertical water-cooled finger hinged to the stationary top of the producer and made to oscillate between the center and the wall while the body of the producer and its contents revolve underneath. Thus, in time, the entire contents of the producer are stirred. The speed of this producer was originally one revolution in 20 min., but every few years it has been increased until now the walls make one revolution in 8 min., with considerable increase in capacity.

Since the installation of the first Hughes producer, an automatic ash-removing device has been added. It consists in a stationary bar arranged to sweep the ashes from a revolving grate. The bar

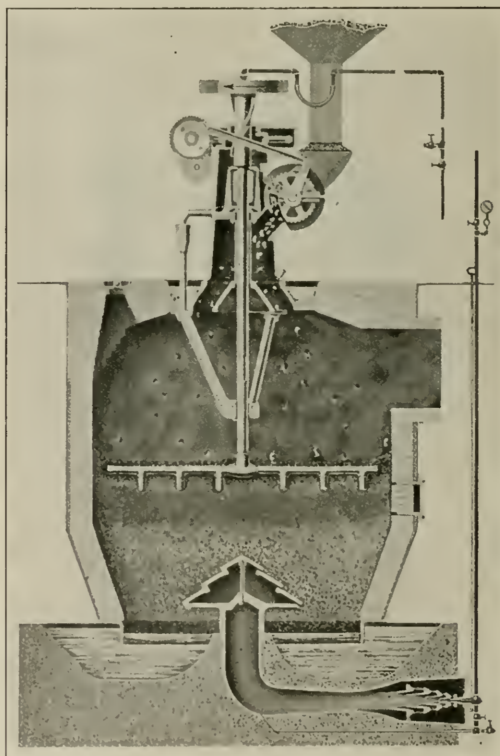

Fig. 4 Chapman Producer

is inserted once or twice every 24 hr. for a short period and then removed. No attempt is made to use the device for agitating the lower portion of the fire bed. Recently an automatic feed—in fact two automatic feeds—has been added, thus making the producer completely mechanical. The double feed gives unusually good coal distribution. This is the oldest producer on the market, and there are over 800 in operation—more than any other mechanical producer.

[1] The Wood type is manufactured by two different companies.

The R. D. Wood producer, Fig. 2, is somewhat like the Hughes, in that it uses the vertical-stirring-arm principle. There are two vertical arms, one near the center and the other near the wall. These stirring arms are bent as shown in the illustration, but instead of oscillating from center to side they revolve around their vertical axes. The walls of the producer revolve and thus the fire bed is carried past the stirring device. The coal is fed from a rotating drum located eccentrically. As the revolving fire bed comes under the feeding device fresh fuel is supplied to it. The speed of the producer is one revolution in 30 min. A steam-turbine blower is supplied in addition to the ordinary steam-jet blower. The turbine has an extra large capacity, operates quietly, and usually gives results that are more uniform than a steam-jet blower.

The ash is removed by a blade or plow attached to the lower edge of the revolving producer wall and extending down into the ash bed. The blade takes out ashes at a fixed rate, which is somewhat faster than they are made and therefore it cannot be operated quite continuously. Scoops are attached to the skirt of the revolving wall for carrying the ashes aronnd to a suitable point for final discharge. The capacity of this producer is unusually large, owing to the facts that there are two stirring arms in place of one, and the removal of the ash is nearly continuous. Moreover, the diameter of the Wood producer is 10 ft. 6 in., instead of the usual 10 ft. This producer is particularly popular among glass mannfacturers, and some remarkable records have been secured with it.

In a producer having vertical stirring fingers it is highly desirable to keep the top and bottom of the fire bed always at the same level so that the stirring fingers will always project the right distance into the fire bed for best results. If these fingers should reach too near the ashes, the air blast would break through into the recess or gap left in their wake and spoil the gas. A continuous, or at least semi-continuous, ash removal would thus seem to be necessary in order to keep approximately the same amount of ashes in the fire bed all the time and approximately the same amount of fire.

The Morgan prodncer, Fig. 3, like the Hughes, is 10 ft. in inside diameter and has about the same capacity. Also, like the Hughes, it is very popular in the steel trade. However, it differs radically in both the method of agitation and in the ash removal. Instead of vertical arms projecting deep into the fire bed, a horizontal arm which rides on the surface is used, it being claimed that surface agitation is quite sufficient and anything more is detrimental. The writer's experience would seem to prove that surface agitation is hardly adequate when caking coals are used. Nevertheless some very excellent results have been obtained. As will be seen from the illustration, the agitator is in the form of a swinging U-tube with the ends hinged to the stationary top of the producer. The walls and the ashpan of the producer revolve and carry the fire bed around with them. The speed has recently been increased to one revolution in twelve minutes.

The ash is removed by a spiral arm lying on the bottom of the ashpan. Ordinarily the arm revolves with the pan so that no ashes are removed. From one to three times every 24 hr. the outer end of the spiral arm is engaged and held fast, thus producing relative motion between the arm and the pan and causing the ashes to flow out rapidly. An ingenuous device provides for the automatic release of the ash arm when the producer has made a full revolution. The ashes obtained in this way are exceptionally free from carbon. After the ashes are taken out the fire bed is "broken down" by hand poking and drops from six inches to a foot.

In all gas producers that do not provide for continuous removal of the ash there is a definite *cycle of operation*, extending from one ash-removing period to the next. This is usually a 24-hr. cycle, but in some cases it is 12 or even 8 hr., and in the case of the Wood producer it is semi-continuous. At the beginning of the cycle (immediately after the ashes have been removed) the fire bed, though not changed in thickness, is located much lower down in the producer than at the end. This difference in height of the location of the fire bed in the producer from the beginning to the end of the cycle is usually about 2 ft. if the ashes are removed but once in 24 hr., but is correspondingly less when the ashes are removed more frequently. It is therefore apparent that if a producer is to be agitated uniformly it should be provided either with approximately continuous ash removal or with an agitator which automatically varies in height according to the varying height of the fire bed.

The Chapman producer, Figs. 4 and 5, is the only gas producer sold in parts. The agitator alone may be installed on any stationary producer, or the agitator in combination with the automatic feed may be installed on old or new stationary producers, or, again, a completely mechanical producer including automatic feed, agitator and ash remover may be obtained. The agitator, as will be seen from the illustrations, is in the form of a rake with water-cooled teeth. The rake revolves once in 7 min., and thus every portion of the fire is passed over every $3^1/_2$ min., which is more than twice as frequent as in any other producer. In most producers agitation depends upon the speed of the walls, which are rather cumbersome to operate rapidly.

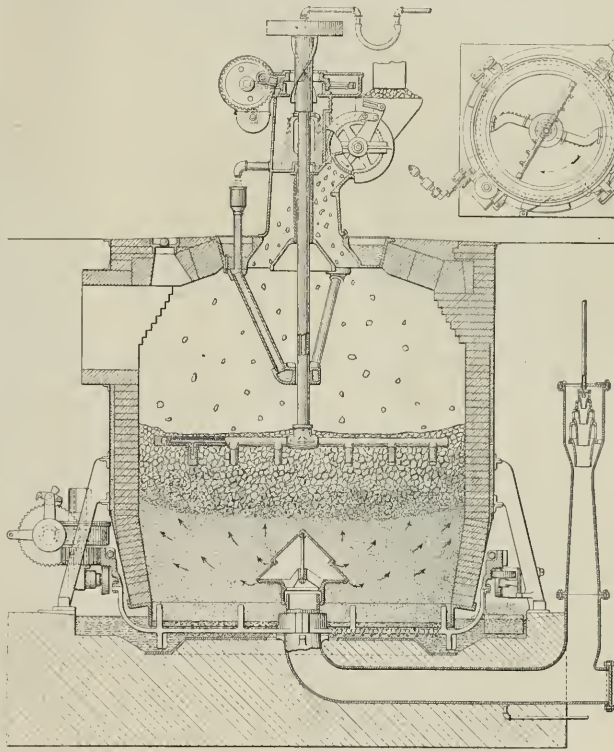

Fig. 5 Chapman Continuous Gas Producer

The agitator is driven by a patent driving head having two long spiral flanges upon which the agitator automatically "screws up" as the fire bed grows higher and "unscrews" when the height of the fire bed drops. These spiral flanges are in sliding contact with two revolving lugs which project inwardly from the hub of the driving wheel. As fresh coal is put on the fire it tends to bury the agitator beneath it. This makes the agitator turn harder through the fire bed, and immediately the torque is increased the driving head screws up to where the forces are again in balance.

If the agitator strikes a large clinker fast to the wall it screws up over it and drops down on the other side, thus avoiding any undue strain on the machinery. The action is a little like that of the Yankee screw driver.

The cross-arm of the agitator operates a few inches below the surface of the fire bed, and the fingers project down 8 in. farther. This makes the depth of the agitation about midway between the surface agitation of the Morgan and the deep agitation of the Hughes and Wood. As the fingers project forward the cross-arm immediately fills in the gaps in their wake. The out-stroking effect of the cross-arm tends to pack the fuel against the wall, which helps to prevent blowholes and clinkers.

The automatic feed drops the coal evenly over all parts of the fire bed simultaneously, and thus does not require a revolving fire bed. The object is to produce slightly better gas-making conditions than when the fuel is dropped only in one corner or sector of the producer at a time.

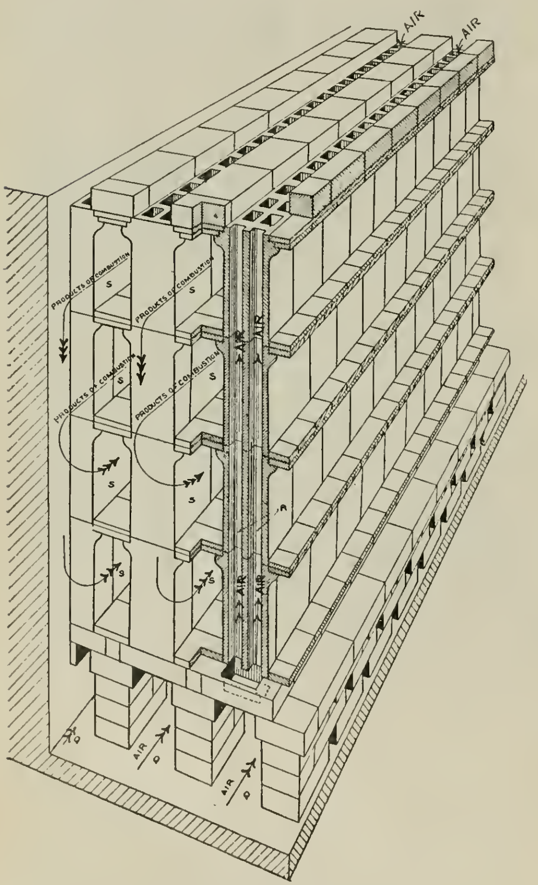

Fig. 6 Stein Recuperator

The ash-removing device operates continuously. It consists in a slowly revolving beam extending across the producer through the ashpan and driven by a gear ring which encircles the producer just above the pan, the speed being adjustable to synchronize with the rate the ashes are being made. The speed of the gear ring is adjustable from a revolution an hour to one in ten hours. After the ashes have been forced out by the beam into the outer portion of the ashpan they are picked up by scoops attached to the gear ring and carried to the point of discharge.

The Chapman producer makes use of the European idea of agitating the firebed from beneath. The ash beam is provided with fingers which project upward and impart motion both to the ashes through which they move and the fire bed resting on the ashes. This is to help in preventing blowholes and clinkers and to increase the capacity.

The size of this producer is 11 ft. inside diameter—the largest made—and the capacity is increased accordingly.

Savings With Mechanical Producers

With the usual more or less unskilled and indifferent handling, any of the four American mechanical producers can make a gas averaging 150 B.t.u. (low values) instead of the customary 125 B.t.u. obtained in hand-poked producers if operated with zeal. With skilled handling the best mechanical producers will average from 160 to 175 B.t.u., provided the coal is fair and the rate of gasification does not exceed 25 or 30 lb. per sq. ft. per hr., which is about twice the capacity of hand-operated producers.

A Duff producer, operating originally at 10 tons a day and making gas having 125 B.t.u., was fitted with a Chapman agitator and automatic feed, and at 36 tons a day gave an average of 163 B.t.u. Similarly, a Von Kerpley producer, the most popular mechanical type in Europe, gasifying 20 lb. per sq. ft. per hr., making about 135-B.t.u. gas, was equipped with Chapman agitator and automatic feed and changed to 34 lb. gasified per sq. ft. per hr. and 178 B.t.u. This was maintained without difficulty and without any hand poking.

The best modern producers properly operated will usually save about 25 per cent of the coal and an equal amount of labor. These savings should amount to the total cost of the installation in from one to four years.

The temperature in a gas producer is highest at the bottom of the fire, and the thicker the fire the cooler the top. The temperature at the bottom should be as high as the fuel will stand without running too much risk of melting the ash. The melting point of the ash in all the good Pittsburgh gas coals is well above 2500 deg. fahr., and the melting point of the ash in Illinois coals is about 300 deg. lower. The temperature at the top of the firebed should be as low as will permit the gas to be conducted to the place of use without forming objectionable tar deposits, and also as low as possible without making the top too sticky and difficult to blow through. Usually a "top temperature" of 1000 deg. fahr. is about right, but if the gas is to pass through a water-cooled reversing valve located some distance away 1200 deg. would be better. A "hot top" destroys some of the richest gases and thus wastes fuel. More fuel is wasted in a producer from running with a hot top, i.e., over 1300 deg., than from any other cause.

A considerable saving of coal can be brought about by using suitable accessories in the gas house. The most important of these is a pressure regulator, which, when the pressure in the gas main falls, blows the producer harder and makes more gas, and vice versa. A temperature recorder is also of great assistance. A few additional regulating and recording devices are needed if one is to obtain the highest efficiency in daily operation.

The Furnace Part of the Problem

But, *gasifying the fuel is only half the problem of conserving it.* The other half lies in its utilization in the furnace. The two halves of the problem are inseparable. They are both the field of the combustion engineer. Space is too limited to take up more than one kind of furnace—the kind that holds the most promise for fuel conservation and the kind that until the last decade has largely been a failure—the recuperative furnace.

A recuperative furnace is never "reversed" and, except in rare instances, only the air is preheated. It costs much less to build and to repair, is easier to operate and gives practically the same efficiency as the expensive and cumbersome regenerative furnace.

The field of application for the recuperative furnace is very broad and it can be used effectively in both large and small operations, for furnace temperatures as high as 2700 and as low as 1400 deg. About the only uses to which it is not suited to are for operations which periodically require a large overload such as the open-hearth process and large forgings over 32 in. in diameter, also for large glass melting tanks. For almost all other purposes the recuperative furnace can be used with great economy.

In many operations where the air is not now preheated it will be found that from 20 to 40 per cent of the fuel can be saved by using a good recuperator—one that preheats the air to within 500 deg. fahr. of the temperature of the furnace.

The Stein recuperator is shown in Fig. 6 and the Stein recuperative furnace in Fig. 7. The furnace is the one most favored in Europe, where, as might be expected, the necessity for fuel economy has caused engineers to give more attention to the problems of combustion than in this country. The recuperator of this furnace preheats the air to within less than 500 deg. fahr. of the temperature of the gases leaving the furnace and is as efficient after six years of operation as when first installed.

Another distinctive feature of this furnace is that the gas and air are mixed together a few feet before they enter the furuace but are not given room enough to burn until they reach the combustion chamber. A high heat is then obtained immediately.

The recuperative tile in this furnace is set to form horizontal passages for the spent gases, the joints being protected by a double seal. Each tile is provided with four small vertical passages for the air. These passages form straight chimneys about 6 ft. high with no

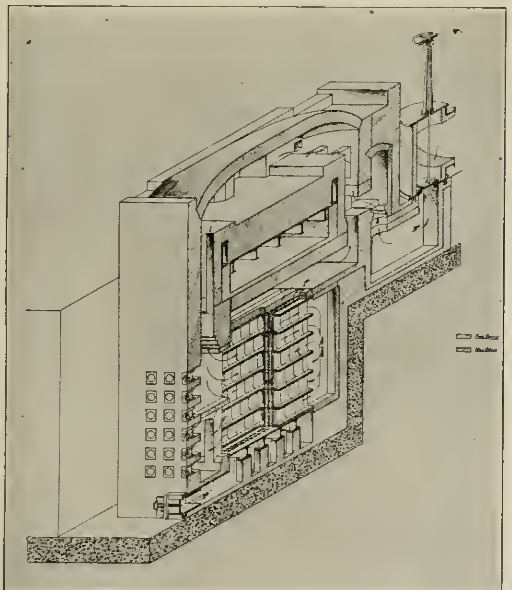

Fig. 7 Chapman-Stein Forge Furnace

offsets or turns to hinder the accelerating speed of the rising column of air. The energy of velocity of the air thus attained is transformed on entering the furnace into the energy of pressure. The furnace is thus automatically operated under a slight pressure without requiring the usual blower for the air. The saving of a blower and the power to operate it, however, is not so much of a gain as the fact that the air in the recuperator is not under pressure (from a blower) but under suction caused by the chimney effect of the vertical passages, and thus the suction of the air inside the tile balances the suction of the spent gases in the passages between the tile. There is therefore no leakage—in fact no cause for leakage—from the air passages to the gas passages, which has been the bane of the recuperative furnace heretofore.

To give one example, a furnace of this description installed in this country nine months ago is now performing a certain heating operation which formerly required 550 gal. of oil a day for 350 gal., a saving of 36 per cent. The saving in oil for the first year will more than pay for the cost of the furnace.

Large Fuel Savings Possible

It is not the purpose of this paper to dwell on pulverized coal or oil as fuel, but 20 to 40 per cent of these fuels might be saved if air for combustion were properly preheated from the waste gases by a suitable recuperator.

In view of the facts as outlined in this paper we trust that many will agree with us that from 3,000,000 to 4,000,000 tons of bituminous coal could be saved annually by better furnaces and furnace operation, and better producers and producer operation. May we therefore suggest that our Society in the future take suitable action in recognition of the situation herein set forth.

In closing the author wishes to acknowledge the kind coöperation of the Morgan, Wood, and Hughes companies who have supplied the illustrations of their producers and also some of the information contained herein.

Appendix 1

As there are more Duff producers in use in the United States than any other type of hand-poked producer, the following test made by the engineers at one of the largest steel works will be of special inter.st.

TABLE 1 TEST OF DUFF-BRADLEY PRODUCER WITH NEW BLOWERS AND CHAPMAN AUTOMATIC FEED FLOATING AGITATOR.[1]

Analysis of Seven-Hour Continuous Sample of Gas

Rate of gasification per 24 hr. = 37.36 tons.
Rate of gasification per hr. per sq. ft. = 36 lb.

CO_2 per cent	C_nH_{2n} per cent	O_2 per cent	CO per cent	CH_4 per cent	H_2 per cent	N_2 per cent	B.t.u.	Steam lb.
4	1.4	0.2	26.8	3.0	10.4	54.2	163	52

Calorific power of gas per min	552,750 B.t.u.
Sensible heat of gas per min	94,100 B.t.u.
Total useful heat of gas per min	646,850 B.t.u.
Average coal fed per hr., lb. by weight	3114
Average coal fed per hr., lb. calculated from above analysis	3081
Difference, lb	33

External Heat Balance

Dr.	B.t.u.	Per cent	Cr.	B.t.u.	Per cent
B.t.u. per lb. coal	13,039.0	97.5	Calculated power of gas	10,660.0	79.7
B.t.u. steam and air	336.5	2.5	Sensible heat of gas	1,803.0	13.5
			Loss unburnt coal	146.5	1.1
			Other loss (radiation, etc.)	716.0	5.7
	13,375.5	100		13,375.5	100

Total losses, 6.8 per cent.
Efficiency of producer, 93.2 per cent.
Standard gas temperature of 62 deg. fahr. used.
No band poking was done during test and no clinkers were made.
In calculating B.t.u., U. S. Steel Corpn. lower values are used.
West Virginia coal used carrying 37 per cent volatiles.

[1] Former capacity of this producer was 10 tons in 24 hr. and the gas averaged 125 B.t.u. Producer was rebuilt to 10 ft. 6 in. diameter.

Appendix 2

As there are more Von Kerpley producers in Europe than any other mechanical type, we give the following test. The Kerpley producer, like the other European producers, has continuous ash removal and continuous agitation of the ash bed and lower part of the fire bed, and there is no agitation of the upper part of the fire bed and no automatic feed. Before installing the Chapman automatic feed and floating agitator the capacity was 12 cwt. per hour and in spite of an enormous amount of hand poking the producer was usually full of clinkers. After the new equipment was added the capacity was increased considerably over 50 per cent, no hand poking was required and no clinkers were made. The works engineer estimated that the saving in labor alone was sufficient to pay for the equipment in nine months. The B.t.u. in the gas was increased about 30 per cent.

TABLE 2 TEST OF VON KERPLEY PRODUCER, WITH CHAPMAN AGITATOR AND AUTOMATIC FEED

Test on 9 ft. 7 in. inside diameter Von Kerpley gas producer fitted with a Chapman agitator with automatic feed.
Duration of test, 49½ hr.
Average analysis of gas samples taken hourly:

CO_2	O_2	CO	C_2H_4	H_2	CH_4	N_2
4.74	0.30	24.6	0.30	12.80	5.26	52.00

Total combustibles, 42.90 per cent.
Average coal fed per hour, 2408 lb.
Calorific value of gas, 178 B.t.u. per cu. ft.
Net English heat values used: CO—345, H_2—290, CH_4—975, C_2H_4—1590.

Heat Balance

Dr.	B.t.u.	Per cent	Cr.	B.t.u.	Per cent
B.t.u. per lb. coal	13,906.0	97.2	Calculated power of gas	11,498.9	80.34
Sensible heat of coal	13.2	.09	Sensible heat power	1,925.0	13.50
Sensible heat of steam	328.8	2.3	Loss in unburnt coal	46.3	.32
Sensible heat of air	54.0	.41	Sensible heat of ash	1.8	.01
			Do. of water passed through agitator	55.46	.38
			Other losses (radiation etc.)	774.54	5.45
	14,302	100		14,302	100

Total losses, 6.16 per cent.
Efficiency of producer, 93.84 per cent.
Producer equipped with Chapman 5-stage blower with 7/16 in. nozzle.
Coal used: Florence beans 17.62 per cent, Florence nuts 30.65 per cent, Stafford cobbles 20.73 per cent, Florence cobbles 31.00 per cent.
Coal gasified per sq. ft. per hr. 34.01 lb.
Steam used, 0.278 lb. per lb. of coal.
Gas per lb. of coal, 64.6 cu ft.

Boiler-Plant Efficiency

By VICTOR J. AZBE,[1] ST. LOUIS, MO.

The usual wastes in boiler plants are brought out strikingly by means of tables and curves of boiler performance compiled from a large number of observations.

The object of this paper is to show to what extent these wastes are preventable or can be made to balance each other, and to recommend a standard for boiler operation toward which designers and operators of boilers may aim.

The author considers that there still remains an immense field for experimental research to obtain the necessary data for boiler construction. The requirements of the ideal boiler installation of today are summarized.

The degree of waste in boiler plants is not generally realized and there is a tendency to judge conditions by a few of the better plants where improvements have been made and whose results are considered as representative of the average-run boiler plants.

Tables 1 and 2 show two boiler tests made under ordinary operating conditions, one on a hand- and one on a stoker-fired boiler. During these tests care was taken that actual operating methods were pursued. The results are very bad but representative of most smaller and some of the larger installations.

Table 3 gives the results of three boiler tests, all made on the same boiler some time apart. The boiler was of the B. & W. type, but poorly set, with a limited combustion chamber of only 0.87 cu. ft. per rated boiler hp. The stoker in use was of the old Jones type.

During Test A the aim was to maintain the same operating conditions as existed before any improvements were made; the result was an efficiency of 56 per cent and boiler rating of 102 per cent. After this first test improvements were begun, without, however, altering the stoker or increasing the combustion space.

After about six months, results were obtained as represented by Test B in Table 2; the efficiency was increased to 68.5 per cent and capacity to 140 per cent of rating. The results were not as yet considered satisfactory and efforts for further improvement were made. In all about 30 boiler tests were run under different conditions and with different fuel and one of the last tests is represented by Test C in Table 3. This last test is very remarkable in several respects, but is correct. In fact, the results are checked by other tests giving equal or even slightly better results.

The remarkable features of the results of this test are as follows:

1. High boiler efficiency with a relatively inefficient installation and relatively poor coal
2. Complete combustion with high volatile coal and a combustion space of only 0.47 cu. ft. per developed boiler hp. or 0.11 cu. ft. per lb. of coal including the space occupied by the coal
3. A draft drop through a 16-section, 9-tube (each 16 ft. long) B. & W. boiler of only 0.1 in. at 85 per cent overload
4. A flue-gas temperature of 532 deg. fahr. at 85 per cent overload in spite of the limited combustion space and flame extension to almost the end of the first pass
5. An improvement of 39.5 per cent in economy over that of Test A
6. An improvement of 81.4 per cent in capacity over that of Test A, in spite of the fact that during the first test maximum boiler rating was aimed at. Other examples could be enumerated of great improvements being made.

Standard of Economy

The writer considers 90 per cent efficiency as the standard of economy attainable under favorable conditions, this 90 per cent representing boiler and economizer without taking auxiliary power into consideration, however. The requirements for this efficiency are rather severe and with 12,000 B.t.u. bituminous coal, 15 per cent excess air would have to be used, flue-gas temperature would hav to be no more than 250 deg. fahr., combustion complete and n carbon in the ash. These requirements are listed in Table 4

TABLE 1 TEST ON HAND-FIRED BOILER REPRESENTING VER UNECONOMICAL CONDITIONS

Date of test	Dec. 2, 1920
Type of boiler	B & W
Grate	Shaking
Kind of coal	Illinois screening
Steam pressure, gage, lb	135.6
Temperature of feedwater, deg. fahr	205.0
Temperature of flue gas, deg. fahr	568.4
Draft at back damper, in	0.48
Draft over the fire, in	0.24
Carbon dioxide, per cent	5.68
Quality of steam, per cent	98.5
Rated boiler hp	150.0
Per cent of rated capacity developed	105.9
Evaporation, equivalent, coal as fired, lb	4.91
Evaporation, equivalent, coal dry, lb	5.51
Calorific value of coal, dry basis, B.t.u	11510
Coal analysis, per cent: Moisture	10.9
Ash	15.8
Volatile matter	35.2
Fixed carbon	38.1
Carbon in ash, per cent	24.4
Heat Balance	**Per cent**
Heat absorbed by the boiler	45.31
Loss due evaporation of moisture in coal	1.31
Loss from vapor of hydrogen combustion	5.41
Loss in dry flue gas	28.21
Loss due to carbon monoxide	4.24
Loss due to combustible in asb	5.40
Loss due to heating of moisture in air	0.30
Loss due to radiation, hydrogen, hydrocarbon, etc	9.22

TABLE 2 TEST ON STOKER-FIRED BOILER REPRESENTING VER UNECONOMICAL CONDITIONS

Date of test	Feb. 23, 1917
Type of boiler	Heine
Type of grate	Detroit
Kind of coal	Pocahontas nut & slac
Steam-pressure, gage, lb	138
Temperature of feedwater, deg. fahr	152
Temperature of flue gas, deg. fahr	761
Draft at back damper, in	0.98
Draft over the fire, in	0.38
Carbon dioxide, per cent	8.1
Coal burned, lb	14700
Water evaporated, lb	96480
Evaporation (actual), lb	6.56
Evaporation (equivalent), lb	7.25
Boiler hp. developed per hr., lb	386.6
Boiler rating, bp	328
Per cent of rating developed	118
Heat value of fuel, B.t.u	13950
Boiler efficiency, per cent	50.4

TABLE 3 BOILER TESTS REPRESENTING IMPROVEMENT O BOILER PERFORMANCE

Test[1]	A	B	C
Type of boiler		B & W	
Type of stoker		Jones	
Kind of coal		Illinois screenings	
Steam pressure, gage, lb	130	127	129
Temperature of feedwater, deg. fahr	180.6	187.0	176.8
Temperature of flue gas, deg. fahr	612	533	532
Draft at back damper, in	0.57	0.34	0.11
Draft on fire, in	0.45	0.24	0.01
Forced-draft pressure, in	3.00	3.52	4.04
Carbon dioxide, per cent	7.6	13.3	14.0
Quality of steam, per cent	0.991	0.991	0.99
Rated boiler hp	269	269	269
Per cent of rated capacity developed	102	140	185
Evaporation, equivalant, coal as fired, lb	6.14	8.19	8.43
Evaporation, equivalent, coal dry, lb	6.95	9.05	9.55
Calorific value of coal, dry basis, B.t.u	12080	12850	11864
Coal analysis, per cent: Moisture	11.7	9.9	11.7
Ash	13.4	8.9	12.5
Volatile matter	31.0	32.2	32.5
Fixed carbon	43.9	49.5	43.3
Carbon in ash, per cent	16.7	19.4	17.2
Efficiency of boiler furnace and grate, per cent	56.0	68.5	78.1
Improvement in economy over Test A, per cent	....	22.3	39.5
Increase in capacity over Test A, per cent	....	31.4	81.4

[1] Test A indicates conditions when no effort toward economy was made, whil Tests B and C show gradual improvement under an economy campaign. In al three cases maximum possible capacity was striven for.

TABLE 4 IDEAL BOILER AND FURNACE PERFORMANCE

Kind of fuel	Bituminons coa
Heat value of fuel, B.t.u. per lb	12000
Moisture of fuel, per cent	10
Hydrogen in fuel, per cent	3.5
Theoretical air per lb., lb	8.98
Excess air, per cent	15
Actual air per lb., lb	10.33
Flue-gas temperature, deg. fahr	220
Heat Balance	**Per cent**
Loss due to dry chimney gas	3.15
Loss due to moisture from H_2O	2.85
Loss due to moisture in coal and air	1.00
Loss due to carbon in ash	1.00
Loss due to incomplete combustion	0.00
Loss due to radiation and conduction	2.00
Total loss	10.00
Boiler efficiency	90.00

[1] Consulting Engineer. Assoc-Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

This ideal or 90 per cent boiler and furnace efficiency has been attained only once, and then by Henry Kreisinger and John Blizard at the Lakeside Station of the Milwaukee Electric Railway & Light Co.

Fuels

With a suitable installation, almost as high an efficiency will be obtained with low- as with high-grade fuels. The only real obstacle to this is the tendency toward a greater ashpit loss with lower-grade fuels.

As a rule low-grade fuel should be burned close to the mines and igher-grade fuel transported. Freight to distant points should not be compared on a tonnage but on a heat-value basis. The cost of fuel also should be based on heat value rather than on the weight.

Combustion

There are several reasons why properly proportioned furnaces with ample combustion space are necessary, the most important being the prevention of escape of unburned gas and formation of

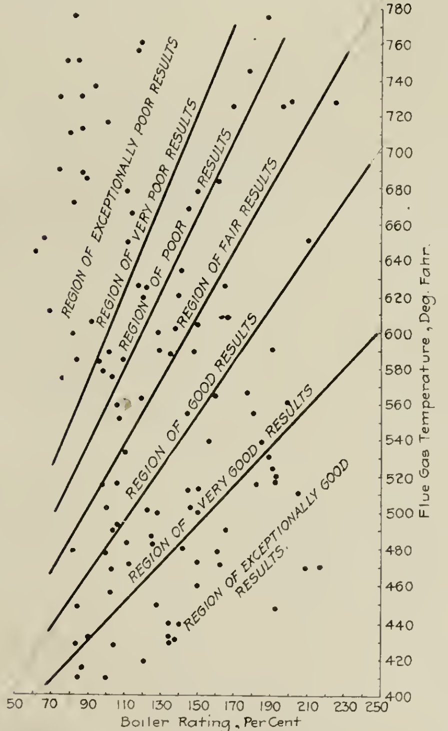

Fig. 1 Flue-Gas Temperatures Representative of Good and Bad Results

soot, the possibility of operating with the least amount of excess air without incomplete combustion, and the prevention of flame entrance among the boiler flues. This last is necessary to obtain low flue-gas temperatures and will be considered under that head.

Furnace volumes vary from 1 cu. ft. per lb. of coal burned per hr. down to less than 0.1 cu. ft. in some cases. The lower amounts, of course, do not represent the entire combustion space because combustion under such conditions extends among the tubes, at times for a considerable distance, but this is not what is to be desired. The larger amounts are used with powdered fuel and are necessary because the solid particles burning are relatively large and require a larger combustion chamber for their gasification and combustion than is the case when gasification, and to a certain extent mixing with air, takes place on a grate.

The aim is to have the gas completely burned and no flame entering the first tube pass. To accomplish this, more than mere furnace volume is necessary. There are such things as effective and ineffective combustion space.

Excess Air

The largest preventable loss in boiler plants is that caused by excess air. Determination of this loss by the measure of the CO_2 and flue-gas temperature has achieved considerable popularity.

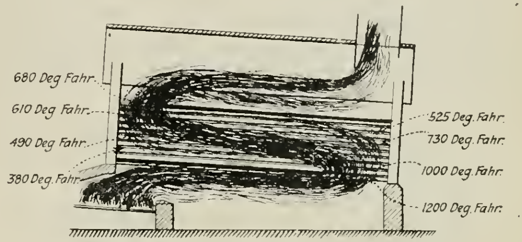

Fig. 2 Unequal Gas-Flow Distribution Through a Boiler

Where such popularity has been attained, the trouble is, however, that quite generally there is satisfaction if the fuel is burned with 100 per cent excess air, and even in well-operated plants no better results are obtained on the average. This is because of the tendency of many an engineer to assume statements as correct without sufficient consideration. With the large combustion chambers coming in vogue nowadays the old assumption that 10 or 12 per cent CO_2 is all that pays becomes obsolete. If we design our furnaces so that flame terminates before gas enters the tubes or soon thereafter and with the boiler heating surface so exposed that the maximum amount of heat is radiated to it, then the standard of good performance is the burning of the fuel with 15 or at the very most 25 per cent of excess air, and the CO_2 maintained should be around 16 per cent.

The point at which excess air enters in very important and should be given greater prominence when boiler-test data are recorded. At present during a test we tend to be primarily concerned with what occurs on the ends; that is, in the furnace and uptake, and few, if any, observations are taken and records made of what occurs between these points. Such items as point of flame termination, relative amount of oxygen, carbon dioxide percentage (which is a true measure of excess air), and temperature drop at various points through the settings, should be carefully recorded and interpreted; then it will be possible to really compare the performance of one boiler with another, which can hardly be properly accomplished with the data now commonly obtained.

A somewhat overlooked but also very important factor affecting boiler plant economy is "constancy." The percentage of CO_2 may fluctuate during the day from high to low, but if for the whole day a 10 per cent average is taken, it will be found that for a number of reasons the efficiency will not be nearly so good as when 10 per cent of CO_2 is constantly maintained. Therefore the average CO_2 is an improper measure of the loss, but at the same time is a good indicator of improper conditions.

Heat Transfer and Flue-Gas Temperature

The temperature of the escaping products of combustion determines fuel loss to a great extent, but what is low and what is high flue-gas temperature? The lack of a suitable measure and standard has in the past prevented proper comparison of results and has also caused a certain lack of incentive for improvement. The writer, in his effort to evolve a measure, has drawn Fig. 1 based on 150 different boiler tests. Each dot represents the average flue-gas temperature at the average rating developed in each test. The space is divided into sections varying from exceptionally good to exceptionally bad results, with the slope of the line following as closely as possible the increase of flue-gas temperature with the increase of boiler output of a number of boiler-test series.

To absorb the heat, it is necessary to bring the gas in contact with the heating surface. This some boilers do imperfectly. If the surface is clean everything depends upon gas velocity and distribution. Fig. 2 shows what happens under certain conditions. In the dead spaces temperatures as low as 380 deg. fahr. were recorded when the flue-gas temperature was 680 deg. fahr. The gas has the tendency to take the shortest cut, a great deal like a stream of water; in fact, much might be learned from the study of water stream flow which could be applied very profitably to boiler-pass design.

Fig. 3 was drawn as an effort to show how boiler-heat transfer varies according to different influencing factors.. This chart is interesting from many angles and while not exactly correct for all conditions, it is sufficiently so to permit its use The chart is

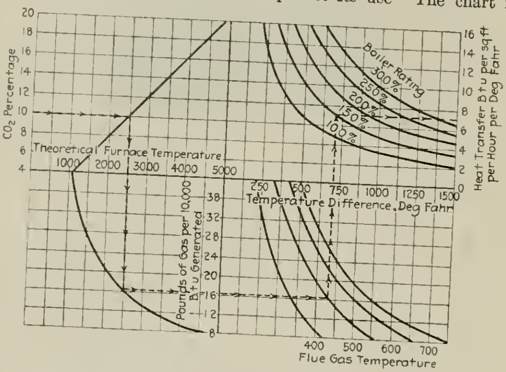

Fig. 3 Boiler Heat-Transfer Variation Under Different Conditions

Based on 365 deg. fahr. steam temperature.

based on the theory that from the actual heat-transfer standpoint we are not concerned with what the furnace temperature is, but only with the maximum theoretical temperature that would have existed had there been no absorption of heat in the furnace. If the boiler absorbed no heat from the furnace, the theoretical temperature corresponding to CO_2 would be obtained very nearly. According to this theory, if CO_2, flue-gas temperature, and rating at which boiler is operated are known, heat transfer can be determined with the aid of the chart.

Fig. 4 demonstrates that with 140 lb. boiler pressure, from 14 to 25 per cent of the total heat used to generate steam is required just to heat the feedwater 350 deg. fahr. It also shows how the necessary boiler and economizer surface varies with different temperatures of feedwater and that the total boiler and economizer surface is less than the necesary surface of the boiler only without economizer. For maximum economy, counter-current heat-flow effect must be employed in boiler plants.

Economizers pay under almost any conditions if they are installed correctly, especially if we take into consideration that they replace more than their own amount of boiler surface. It should be general practice to install smaller boilers which may be forced to greater overloads and the consequently high flue-gas temperatures reduced in economizers. Water should always enter boilers at above 325 deg. fahr. In fact, it is the approach of feedwater temperature to steam temperature in the boiler that is a measure of fuel loss resulting from not employing at all or not to full enough extent the principle of counter-current heat flow. Fig. 5 applies when there is sufficient heat in the flue gas to heat the water to the temperature of the steam, giving the fuel loss for whatever temperature of water enters the boiler. With this chart, it is possible to tell not only what good a certain economizer installation accomplishes but also what good it does not accomplish.

Boiler Capacity

When boiler capacity is increased by the burning of more fuel, the following either does or may occur:

1 Temperature in combustion chamber increases
2 Temperature of gas throughout boiler setting increases
3 Temperature difference between water in boiler and gas surrounding tubes and drums increases
4 Gas velocity increases
5 Heat absorption by radiation increases owing to higher furnace temperature
6 Heat absorption by convection increases owing to higher gas velocity and higher temperature difference
7 Flue-gas temperature increases
8 Dead spaces become more active
9 Incomplete combustion increases

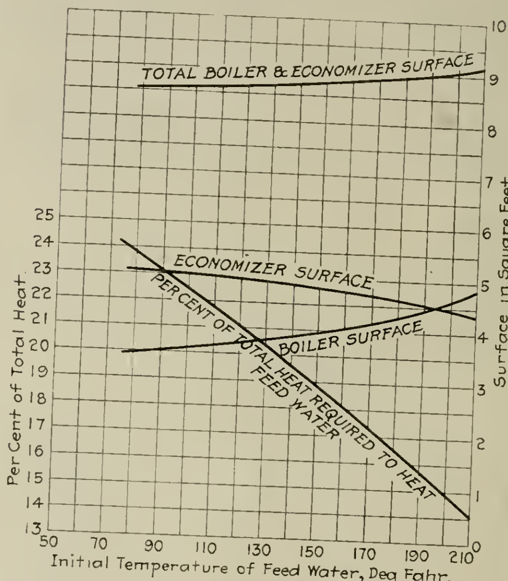

Fig. 4 Heat Required to Raise Feedwater to Temperature of 350 Deg. Fahr.

Based on economizer heat transfer of 3 B.t.u. per sq. ft. per hr. per deg. fahr.

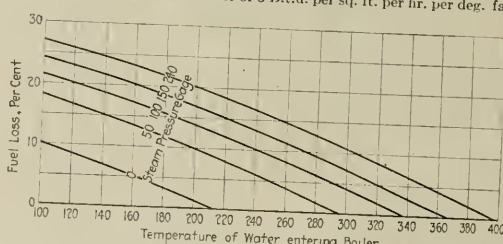

Fig. 5 Fuel Loss When Water Enters Boiler Below Steam Temperature

This figure applies only when water could be preheated by waste heat.

10 Fuel loss resulting from air in leakage and radiation expressed as a percentage of total decreases
11 Excess air decreases
12 Fireman's attention usually increases
13 Return received from investment increases.

There are several factors in this list that counteract each other, some increasing and others reducing efficiency, but as a balance, within limitations, increased boiler capacity is more economical, especially when the installation is correctly made.

It is the writer's experience that the very large majority of plants possess and operate too many boilers, at times twice as many as necessary. The cry is, "Give us plenty of boilers," and the result is waste in investment and waste in operation.

Since high boiler efficiency at low ratings is more difficult to obtain than at high ratings, it follows that owing to this and also for

(Continued on page 726)

Fuel Saving in Relation to Capital Necessary

Investigation Shows Economy Resulting From Use of Efficiency Equipment—Concrete Illustrations Given in Support of the Theory Discussed

By JOSEPH HARRINGTON,[1] CHICAGO, ILL.

SOMETHING definite and reliable in the way of information for the enlightenment and guidance of the prospective investor in efficiency equipment seems to be needed, and the object of this paper is to provide evidence to support the rather general understanding that it pays to economize. The author's original opinion was that there would be no difficulty in obtaining an abundance of first-hand information from engineers and owners who have recently installed efficiency equipment. These men invariably express satisfaction with the outcome of their endeavors, and it was thought that a compilation of such evidence would be the best possible manner of presenting this subject to the public.

In furtherance of this idea, numerous letters were written to consulting engineers, chief engineers of power plants, and owners, stating the desire of the author to secure such data. In all cases, with about three exceptions, the replies were similar, and to the effect that, while they had done this class of work, they had no records or data on which to base any figures, and they were therefore unable to provide the information requested. This in itself seems to be a fitting subject for serious thought.

Engineers in general are supposed to work along lines of precision and not guesswork, and it seems rather like an unfavorable commentary on the profession, as a whole, to state that less than five per cent of those corresponded with were able to furnish any data at all. It seems necessary, therefore, to draw upon the experience of the few having such data and let these specific instances form the starting point for what is hoped will develop into a strong body of testimony in favor of efficient methods.

Let me first present a theoretical discussion which forms, in all cases, the nucleus of the whole matter. Consider a unit of 500 hp. to be operated at 200 per cent of rating over a 10-hr. manufacturing period with coal used for starting and banking, which brings up the total coal to the equivalent of 12 hr. at double rating. This then requires 12,000 boiler hp-hr. per day, which, at 4 lb. per hp-hr., amounts to 48,000 lb., or 24 tons of coal. Now, assume that the more efficient equipment will either utilize an equal tonnage of a grade of coal costing one dollar less per ton, or by an increase in efficiency reduce the amount of coal actually used by an amount which is the virtual equivalent of the one-dollar differential. We start, then, with either a direct decrease in coal cost or an efficiency producing a differential or saving of one dollar per ton. Twenty-four tons at one dollar would provide a net saving of $24 per day.

Now, the investment necessary to save this amount, we will say, is made up as follows:

One mechanical stoker	$5000
Fans and installation cost in excess of equivalent hand-fired setting	2000
Total	$7000

This amount of $7000 divided by 24, gives 292 days as the time required for completely recovering the initial investment. This is approximately the number of working days in one year, so that in this case, it could be stated that the investment provided a return of 100 per cent per annum. Should there be a greater or less differential in the price of coal or in the efficiency, this figure must be modified accordingly, or if there is a greater cost initially, the returns would be correspondingly diminished; but assuming that this is substantially correct, the dividends are of such magnitude as to overshadow any other form of investment other than finding the money or striking oil. It can be reduced to one-half or one-third of this figure, and still loom up as a phenomenal return for any concern, however prosperous. It is more than improbable that any such return can be secured by investing the same amount of money in equipment directly providing the output of the institution in question.

To support this by specific evidence, the author presents a few concrete illustrations. The power plant of the Waterloo, Cedar Falls and Northern Railway Company was overhauled in the fall of 1913, and the author followed this installation through for some two years thereafter, the results being published in the August

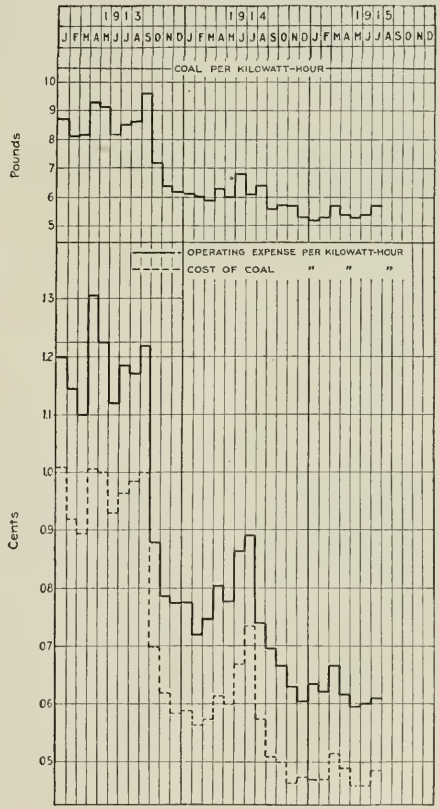

Fig. 1 Effect of Campaign to Cut Coal Cost

22, 1916, issue of *Power*. Two of the resulting curves are shown in Fig. 1. In this case there were four 500-hp. boilers installed, replacing older water-tube boilers which were also fired with the same make of stoker. With the same stoker, the same fuel, and similar boilers, the savings may very definitely be attributed to the greater efficiency secured by the then more modern setting. Not only was the furnace better proportioned and much more ample, but efficiency equipment was installed, such as gas-analysis recorders, draft gages, recording thermometers, feedwater heaters, and coal-weighing equipment. A simple system was developed for watching the indications of these instruments and drawing therefrom the logical deductions. In this particular instance, the new equipment actually paid for itself in a little over a year's time. It will be

[1] Vice-President, James A. Brady Foundry Co. Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. Copies of the paper may be obtained gratis upon application. All papers are subject to revision.

observed that the coal cost per kw-hr. was just about cut in two.

During the summer of 1919 the Armour Institute of Technology made a change in their mechanical stokers from the old-style chain grate to the new traveling grate, boiler and other conditions remaining exactly the same.. The modern stoker had a better grate ratio (70 sq. ft. grate surface as against 90 sq. ft.) and was designed to be more efficient at the lower ratings which occurred during the major portion of the year. Only for about two months in the year was the boiler worked up to anywhere near its capacity. Natural draft was used throughout this period—chimney 175 ft. high. The average pressure was 100 lb. gage and the average feedwater 198 deg. fahr. The remarkable result of this change is best shown in the curves in Fig. 2, furnished by Professor Gebhardt, and in the accompanying data in Table 1. Owing to the fact that no change was made in this case other than the stokers, we can safely attribute the improvement to the improvement in the stoker.

Figuring on the basis of Carterville, Ill., No. 3 washed nut coal at $5.67 per ton delivered to the boiler-room floor, an annual gross saving of $1553.58 was realized on the total saving of 274 tons of coal. The average cost of repairs to date is $50. The approximate price of the new stoker was $3500 and the installation

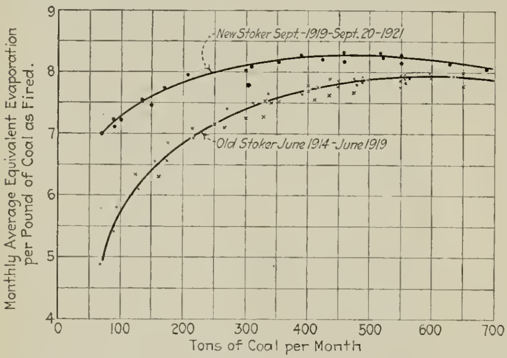

Fig. 2 Average Monthly Evaporation, 350-hp. Stirling Boiler, Armour Institute of Technology, Chicago

cost $1000, making a total of $4500. The return on the investment is therefore 33.3 per cent.

TABLE 1 SAVINGS OBTAINED BY USE OF NEW STOKER

	Average Evaporation		Saving in Coal		
	Old Stoker[1] *A*	New Stoker[2] *B*	Tons burned New Stoker[2] *C*	Tons required Old Stoker *D*[3]	Tons Saved[2] *E*[4]
June-Aug.	5.5	7.2	84	110	26
Sept.	5.5	7.2	85	111	26
Oct.	7.2	8.0	248	276	28
Nov.	7.5	8.2	335	366	31
Dec.	7.8	8.3	463	493	30
Jan.	7.9	8.2	543	554	20
Feb.	7.9	8.2	529	549	20
Mar.	7.6	8.2	413	445	32
Apr.	7.2	8.0	253	282	29
May	6.9	7.9	218	250	32
			3162	3436	274

[1] June 1914 to June 1919
[2] June 1920 to June 1921
[3] $D = (C \times B)/A$
[4] $E = D - C$

A third instance of a quite different nature is exemplified by the work of Neiler, Rich & Co. at the University of Chicago during the past season. The boiler room here consists of a number of 72-in. by 18-ft. horizontal return tubular boilers, stoker-fired, and using the usual run of bituminous coal that comes into the Chicago market. Considerable difficulty was experienced in carrying the 1919–1920 load on twenty boilers. Neiler, Rich & Co. undertook to keep this plant in operating condition until a new plant could be completed, so that what was done was merely for the purpose of keeping things going until that time, and not with the idea of a permanent improvement. No attempt was made to change any of the equipment, but it was found that the draft loss due to circuitous gas passages was very great, providing insufficient furnace draft. The combustion chamber was entirely too small, so that attention was given to improving these conditions.

By a change in the brickwork surrounding the boiler, both of these improvements were accomplished. Examining the boilers, it was found that there was insuffcient circulating space between the tubes; this was corrected by removing one of the center rows and several tubes at the sides, which too closely approached the shell. These changes provided circulating space for the downward and upward flow of the water.

Apart from patching up the brickwork, covering pipe lines, etc., nothing else was done; but it was found that these changes enabled the engineer to carry a somewhat increased load on fourteen boilers. The same coal was used, and the same chimney and breeching connections were retained, so that in this instance the economies are properly credited to improved boiler circulation, furnace draft, and combustion space. The coal saving is not proportional to the number of boilers used, because the better circulation in the boiler enabled higher capacities to be carried. Very accurate figures are not available in this instance, but it is beyond controversy that the cost of the improvements made will be covered by the fuel saving, within the period of two heating seasons.

BOILER-PLANT EFFICIENCY

(*Continued from page 724*)

investment reasons, boilers should be installed designed for high overloads and high and constant efficiency over a considerable capacity range. Especially in plants where load varies a great deal the boilers should be able to take the peaks; even if these peak loads are somewhat uneconomical they are to be preferred to boilers loafing the greater part of the time. As a rule good boilers, well installed, should be operated at between 150 and 200 per cent of rating, and when a peak is of short duration 300 per cent of rating is permissible. Ratings below 150 per cent should not be permitted except under unavoidable circumstances.

Features of an Ideal Boiler Installation

It may appear to some that the boiler with its appurtenances has been developed to what might be called the limiting point; this, however, is not so. There remains an immense field for experimental research to obtain the necessary data for boiler construction.

The ideal boiler installation of today should embody the following features:

1 A construction permitting counterflow where flue gas will heat the feedwater for the boiler which will enter the boiler at as nearly the steam temperature as load fluctuations will permit
2 A combustion chamber sufficiently large and effective throughout to prevent the entrance of any flame among the tubes, thus assuring complete combustion, absence of soot, and proper cooling of the gas
3 Boiler passes which will be effective throughout without dead spaces where there is no gas flow or only little, and in which the draft drop will be the minimum corresponding to gas velocity. The gas velocity will be the highest permissible by the cost of producing this velocity
4 Fuel resistance will be overcome by forced draft
5 The relative location of fire bed and boiler-heating surface is to be such that the maximum possible amount of radiant heat will be transmitted to the boiler surface consistent with complete combustion
6 Tight boiler walls properly insulated, probably an air-jacketed furnace, the air from which will be injected over the fire bed at high velocity to aid mixing effect or passed through the grate in the ordinary way
7 A stoker permitting combustion with no more than 15 to 25 per cent excess air, no more than 1.2 per cent unburned carbon in ashpit, no deposit of slag on the tubes and these conditions maintained at low and also at reasonably high ratings
8 Scale deposit in the boilers prevented by specially constructed self-cleaning boiler, external chemical treatment of feedwater, use of distilled makeup water, filtering of the water in the boiler by recirculation or by a combination of these methods.

Control of Centrifugal Casting by Calculation

By ROBERT F. WOOD, BAYONNE, N. J.[1]

In the application of various methods of centrifugal casting there arises frequently the question of the influence of speed of rotation upon the shape or characteristics of the casting. This is particularly true if the axis of rotation is not in a horizontal plane, in which case the effect of any change in speed of rotation or in inclination of the axis is immediately felt, since every such change is accompanied by a corresponding modification in the paraboloidal shape of the bore of the casting. For certain classes of work advantage is taken of this fact to produce centrifugal castings of more or less tapering shape, instead of cylindrical as ordinarily made, an instance in point being the production of cast tubes for submarine periscopes.

This paper analyzes the controlling factors, with a view first of setting down the definite mathematical relations between them, and secondly so expressing these relations as to make them useful both in the design of machines for casting and in the operation of such machines.

As a basis for this analysis there are selected several processes which have long been on record in the U. S. Patent Office, and an examination is made of the forces brought into effect when these processes are carried out. Equations and formulas are deduced which cover the general case and which can accordingly be used for the solution of any particular case; these are so arranged as to fit them for practical everyday use, and illustrations of their application are given.

CENTRIFUGAL casting, as here dealt with, concerns concentric methods or those wherein the axis of rotation lies within the casting, in a central position. As the casting operation may be carried out in a horizontal, a vertical, or an inclined position, methods of casting fall naturally into three corresponding divisions.

The simplest, oldest and commonest method of making centrifugal castings, and the one which produces by far the greatest tonnage, is with the axis of rotation lying in a horizontal plane. The fluid material, such as molten metal, is introduced into a horizontally mounted rotating mold, over the interior surface of which the material becomes spread out by the action of centrifugal force. When solidification has taken place there is obtained a casting whose outer conformation is a reproduction of the internal shape of the mold, and whose inner surface is cylindrical and symmetrical about the axis of rotation. This process has been experimented with for a hundred years or more, has been the subject of numerous patents for nearly as long, and has long been in commercial use in this and in other countries.

Vertical casting also has been practiced for a long time, but in its application has not found nearly so broad a field as has the horizontal method. Here again the method consists essentially of introducing molten metal or other fluid material into a rotating, but in this case vertically mounted, mold. Instead of forming a cylindrical inner surface, as in horizontal work, the metal here takes a bowl-shaped form; the shape of this curve is that of a paraboloid of revolution, and the higher the speed of rotation, the more nearly parallel will the sides of the paraboloid become. If the speed is kept relatively low the resulting casting will be only moderately hollowed out, or dish-shaped, and with intermediate speeds intermediate results will be obtained.

If the axis of rotation be inclined, a casting with a more or less bowl-shaped interior will result, and here too, by properly adjusting the speed, the bore of the casting may be made to approximate either the near-cylindrical or the bowl or dish shape. Mathematically considered, the inclined axis opens to us the general case, a concentric centrifugal casting made in any position; the horizontal and vertical positions are special cases at the two limiting extremes of the general proposition.

Castings with Paraboloidal Bores

The production of castings with paraboloidal bores by use of inclined or vertical methods is covered in a number of patents extending over the past fifty years. However, there is nothing to indicate that control of these methods was developed very far, and it is probable that their application was so limited that until lately there was no great need for refinement of control. We shall here refer to a few of the more important of these patents, and analyze the principles involved.

British patent 3819 by Taylor and Wailes in 1878 states that the inner surface of the casting forms "in fact a ring-shaped section of the paraboloid of revolution which is the form taken by the free surface of a mass of heavy liquid in rapid rotation round a vertical [or inclined] axis;" British patent 21,213 by Huth in 1895 states that the metal "is thrown to the periphery and is raised in such a manner as to form a parabolic curve to correspond with the velocity of rotation....The parabole....depends upon the radius of the wheel and the velocity of rotation;" and patent 98,673 by Davies in 1870 mentions the "hollow" or "basin" that forms in the center. The Huth and Davies patents are both for vertical machines; there is nothing to indicate whether or not work had been done with an inclined axis, but Taylor and Wailes are very clear on this point. Huth knew that a paraboloid was formed when casting vertically, and Taylor and Wailes were clearly aware that when made in any position other than horizontal the casting would have a paraboloidal

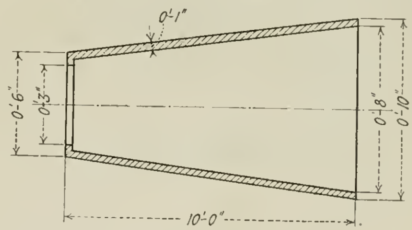

Fig. 1 Dimensions of Desired Casting

or basin-shaped bore. Davies proposed to cast cannon by his method, and Huth showed how, when casting shells, his plan was adaptable to making the bore of the casting somewhat conform by its paraboloidal shape to the pointed shape of the shell.

The inclined or the vertical method is indicated wherever the requirements of the shape of the bore can be approximated by a paraboloid, as for instance in the production of a casting whose finished bore is to be the frustum of a cone. The specific purpose for which this control was devised and used was the production of hollow tapering brass castings about 6 in. in diameter and upward of 20 ft. long for submarine-periscope tubes. However, as the solution is here worked out for the general case, it may be used to determine conditions for making concentric centrifugal castings of any size and in any position. Owing to the simplicity in principle of horizontal casting, it finds but little application there; inclined casting, however, is not so self-evident in principle, and really requires this exact means of control which is especially useful in connection with large work where cut-and-try methods are ruinous and where dependable data must be at hand before adequate specifications can be drawn for equipment, or intelligent plans made for its use.

It can be shown that the bore of a casting made with axis inclined is paraboloidal, and that the equation of the parabola has the form $x = ay^2$, with the axis of X coinciding with the axis of the casting and with the vertex at the origin. The coefficient a has the value $a = 0.61463\ (R^2/\sin\ \alpha)$, where R is the revolutions per second and α is the angle of inclination of the axis. Another value for the coefficient a is found to be $a = L/(y_2^2 - y_1^2)$, where y_2 and y_1 are any two radii (in feet) of the bore, and L the axial distance (in feet) between them.

Production of a Given Casting

Suppose now it is desired to produce a rough casting which will allow of machining to the shape and dimensions shown in cross-

[1] Metallurgist, Monel Metal Products Corporation.

For presentation at the Annual Meeting, New York, December 5 to 10, 1921, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

section in Fig. 1. Allowing finish on the various diameters and extra length for cropping, the rough casting to be obtained, with its dimensions, may be taken as shown in cross-section in Fig. 2, which also illustrates where the parabola will be located with respect to the casting.

Taking the radius of the large end of the rough casting as y_2 and the radius of the small end as y_1, the equation of the parabola which will generate the required bore is found to be $x = 121\ y^2$.

At this point it is well to determine the speed range within which the parabola $x = 121\ y^2$ may be produced. From the equivalent expressions for the coefficient a it is seen that for every assigned value of inclination α there will be a corresponding value for R, the speed of rotation. In the example before us the highest speed that may be used is found by assigning the values $a = 121$ and $\alpha = 90$ deg., which makes $R = 14$ revolutions per second or 840 r.p.m., for the mold vertically placed.

For a very elongated parabola, owing to the high value of the coefficient a the speed corresponding to vertical or steeply inclined positions may come out so high as to show at once that only moderate values of α should be selected if it is desired to avoid excessive speeds of rotation.

The lower limit of speed may be found, theoretically, at the

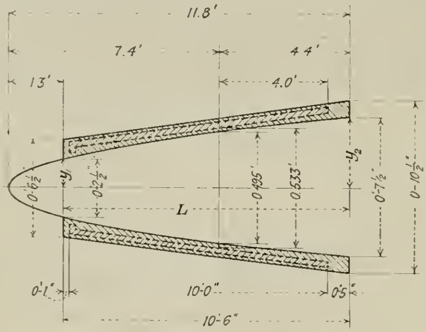

Fig. 2 Rough Centrifugal Casting for Machining to Dimensions Shown in Fig 1

least inclination whose corresponding speed value is just sufficient to carry the metal around in the mold. This theoretical lower limit need not be solved for, however, as requirements of practice naturally demand a higher value, determined experimentally or in regular operation. If we assume that the lowest practical speed for a casting of this type has been set at 400 r.p.m. we may then use the values $a = 121$ and $R = 400/60 = 6.67$, getting thereby the value $\alpha = 13$ deg. inclination. For every value between 13 and 90 deg. there may be found in similar fashion a corresponding speed value lying between 400 and 840 r.p.m., and every correlated pair will produce identically the same shape of casting. (This suggests the somewhat odd conception of the possibility of a rotating mold waving irregularly about during the casting operation without detriment to the shape of the casting, provided only that the rotation be accelerated or retarded in harmony with the gyrations of the apparatus.) It may happen, in case the coefficient a has a low value, that the lowest speed permitted by requirements of practice can be attained or approached only by use of the highest speed allowed by the equation of the bore, i.e., by using the vertical position; a good example of this may be found in the Huth patent.

From the foregoing will be seen the utility of these calculations in the design of equipment. By ascertaining the equation of the parabola that will give to the bore the desired shape, and then by assigning the desired speed or range of speeds of rotation there may be obtained immediately the angle or the range of inclination of axis, which must be known before plans for the casting equipment can be laid out. Conversely, having given the range of speed and the range of inclination of any machine, it is then possible to ascertain whether any particular piece of work will fall within those limits.

Weight of Metal Required

Having found the relations between inclination and speed, it is convenient to find the weight of metal needed to form the casting. This is done by taking the difference between the volume of the mold (frustum of a cone) and the volume of the bore (frustum of a paraboloid) and applying to it the per-unit weight for the metal used. For the case in hand the volume is thus found to be, by well-known formulas, 2.42 cu. ft., which, if the metal weigh 500 lb. per cu. ft., indicates 1210 lb. as the weight needed to make the given casting. Shrinkage may be allowed for in the per-unit weight used. In this connection it is worth while noting that no matter what be the per-unit weight of the material, the control equations are not changed; conditions relating speed, inclination, and shape of bore are the same whether for lead or for aluminum.

As in other matters, many specific cases will be found to have features peculiar to themselves for which special provision must be made. For instance, after ascertaining the equation of the parabola that would fit in with the rough inside diameters assigned in Fig. 2, it would be desirable to find out whether the bore as cast would encroach at any point upon the thickness of extra metal needed for inside finish, owing to the bulging shape of the sides of the parabola. In some cases these factors can be taken care of without calculation, in others it may be necessary to determine the diameters of the rough bore at certain points, or to solve by familiar methods for the slope of the curve (for parabola of form $x = ay^2$ the slope is $1/2\ \sqrt{(ax)}$ or $1/2\ ay$), to compare this slope with the shape of the finished bore at and near the point under examination and then to modify the parabola accordingly if necessary. To illustrate, the slope of the wall of the finished casting (Fig. 1), is $^1/_2(10 - 6)/120$ or 0.0167, corresponding to 0 deg. 57 min., while the slope of the parabola at the large end of the casting, where y has been found to be 0.3125 is $1/(2 \times 121 \times 0.3125)$ or 0.0132, corresponding to 0 deg. 46 min., which being less indicates that there will be at least some encroachment of the kind mentioned. By investigating the amount and the location of this encroachment by a side calculation, it will be found that there remains a finish of $^7/_{16}$ in. on the inside diameter at the most critical point. If this finish is not enough, the lack is made up by taking a smaller inside diameter for either end or for both ends of the rough casting and recomputing the parabola.

Application of Calculations to Long Tubes

Another use to which these calculations could be put is to control the casting of long cylindrical tubes of small diameter, in which there might be some likelihood of the metal not reaching evenly to the far end of the mold before freezing. In cases like this it is evident that the cylindrical shape could be approximated by setting the mold at a slight inclination and driving it at first, during introduction of the metal, at a speed relatively low, thus giving the metal a chance to flow downward, then increasing the speed so as to obtain the near-cylindrical shape. This plan is closely equivalent to the mode of operation in a number of old patents, among them 648,601, Stridsberg, year 1900. By calculating the shape of the bore for the several speeds used this kind of control could be developed quite satisfactorily. Speed requirements for the vertical casting of near-cylindrical shapes may be calculated in a similar way. No illustrations are needed here because the computations are similar to those already described, differing only in their application.

Regulation of Speed or of Centrifugal Force

Reference was made to the fact that calculation of the theoretical lower limit of speed was made unnecessary by reason that requirements of practice demand a higher value. By this is suggested a question upon which there has been a little difference of opinion among various operators of centrifugal casting processes, and since it directly concerns the subject of control a brief analysis of it here should not be out of place. Let us say that in order not to rotate the mold so slowly as to run the risk of spoiling the casting, a certain speed of rotation has been settled upon and accepted as the most favorable one for castings of a certain diameter. It seems pretty well agreed that having been determined for one diameter, this favorable speed condition should be extended, if possibie, for the sake of uniformity in practice, to cover other diameters. In the main, two different means have been adopted in the effort to

(Continued on page 730)

Avoidable Waste in Locomotive Operation as Affected by Design

By JAMES PARTINGTON,[1] NEW YORK, N. Y.

The best way to overcome waste in locomotive operation is to design the locomotive in the first place so that it will fulfill the efficiency requirements of

1 A drawbar horsepower for the minimum amount of fuel

2 A drawbar horsepower for the minimum amount of weight of locomotive and tender

3 A drawbar horsepower for the minimum cost of repairs.

Fuel economy is effected by firebrick arches, superheaters, feedwater heaters, generous steam spaces, automatic stokers, etc. Minimum weight is secured by careful design of the machinery parts, use of special materials, use of the independent booster for special grades. Minimum cost of repairs is dependent on the use of as few bolted parts as possible, accessibility of parts, removability, and interchangeability. Standard replacement parts can be secured from builders.

Much waste in locomotive operation can be avoided by making a careful study of present motive-power equipment, modernizing it where necessary, or replacing it by new equipment.

IT SEEMS advisable to consider this subject from the constructive standpoint of indicating what constitutes good design as demonstrated by locomotives in actual service, rather than to attempt to point out the defects in locomotives which do not show maximum efficiency. If any power plant or engine is not properly proportioned for the work it has to do, the most expert skill in operation can reduce only in part the waste resulting from having such equipment in service.

First, considering the design of steam locomotives from the standpoint of new equipment, when a railroad company is in the market for new locomotives its requirements may be met sometimes by duplicating locomotives in service on their road, but adding newly developed attachments which make for increased efficiency and economy. More frequently, however, it will be found that increased traffic, change from wooden to steel cars, improvement in track, roadbed and bridges, etc., will justify and make advisable the adoption of locomotives of a larger and more powerful type.

Then careful consideration must be given to service requirements —maximum loads to be hauled, capacity of cars, approximate proportion of loaded to empty cars per train, grades, curves, running time over divisions, maximum allowable load per axle, location of coal chutes and water tanks, clearances, conditions under which trains must be started, and any other special requirements of the service.

Having determined the drawbar pull necessary, it remains to design a locomotive that will have the following efficiency requirements:

1 A drawbar horsepower for the minimum amount of fuel

2 A drawbar horsepower for the minimum amount of weight of locomotive and tender

3 A drawbar horespower for the minimum cost of repairs.

Fuel Economy

As standard practice in modern locomotives, a sectional brick arch in the firebox and a fire-tube superheater should be applied as a means of saving fuel in any class of service. A sectional brick arch is low in first cost, easily applied and easily renewed. It usually accomplishes a fuel saving of from 10 to 12 per cent in coal-burning engines, and about 5 per cent in oil-burning engines.

The very general use of superheaters has gradually brought about improved conditions of cylinder lubrication which now make it possible and desirable for the greatest economy to use a high degree of superheat, 250 to 300 deg. now being considered the best practice. A saving of 25 to 30 per cent can be obtained.

[1] Estimating Engineer, American Locomotive Company. Mem. Am. Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

The use of feedwater heaters will further conserve fuel, and these are now in general use in continental Europe and are gradually being applied to locomotives in the United States. The saving that can be realized is as much as 12 per cent. The initial cost is considerable, but the effect of the feedwater heater in operation, aside from fuel economy, will be to help reduce other boiler-maintenance charges.

The general proportions of the boiler should also receive careful consideration. For the best results with bituminous coal, the length of the boiler tubes should be approximately within the following limits;

Size of tube, in.	Distance over tube sheet
2	18 ft. 0 in. to 19 ft. 6 in.
$2^1/_4$	22 ft. 6 in. to 24 ft. 6 in.
$2^1/_2$	28 ft. 0 in. to 30 ft. 0 in.

For many designs of locomotives, a combustion chamber can be provided, and this will help further in the economical production of steam. A generous steam space should be provided, and the throttle designed and located to secure dry steam. The evaporative capacity of the boiler should be as nearly 100 per cent of the maximum steam requirements of the cylinders as the type of locomotive will permit. Based on 100-per cent boiler, the grate area should be sufficient to prevent the maximum coal consumption per sq. ft. of grate per hr. from exceeding, for bituminous coal, 120 lb., and for anthracite coal, 55 to 70 lb., depending on size.

When the total coal consumption exceeds 6000 lb. per hr., it is generally necessary to apply an automatic stoker. These have now been so adapted to locomotive requirements that a properly designed stoker will show economy over hand firing, aside from the necessity of its use on account of the coal consumption being greater than the physical capacity of one fireman if the boiler were hand-fired.

The arrangement of deflector plates and netting in the smokebox should be carefully adapted to the fuel and combustion conditions, to provide minimum fuel waste and minimum back pressure in the cylinder-exhaust passages with proper provision against fire hazards which might obtain by the throwing of sparks.

The boiler being designed to produce steam at a minimum cost, it is now necessary to design the engine to use this steam with maximum economy.

The cylinder proportions and diameter of the drivers should be such as will develop maximum horsepower at the ruling speeds for train movements. The greatest horsepower of locomotive cylinders will usually be developed within a piston speed ranging from 700 to 1000 ft. per min. Therefore, if other traffic conditions will permit, the operation of trains within these limits should show the greatest operating economy.

Minimum Weight of Motive-Power Equipment

The weight on the locomotive drivers gives an engine friction, independent of other factors, of 22 lb. per ton. The desirability of avoiding excess weight on the drivers from this standpoint alone is therefore readily apparent. When the type of engine will permit, this weight should not exceed what is necessary to give a satisfactory factor of adhesion; this is usually $4^1/_4$ times the maximum tractive power. All weight in excess of this and all other excess weight and excess tender weight should be eliminated, as far as this can be done without detriment to the design of engine and tender. This applies with particular force to the machinery parts of the engine, especially those parts which affect the counterbalance. All saving in weight in these parts usually produces a similar saving in counterbalance weights and a reduction in the dynamic augment, which is very desirable from the standpoint of track and roadbed maintenance.

The use of special materials to keep down weight is often amply justified if repair parts can be obtained promptly when required.

This, in the past, has often been the cause of delay, but it can be guarded against by carrying a few spare parts in stock ready for renewals. High-tensile alloy steel can frequently be used to advantage for driving axles, crank pins, main and side rods, piston rods, etc.

Occasional steep grades or hard starting conditions at stations may cut down the hauling capacity of locomotives over a division to a serious extent. In such cases, the utilization of the weight on trailer trucks for additional tractive power in starting and at slow speeds may increase the capacity of the locomotive from 10 to 25 per cent, depending on the number of driving wheels and working pressure. It has been demonstrated that a separate steam engine or booster geared to the trailing axle will give this additional traction, and that it can be cut in or cut out very satisfactorily as occasion may require.

This is an item in economical operation worthy of consideration where hauling capacity is restricted by such limitations, and the use of an independent booster may often permit the satisfactory operation of considerably lighter locomotives for service of this character.

Within the limits of this paper, only the major features of design can be outlined briefly, and only such devices as have been carefully tried out and are in successful operation are cited. The writer believes the savings mentioned are well within what may be obtained in practice.

Many other improvements promising further economy in the generation and use of power in the steam locomotive are contemplated and in the experimental stage, but these do not properly come under the scope of our subject as here treated.

Cost of Repairs

It has been pointed out that locomotives and tenders should be designed to produce the required drawbar horsepower with as little excess weight as possible. In this connection, however, due consideration must be given to the question of repairs.

The design of boilers from the standpoint of weight is practically fixed by existing boiler regulations, which provide that locomotive boilers must be operated with a factor of safety of not less than four. Practically all boilers at the present time are designed with a factor of safety of $4^1/_2$, which leaves a comfortable margin between this and the minimum allowable operating factor.

The maximum stresses in other parts of the locomotive must also be carefully considered, and the parts must be designed to keep these stresses within limits which will eliminate costly failures in service.

Aside from the consideration of stresses, much repair cost can be avoided by adopting designs which reduce the number of parts, as far as reasonably may be, especially where these parts must have bolted connections. Here, however, care must be taken to avoid construction which cannot readily be removed for repairs or renewals or repaired in place with reasonable facility.

Many roads today are giving a great deal of thought to locomotive design along these lines, having especially in mind the desirability of making the engine parts:

- Accessible for oiling and inspection
- Easily removable with proper shop facilities
- Of the minimum number of pieces
- Interchangeable with equipment now in service.

The repair-shop facilities must, of course, be kept abreast of the requirements; i.e., as new and larger locomotives are put in service, turntables, cranes, machine tools, etc. must be of sufficient capacity to handle the larger equipment economically.

The repairs of locomotives can often be facilitated and the necessary shop equipment kept down to the minimum by securing from the locomotive builder many parts which he is able to turn out more accurately and more economically than the average railroad shop would be equipped to do. Such parts include:

- Flanged sheets for boiler repairs
- Flexible and ordinary staybolts
- Finished bolts and nuts
- Drop forgings
- Packing rings for pistons and piston valves
- Special equipment which requires special tools for its production.

Without attempting to pursue further the design of new locomotives it may be remarked that a study of the special conditions of individual railroads is necessary to secure equipment best suited to the needs of each.

Old Motive-Power Equipment

Much waste in locomotive operation can be avoided by making a careful survey of present motive-power equipment which is not giving as economical or efficient service as could be obtained if the engines were modernized. This applies particularly to locomotives where the service conditions demand more power than the present equipment can economically produce. All the suggestions made in regard to the design of new equipment are applicable to a greater or less degree to old equipment, providing the old equipment is not meeting the demands of the service from a power standpoint, or is not furnishing this power economically.

In making a survey of this character care should be taken to determine accurately whether the old equipment will warrant the additional cost of changes and betterments necessary to convert it into up-to-date power. This can be decided by taking the number of years the engines will be retained in service and the increased net return or saving for this period as against the cost involved for changes, interest on the additional investment, increased maintenance, etc.

A comparison should also be made with the results that could be realized by the purchase of new equipment best adapted for the service, as against the cost of contemplated changes in the old equipment.

If these comparisons show a saving in favor of modernizing the old equipment or the purchase of new equipment, every month that the engines are kept in service without doing this will result in a loss that is not recoverable. A few concrete examples of what has been accomplished in service by locomotives designed to yield maximum efficiency may be of advantage. Notable designs, for which data is available, are as follows:

- Pacific type passenger locomotive No. 50,000 built by the American Locomotive Company
- Decapod type freight locomotive, Class I1s, built by the Pennsylvania Railroad Company
- Heavy Mallet special service locomotive built for the Virginian Railway by the American Locomotive Company.

The full paper gives performance records of these three engines.

CONTROL OF CENTRIFUGAL CASTING BY CALCULATION

(*Continued from page 728*)

bring about such uniformity, and these are, first, to so regulate the speed in r.p.m. as to hold the peripheral speed at a constant figure, or, second, to so regulate it as to hold the centrifugal force at a constant figure, for all diameters. A third plan is to so regulate the speed as to keep at a constant figure the tensile stress, regarding the casting as the rim of a flywheel, which it resembles in certain respects as soon as solidification has gone far enough to allow shrinkage to begin to draw the casting in, away from the sides of the mold. If the first plan is examined, it will be seen that the r.p.m. must vary inversely as the diameters; in the second plan, on account of the nature of centrifugal force, the r.p.m. will have to vary inversely as the square roots of the diameters; the third plan figures out like the first. The second set of conditions is therefore irreconcilable with either of the other two, which indicates that any effort to find conditions under which the metal of similar castings of different diameters would be subjected to identical physical forces is likely to be a prolonged one.

Conclusion

In closing it may be observed that possibly some foundrymen will look askance at what may seem so far from sand and patterns; they may rest assured, however, that what has been set down here is of an entirely practical nature in the field within which it applies, and that once understood in principle the calculations described do not offer the difficulty nor require the time that might be anticipated on first reading.

Making Work Fascinating as the First Step Toward Reduction of Waste

By WALTER N. POLAKOV,[1] NEW YORK, N. Y.

Confusion of classes of life has resulted in building up of industry around the mistaken idea that workman is an animal and his work a commodity.

Personnel administration, employment and compensation methods recognizing the human nature of workers have failed in so far as they have either concentrated their efforts on the functions outside of the work itself or attempted to stimulate the animal instincts alone.

Such experiments as have been already conducted in uniting brain work with manual work have proved beyond any doubt that such a course liberates dormant or suppressed creative capacities of men and not only improves quality and quantity of production but, above all, substantially ameliorates industrial relations. As to the parties to industry, the advantage to be derived from such an industrial organization that brings mind into labor and makes work fascinating, are at once beneficial to owner group and to the labor group.

Owners thereby develop a steady, contented, intelligent and highly productive personnel, thus eliminating a major part of past and present embarrassments, conflicts and losses. The labor group simultaneously frees itself from the oppressive feeling of drudgery of work, satisfies its human consciousness, secures opportunities for intellectual and technical advancement and improves its material status.

Management for the first time in history attains a position of dignity and stability, since its prime function becomes that of the liberation and direction of human, creative functions instead of partially utilizing only the physical power of men.

INCREASED production has been sought by devising labor-saving machinery and by stimulating individual productivity of workers. The first method, while in itself productive of results, rapidly and inevitably developed two by-effects which greatly reduced the advantages anticipated: (*a*) Automatic high-speed machinery, sold at a high price, increases overhead often in excess of reduction in payroll, materially increasing the capital charges on manufacturing establishments; (*b*) automatic, semi-automatic, high-speed and single-purpose machinery of modern industry makes the work of its attendants monotonous because it lacks the stimulating interest furnished by work requiring exercise of the mental faculties. The general consequence of both these tendencies has been toward increased cost of production instead of expected reduction of expenses. In times of industrial depression, idle expensive equipment greatly increases the cost of ownership. The workers, on the other hand, failing to get stimulation and satisfaction from work as mere parts of automatic machinery, demand shorter hours of this drudgery and higher compensation with which they can buy the interest, stimulation and pleasure which they fail to find in the work itself.

The task before the engineer of today is to overcome the ill effects of automatization and mechanization of industry. The world needs the highest possible production and the workers demand creative self-expression in industry.

This obviously cannot be accomplished by scrapping existing machinery or putting a ban on further inventions and improvements, for such digression will not only throw us further back in output, but is contrary to the nature of mankind. Therefore, the solution will be sought in the development of means of abolishing the industrial monotony and drudgery of work by introducing into it intelligent, self-expressive, creative motives. The problem thus resolves into one of *making work fascinating* as a means of releasing the desire to work.

The early attempts to make workers personally more efficient are generally connected with the Taylor system of management. The characteristic features of this system are (*a*) specialized division of function, and (*b*) detailed time studies of operation. A score of years of trial of this system has clearly demonstrated its inherent, organic shortcomings in many industrial establishments. (*a*) Functional foremanship, with brain work divorced from manual work has made the performance of work still more automatic and irresponsible. Creative, intelligent work has also been removed from the shops themselves and concentrated in a planning department or general office, which lacks direct personal touch with workers. (*b*) Time studies and instruction cards, by standardizing workers' manipulations, have caused the operations to become still more monotonous, repetitive without variations and devoid of stimulative self-expression.

Time studies, motion studies and other means of studying the work are in themselves commendable as steps toward substitution of "guess" and "opinions" by measured *facts*. Unfortunately, however, all these means lead to standardization and mechanization of manipulations. Once man is lowered to the level of an automaton, the creative element is driven out of his work and subsequent difficulties are impending. Again, *while* the studies are being made, a healthy, stimulating interest in the work is aroused, especially if workers' coöperation is invited; but once completed, tabulated, registered and prescribed, they become a monotonous routine. Vigorous protests and even some legislation against this dehumanizing application of scientific methods in an unscientific manner have been the inevitable results.

Recognition of these fatal mistakes has prompted industrial engineers to concentrate on the shortcomings of management itself. These efforts have (1) decentralized the detached intelligence of the planning department by establishing manufacturing offices in the shops, (2) reunited the instructing and inspecting functions of foremanships, (3) substituted for time-study clerks the direct interchange of worker's skill and intelligence, (4) stimulated interest in the work by training and providing instruments for intelligent control of processes, (5) liberated the suppressed creative instincts of workers by providing them with means for observing their own progress, and, finally, (6) devised a charting method permitting the accurate measurement of managerial efficiency separately from the efficiency of workers.

Until recently the acceptance of one or another managerial policy was a matter of personal opinions or sympathies. The error of applying to the workingmen the rules and measures which take into account *only* their animal functions is that of confusing the part with the whole, inasmuch as the physical labor of men is but a part of their nature. This blunder, therefore, is even more fatal in industrial relations than a similar confusion of dimensions would be in mechanical construction.

On the other hand, the strength and correctness of our principle is in its recognition of the time-binding nature of men and consistent provisions for exercise on the part of workers of their *human*, creative functions together with liberation of purely mechanical work.

For some time past weariness of spirit and dissatisfaction with brutalizing monotony of work not only has made the workers in this country as well as abroad restless and irritable, but also has moved them to demand short hours and high pay for drudgery, while the quantity and quality of personal output has sometimes decreased in spite of concessions made.

This failure to recognize true human nature and its fundamental natural power constantly and forcibly seeking self-expression is the basic cause of the alarming extent of industrial waste. The report recently made by the committee of The Federated American Engineering Societies telling of waste in life, health, welfare and wealth caused by business and industry emphasized that: "From this knowledge will grow the certain vision that *mental and moral forces must be added* to the physical resources now employed, if industry is to serve all." It is significant that our losses are primarily due to the application of animal standards to human creative activities in industry.

[1] Consulting engineer, Walter N. Polokov & Co., Inc. Mem.Am.Soc. M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. The paper is here printed in abstract form. All papers are subject to revision.

For some time past studies of industrial fatigue have attracted widespread attention both in this country and abroad. It has been proved by various investigators that a great deal of waste in production is due to unnecessary fatigue, as distinguished from allied factors. Moreover, while mere physical fatigue gives to the man unmistakeable warning, thus preventing physical breakdown, and recuperation is rapid and complete, the nervous and mental fatigue accumulates unnoticed.

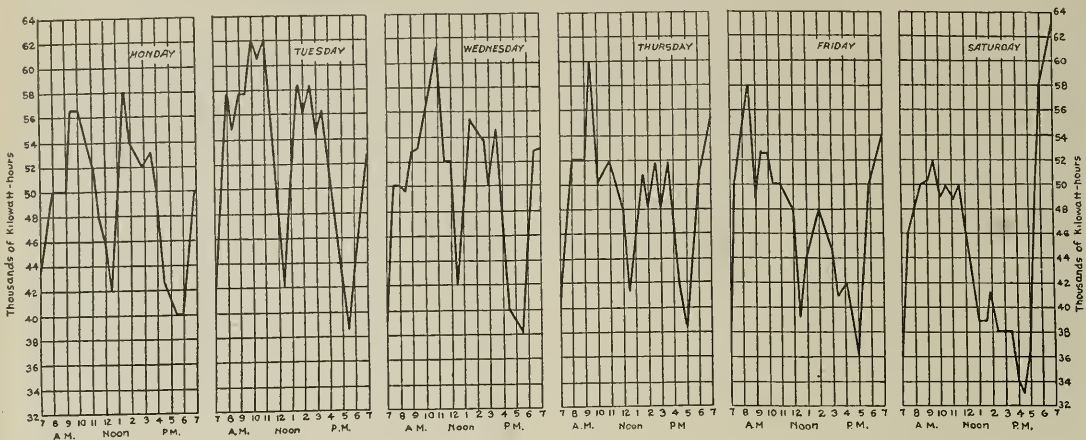

Fig. 1 Relation Between the Accumulation of Fatigue and Drop of Industrial Efficiency

Data collected by the author from records of public utilities supplying power to a variety of industrial establishments, averaging 52 Mondays, 52 Tuesdays, etc., and making a composite average load curve.

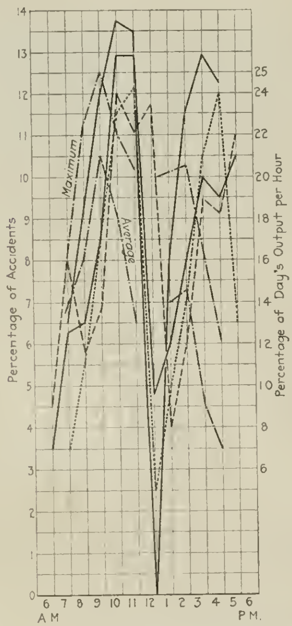

Fig. 2 Effect of Fatigue on Time and Frequency of Industrial Accidents (Due to Carelessness) and Power Used During Preceding Periods

Accidents follow production peaks in four different industries. Data collected at London docks and by several insurance companies in the United States; compiled by Chas. S. Myers, director of the Cambridge Psychological Laboratory.

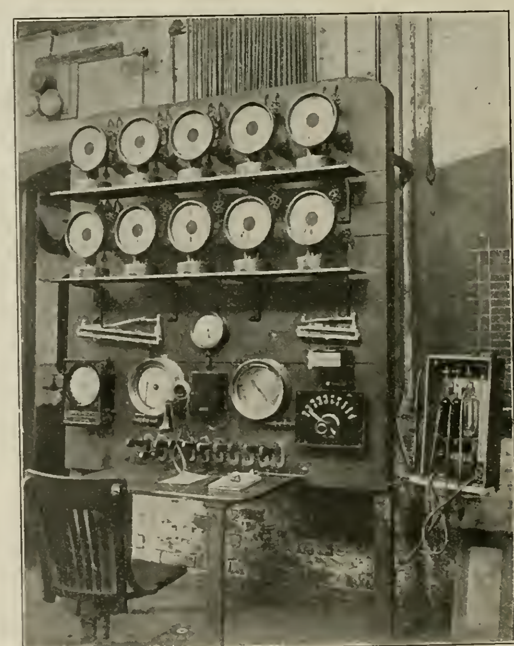

Fig. 3 Instrument Boards in Boiler Rooms Used for Intelligent Control of Processes, Largely Substituting Mental Work for Physical Exertion of Firemen and Providing Interest

that necessary for performance of work under the most favorable conditions. An even more important finding, however, is that physical fatigue itself is largely traceable to mental and nervous fatigue produced by the monotony of repetitive operations and

In this connection the elimination of monotony and the provision of mental and emotional stimuli, making work at least in a measure fascinating, is the fundamental requirement for reduction of such industrial wastes as irregular attendance, large labor turnover,

irritability of workers, inattentiveness, susceptibility to accidents, poor workmanship, high percentage of spoilage, low individual output, etc. Fig. 1 visualizes the well-established relations between

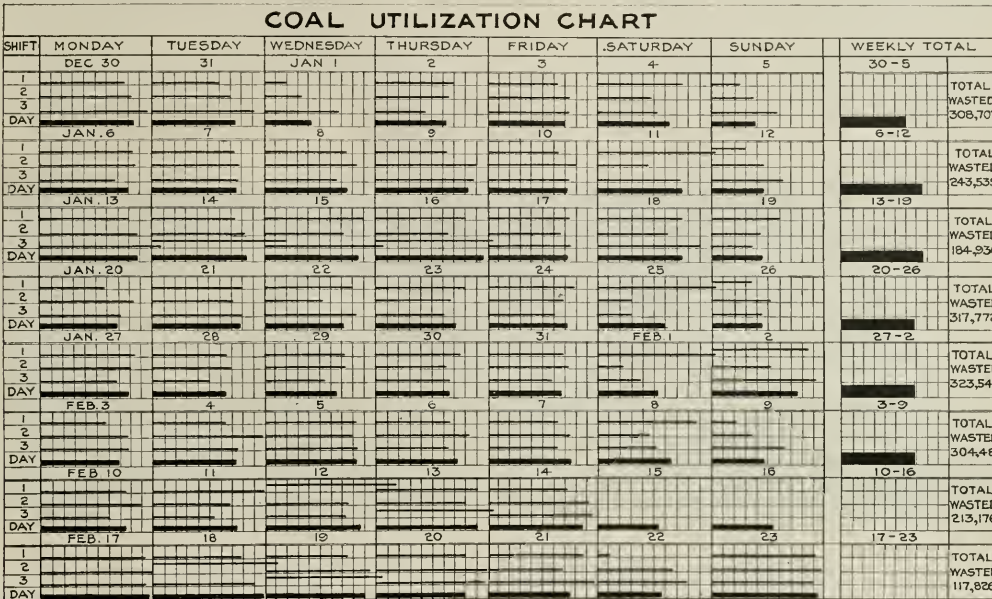

Fig. 4

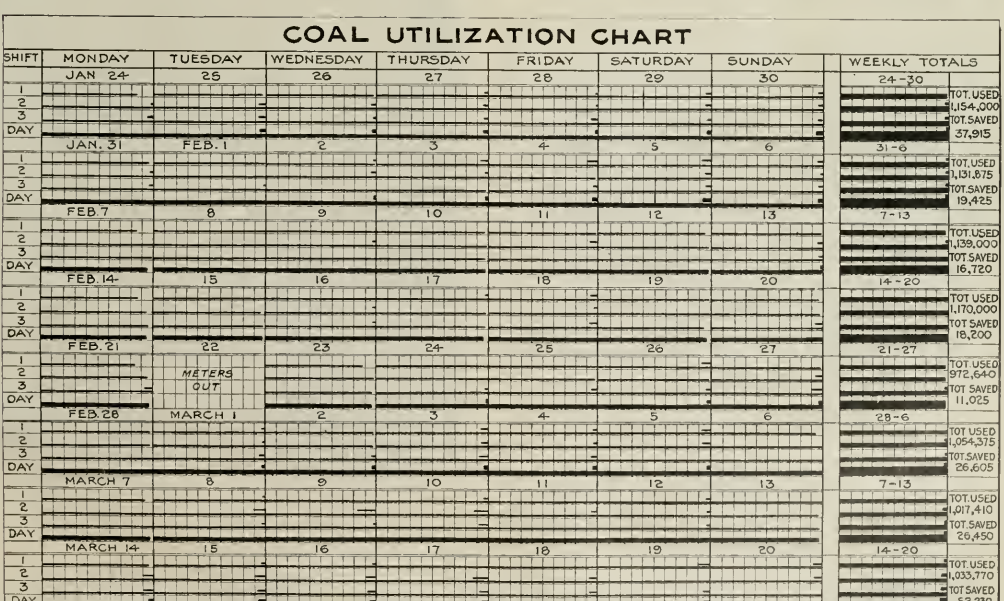

Fig. 5

Figs. 4 and 5 Coal-Utilization Charts

Based on efficiency obtained by each gang for each day. If efficiency is below 72 per cent the bars on the chart are proportionately short; if efficiency is higher than 72 per cent the bars are doubled up. Note the progress in elimination of waste from January 1919 to January 1921 on chart in Fig. 6.

the accumulation of fatigue and depreciation of industrial efficiency. Fig. 2 illustrates the effect of fatigue on the rate of industrial accidents, as well as relation to hourly outputs.

Even the most advanced employment methods alone are impotent to solve this problem, for they deal with men and working conditions *as they are*. If conditions be poor, only poor men can be selected to endure them. This means waste of productive power and a premium of steady employment to the least efficient producers. The personnel executives in their attempt to ameliorate these

shortcomings have dealt however with only one side of the situation: not being engineering executives thoroughly versed with the processes and performance of work, it has remained outside of their jurisdiction to readjust jobs themselves so that workers can derive joy and satisfaction from performing the work.

It would be a mistake, however, to think that repetitive, monotonous operations lack fascination to every one. In fact, there are certain individuals who can best express themselves by performing a well-standardized operation. They find a delight in mere mechanical functions least interfering with an independently occupied mind wandering away from the job. This *imitative* type of men should never be confused with the *creative* type, and the selection of men and women should be practiced along these lines. As to the means of making work fascinating to either type, these are as different as the types themselves.

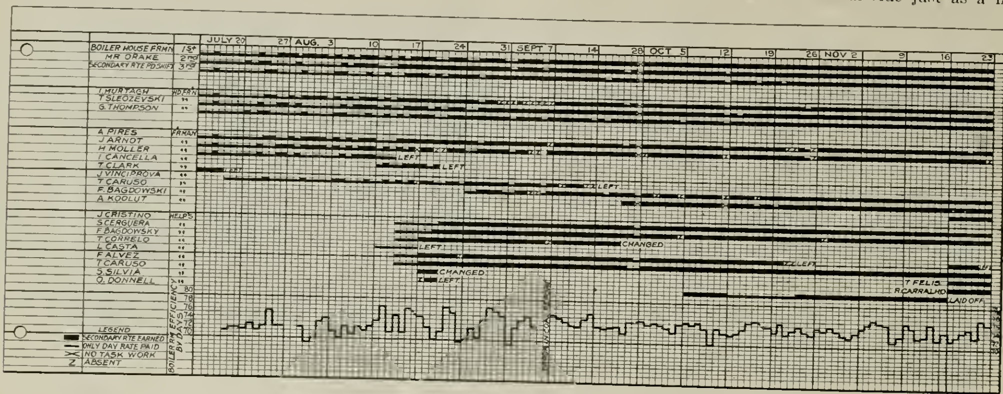

Fig. 6 Coal-Utilization Chart

Showing progress of rapid learning from the beginning of the introduction of the new method.

Instinctively feeling that at the bottom of many labor troubles the monotony of animal-like work is to be found, a large number of manufacturing concerns have adopted a policy of diverting the attention of workers from the shortcomings of working conditions to the refreshing activities of "welfare" work. Some welfare organizations render their assistance in many industrial centers by establishing their Industrial Departments under the direction of men proficient in games. While a measure of success has been recorded in several instances, this movement is obviously directed along the wrong course. It attempts to *divert the attention from work to recreation.*

Incentives to higher production, so far as workers are concerned, have been offered, both financial and non-financial. To the first group belong a variety of such forms as profit sharing, differential piece rates, incentive payments, etc.; in the second group the non-financial incentives of Wolf stand alone. As a means for securing the interest of workers in the work itself, these incentive payments are obviously unfit, for they merely create interest in securing a larger pay. The work itself, in so far as it is spurred and speeded up by anticipation of a monetary premium, becomes still less attractive. If workers were left to themselves to devise more efficient productive methods to attain offered reward, these financial incentives could prove their human worth as mental stimuli for attaining perfection, were it not for the fact that neither workers nor their immediate leaders have sufficient technical training and research facilities to develop more efficient practice without the aid of specialists.

Non-financial incentives, on the other hand, have demonstrated the value of an environment which stimulates thinking. By having opportunity to constantly increase their knowledge of the underlying natural laws of the process, the workers are able to realize the joy which comes from a conscious mastery of their part in any process.[1] The creative activity is the final aim of human beings, yet to preserve life we must not only provide the material requisites of food, clothing and shelter, but meet also the higher demands of human life commensurately with the degree of culture and service rendered. Greater service rendered is both conditioned and followed by greater material reward. It is *conditioned*, inasmuch as a man who is kept by material limitations on a low level of hygiene, comfort, education and refinement cannot produce higher values in his work. It is *followed*, in so far as the higher development of man's creative power is capable of producing greater values. The nature of man involves the material side just as a higher dimension contains a lower. Consequently any wage system, in order to comply with human nature, should not confuse incentives for acquisitive passion with adequate provisions enabling wage earners to reach a higher plane of cultural and productive development. This aim can be attained by a two-rate wage[1] as developed and practiced by the author; it substantially consists of a fixed

(Continued on page 765)

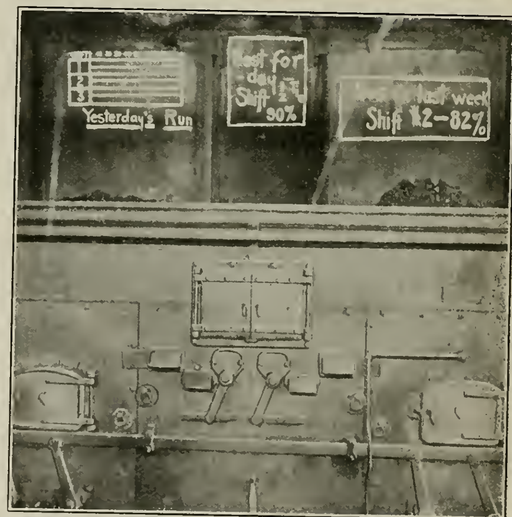

Fig. 7 Man-Record Chart Drawn on Front of Boilers and Score Recorded by Men When Work Has Lost Its Monotony

The full length of space means expected economy (72 per cent boiler and stoker efficiency); short lines indicate falling short of full efficiency. Accordingly 90 per cent means about 65 per cent efficiency of boilers.

[1] Non-financial Incentives, R. B. Wolf, Trans.Am.Soc.M.E., vol. 40 (1918).

[1] *National Engineer*, Two-Rate Wage, Walter N. Polakov, presented before N. A. S. E. Convention in Huntington, W. Va.; also Mastering Power Production by W. N. Polakov, *Engineering Management*, 1921.

Economies Obtainable by Reducing Resistances in Steam Piping

By O. DENECKE

DISCUSSION of the general principles on which the design of steam piping in power plants should be based, with comparison of formulas suggested for various elements affecting steam consumption as a function of resistances encountered to the flow of steam. The following notation is used:

Notation in Original	Notation in This Abstract	
Q	Q =	weight of steam discharged from a pipe or passage, kg. per hr.
Q'	q =	weight of condensation in the steam piping, kg. per hr.
l	L =	length of steel piping, meters
d_{cm}	d =	diameter of piping, cm.
p_1	p =	steam pressure at exit, kg. per sq. m.
p_2	P =	steam pressure at entrance into piping, kg. per sq. m.
Δ	l =	total pressure loss in piping, kg. per sq. m.
Δ_R	r =	pressure loss in piping due to friction, kg. per sq. m.
R	R =	$r \div L$ pressure loss through friction in piping per meter of length of pipe
β	b =	coefficient of friction in the piping
ζ	k =	coefficient of resistance for individual resistances
Z	Z =	Σlk = pressure loss in all the single resistances, kg. per sq. m.
γ_w	w =	average specific weight of steam at $P_1 = (p + P) \div 2$, which is the average steam pressure in the piping, kg. per cu. cm.
v	v =	average steam velocity, m. per sec.

I *Pressure Loss Due to Friction Only.* For conditions considered here the formulas

$$r = \frac{1.251\,bL}{wd^5}\left(Q + \frac{q}{2}\right)^2 \qquad [2]$$

and—since

$$\left(Q + \frac{q}{2}\right)^2 = Q^2\left(1 + {}^1/_2\,\frac{q}{Q}\right)^2 = Q^2\left(1 + \frac{q}{Q}\right)$$

$$r = \frac{1.251\,bL}{wd^5}Q^2\left(1 + \frac{q}{Q}\right) \text{ in kg. per sq. m.} \qquad [3]$$

taken from the German engineering handbook Hütte (22nd edition, vol. 1, p. 449), are sufficient.

The same handbook gives the values for the coefficient of friction, b, as a function of the weight of the steam, Q, as indicated in Table 1.

TABLE 1

Q	b	Q	b	Q	b	Q	b
10	2.03	100	1.45	1000	1.03	10,000	0.73
15	1.92	150	1.36	1500	0.97	15,000	0.69
25	1.73	250	1.26	2500	0.90	25,000	0.64
40	1.66	400	1.18	4000	0.84	·40,000	0.595
65	1.54	650	1.10	6500	0.78	65,000	0.555
100	1.45	1000	1.03	10000	0.73	100,000	0.520

On the other hand, however, Fischer and Gutermuth have adopted a constant value $b = 1.5$ and obtained the formula

$$r = \frac{1.878\,L}{wd^5}Q^2\left(1 + \frac{q}{Q}\right) \qquad [3b]$$

extensively used for low-pressure steam-heating calculations.

Eberle recommends for high-pressure piping a constant value $b = 1.05$, which gives the formula

$$r = \frac{1.31\,L}{wd^5}Q^2\left(1 + \frac{q}{Q}\right) \qquad [3c]$$

The present author derives from Equation [3] an expression for pressure drop per running meter of pipe:

$$R = \frac{r}{L} = \frac{1.251\,L}{wd^5}Q^2\left(1 + \frac{q}{Q}\right) \qquad [4]$$

which may be also expressed in the following form more convenient for slide-rule calculations:

$$R = \frac{1.251\,b}{wd^5}\left(\frac{Q}{d^2}\right)^2\left(1 + \frac{q}{Q}\right) \qquad [4a]$$

and also:

$$d^5 = \frac{1.251\,b\,Q^2}{wR}\left(1 + \frac{q}{Q}\right) \qquad [5]$$

II *Pressure Loss Due to Individual Resistances.* (Changes of direction, cross-section of piping, bends.) Each individual resistance occurring at any point x in the piping creates a loss of pressure expressed by

$$lk_x = k\frac{v^2_x}{2g}\,w_x \qquad [5a]$$

which, with Q_x substituted for v_x, becomes

$$lk_x = \frac{0.64\;Q^2_x}{w_x d^4} \qquad [6]$$

where k_x is the coefficient of resistance, the values of which are given in the German Hütte (vol. 3, pp. 415 and 419), as ζ_v.

For the ranges of pressure which have to be considered in connection with ordinary power-plant design, and for all the individual resistances (k_1, k_2, k_3, etc.), one may with sufficient precision substitute for w_x its average w and hence write $Q_x = Q + \frac{q}{2}$, so that the total pressure drop across all the individual resistances together (Σk) is

$$Z = \Sigma lk = \frac{0.64}{wd^4}\left(Q + \frac{q}{2}\right)^2 \text{ or}$$

$$Z = \frac{0.64}{wd^4}\left(1 + \frac{q}{Q}\right)\Sigma k \qquad [7]$$

or

$$Z = \frac{0.64}{w}\left(\frac{Q}{d^2}\right)^2\left(1 + \frac{q}{Q}\right)\Sigma k \qquad [7a]$$

If a substitution be made here from Equation [4] we obtain

$$\frac{Q^2\left(1 + \frac{q}{Q}\right)}{wd^4} = \frac{dR}{1.251\,b}$$

and hence

$$Z = \frac{0.51}{b}\,d\Sigma kR \qquad [8]$$

This latter, with $b = 1.5$, in accordance with Fischer, gives the following expression suitable for low-pressure steam piping:

$$Z = \frac{d}{3}\,\Sigma kR \qquad [8a]$$

and with $b = 1.05$, according to Eberle,

$$Z = \frac{d}{2.06}\,\Sigma kR$$

Since, however, the values of k and b are somewhat uncertain for

dinary calculations of high-pressure piping, the following equa-
on may be used:

$$Z = \frac{d}{2}\Sigma kR$$

III *The Total Drop in Pressure* through friction and individual sistances in the entire length of pipe L is

$$l = P - p = r + Z$$

hich with values for r and Z substituted from Equations [4] and] becomes

$$l = RL + R\frac{0.51}{b}\,d\Sigma k$$

$$l = R(L + \frac{0.51}{b}\,d\Sigma k) \ldots\ldots [9]$$

$$l = R(L + Lk) \ldots\ldots [10]$$

$$Lk = \frac{0.51}{b}\,d\Sigma k \ldots\ldots [11]$$

In these expressions the individual resistances are replaced by ngths of piping which by friction produce the same drops of essure as the respective resistances. Hence, for each $k = 1$ will be necessary to increase the piping by a length equal to:) for low-pressure piping (according Equation [8*a*]), $d/3$ meters, d (*b*) for high-pressure piping (according to Equation [8*b*] for dinary calculations), $d/2$ meters, or more correctly $0.51\,\frac{d}{b}$ eters, where b has the value given Fritzsche; the piping so ngthened should then be computed with respect to its frictional sistance. Thus, for example, if the pipe diameter is 49 mm. then each $k = 1$ it should be increased in length for purposes of culation in the case of low-pressure steam by $4.9/3 = 1.63$ eters, and for high-pressure piping by $7.35/3 = 2.45$ meters. This method of calculation has the advantage of simplicity and se of remembrance.

IV *Methods of Application* of the above equations for the solution the problem: How to reduce, by decreasing the individual sistances, the pipe diameter, and hence the cost of pipe installa-n. There are given Q, L and the permissible pressure drop $l = -p$, and it is desired to find the proper pipe diameter for ch Σk.

(*a*) $\Sigma k = 0$ gives the smallest possible diameter d_o, since then the tire pressure drop l is due exclusively to friction. Since $Lk = 0$, have according to Equation [10], $l = R(L + Lk)$

$$R_{\Sigma k=0} = R_o = \frac{l}{L} \ldots\ldots [11b]$$

d according to Equation [5]

$$d^5 = \frac{1.251\,bQ^2}{wR}\left(1 + \frac{q_o}{Q}\right) \ldots\ldots [12]$$

ere q_o gives the amount of condensate per hour for the smallest meter d_o. As q_o in well-insulated piping amounts to only a v per cent, the member $1 + \frac{q_o}{Q}$ has scarcely any influence on d d may be either neglected entirely or merely estimated.

(*b*) For any other magnitude of Σk a diameter $d > d_o$ has to be und, as in that case only part of the total drop of pressure l is due friction. From Equations [4] and [10], it follows that

$$\frac{l}{L + Lk} = R\frac{1.251}{wd^5}Q^2\left(1 + \frac{q}{Q}\right) \ldots\ldots [13]$$

ile from Equations [4] and [11*b*] we find

$$\frac{l}{L} = R_o = \frac{1.251\,b}{wd_o^5}Q^2\left(1 + \frac{q_o}{Q}\right) \ldots\ldots [14]$$

dividing [13] by [14], we get

$$\frac{d^5}{d_o^5} = \frac{L + Lk}{L}\,(1 + \frac{q}{Q})/(1 + \frac{q_o}{Q}) \ldots\ldots [14a]$$

it since it may be assumed with no great inaccuracy that $+\frac{q}{Q} = 1 + \frac{q_o}{Q}$ and since further according to Equation [11], $Lk = \frac{0.51\,d}{b}\Sigma k$, the above equation becomes:

$$\left(\frac{d}{d_o}\right)^5 = 1 + \frac{Lk}{L} = 1 + \frac{0.51\,d}{bL}\Sigma k \ldots\ldots [15]$$

Therefore, if the minimum pipe diameter d_o has been computed according to Equation [12] for $\Sigma k = 0$, the diameter d for any other value of Σk may be found from the equation

$$\frac{d}{d_o} = \left(1 + \frac{0.51}{bL}\Sigma k\right)^{\frac{1}{5}} \ldots\ldots [15a]$$

or, more conveniently, for any pipe diameter $d > d_o$, the following holds good:

$$\Sigma k = \left[\left(\frac{d}{d_o}\right)^5 - 1\right]\frac{bL}{0.51\,d} \ldots\ldots [16]$$

(*c*) Numerical example. Given:

Q = 3400 kg. superheated steam flowing per hour
L = 50 m., length of piping
p = 9 atmos. = 90,000 kg. per sq. m., final steam pressure at end of piping
P = 9.6 atmos. = 96,000 kg. per sq. m., initial steam pressure

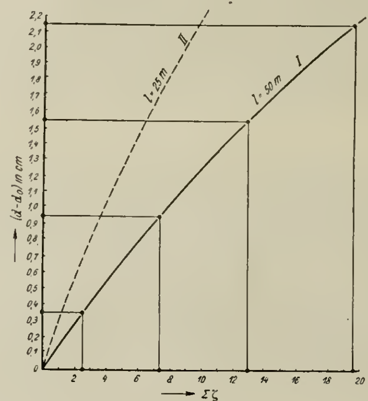

FIG. 1 CURVE SHOWING THE VALUE OF PIPE DIAMETER d AS A FUNCTION OF THE SUM OF INDIVIDUAL RESISTANCES Σk

(Note: 2,3; 2,1; etc. on the drawing mean decimal fractions 2.2, 2.1, etc.)

p_m = 9.3 atmos., = 93,000 kg. per sq. m., average steam pressure for an average steam temperature of 300 deg. cent.
w = 3.51 kg. per cu. m.
l = $P - p$ = 6000 kg. per sq. m., total pressure drop through the piping

$$R_o = \frac{l}{L} = \frac{6000}{50} = 120 \text{ kg. per sq. m., pressure drop per meter}$$

length of pipe.

According to Table 1 (Fritzsche) for $Q = 3400$ kg. per hr., $b = 0.864$ and according to Equation [12] for $\Sigma k = 0$, the minimum diameter is

$$d_m^5 = \frac{1.251\,bQ^2}{wR_o} = \frac{1.251 \times 0.864}{3.51 \times 120}(3400)^2\; d_o = 7.90 \text{ cm.} \ldots [12]$$

The nearest commercial pipe size is $d = 8.25$ cm., and hence $\frac{d}{d_o} = \frac{8.25}{7.90} = 1.044$, which gives

$$\Sigma k = \left[\left(\frac{8.25}{7.90}\right)^5 - 1\right]\frac{0.864 \times 50}{0.51 \times 8.25} = 2.49 \ldots\ldots [16]$$

The next larger commercial pipe diameters according to Equation [16] give

$$d = 8.85, \text{ hence } \frac{d}{d_o} = \frac{8.85}{7.90} \text{ and } \Sigma k = 7.3$$

$d = 10.05$, hence $\frac{d}{d_o} = \frac{10.05}{7.9}$ and $\Sigma k = 19.60$

These diameters d, or rather the differences $d - d_o$, plotted as ordinates (scale 10 to 1) with the values of Σk as abscissæ (scale 1 = 1 cm.), give curve 1, (Schmidt), Fig. 1. This shows how with the decrease of the individual resistances Σk the pipe diameter should be reduced and also permits figuring out the percentage of saving in cost of piping.

It should be noted though that the magnitude of the relative saving is affected not only by k but also materially by the length of the piping L, so that actually the guiding magnitude is the ratio $\frac{\Sigma k}{L}$, that is, the share of the total of the individual resistances for a unit length of pipe, or, say, 1 m. The smaller the value of L with the same $R_o = \frac{l}{L}$, the smaller according to Equation [16] will be the respective value of Σk for any given pipe diameter; therefore the curve will be steeper and the saving in pipe diameter with every reduction of Σk will be greater.

Thus, if in the above example, L have a value of 25 m. instead of 50 m., the values of Σk as computed from Equation [16] would have been only half as large, and instead of curve I in Fig. 1 we should have obtained curve II, which is much steeper. The shorter, therefore, the length of the piping, for example, between boiler and steam engine, the more the individual resistances, (such, for example, as the indispensable valves) increase the cost of piping by affecting its diameter.

V *General Solution.* The solution may be expressed in still more general terms, so that a single curve will suffice for all possible values of Q, L and l, for both saturated and superheated steam. In such a curve all that will be necessary will be to change the scale of abscissæ in order to read off the necessary pipe diameter under all possible kinds of operating conditions, the curve giving at once the diameter of pipe which becomes necessary through the decrease or increase in individual resistances.

If we multiply Equation [16] on its right-hand side by $\frac{d_o}{d_o}$ we obtain

$$\Sigma k = \left[\left(\frac{d}{d_o}\right)^5 - 1\right]\frac{bLd_o}{0.51\, d\, d_o} \quad \ldots\ldots\ldots\ldots [16c]$$

which gives

$$\frac{0.51\, d_o}{bL}\Sigma k = \left[\left(\frac{d}{d_o}\right)^5 - 1\right]\frac{d_o}{d} \quad \ldots\ldots\ldots\ldots [16d]$$

In this case the right-hand side is a function only of $\frac{d}{d_o}$ and is therefore independent of Q, L and l. If further, we equate on the left-hand side

$$\frac{0.51\, d_o}{bL}\Sigma k = x \ldots\ldots\ldots\ldots\ldots\ldots [17]$$

we obtain

$$x = \left(\frac{d}{d_o}\right)^4 - \frac{d_o}{d} \ldots\ldots\ldots\ldots\ldots\ldots [18]$$

which is an equation giving a curve suitable for all kinds of conditions and one that can be easily plotted with properly selected values of $\frac{d}{d_o}$.

Thus, $\frac{d}{d_o}$	x
1	=0
1.05	=0.263
11.1	=0.555
1.2	=1.241
1.3	=2.087
1.4	=3.127

Fig. 2 gives a curve plotted with these values of $\frac{d}{d_o}$ as ordinates (scale $0.1\frac{d}{d_o}$ = 5 cm.) and of x (scale 1 = 10 cm.) as abscissæ.

The following considerations may assist in making use of this curve. Assume that we have given Q, L and $P - p = l$ and hence also $R_o = \frac{r}{L}$. Knowing Q, we obtain from Table 1 the value of b, and further knowing $P - p$ we can obtain $p_m = \frac{P+p}{2}$ and hence w. Equation [12] gives then

$$d^5_o = \frac{1.251}{wR}Q^2\left(1 + \frac{q_o}{Q}\right) \ldots\ldots\ldots\ldots [18a]$$

Here, in the case of superheated steam, $q_o = 0$, while in the case of saturated steam with well-insulated piping, we may set $\frac{q_o}{Q} = 0.02$. Further, for $\Sigma k = 1$, we obtain from Equation [17] the value

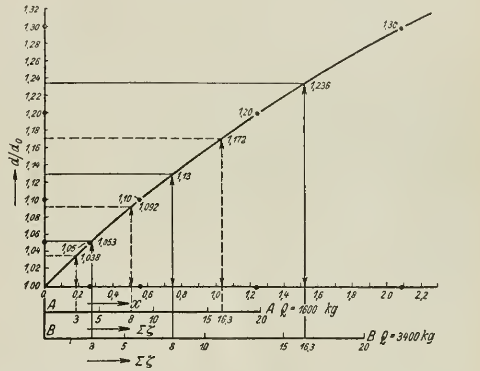

Fig. 2 Curve Showing Ratio $\frac{d}{d_o}$ as a Function of $x = \frac{0.51}{bl} d_o\Sigma k$

(1,32; 1,3; etc. mean decimal fractions 1.32, 1.30, etc.)

$$x_{\Sigma k=1} = 0.51\frac{d_o}{bL} \ldots\ldots\ldots\ldots\ldots\ldots [19]$$

which may be used as a unit in dividing the axis of abscissæ in the curve shown in Fig. 2.

As an illustration of the foregoing we may use a numerical example in which the following values are given: L=0 m.; p = 9 atmos.; P = 9.6 atmos., hence p_m = 9.3 atmos., and w = 3.51 kg. per sq. m.; $R_o = \frac{r}{L} = \frac{6000}{50}$ = 120 kg. per sq. m. Required the pipe diameters for Σk = 3, 8 and 16.3, respectively, these values corresponding to three different types of valves in the piping.

(*a*) Q = 1600 kg. per hr. According to Table 1, b = 0.963, and according to Equation [12]

$$d_o{}^5 = \frac{1.251 \times 0.963}{3.51 \times 120} = 1600^2$$

$$d_o = 5.947 \text{ cm} \ldots\ldots\ldots\ldots\ldots\ldots [20]$$

Further, from Equation [19] we have

$$x_{\Sigma k=1} = \frac{0.51 \times 5.947}{0.963 \times 50} = 0.0633 \ldots\ldots\ldots [21]$$

and hence, if we select as a scale of abscissæ x = 1 = 10 cm., the scale for the new axis of k indicated as $A - A$ and located below and parallel to the original axis of abscissæ will be

$$\Sigma k = 0.0633 \times 10 = 0.633 \text{ cm.} = 1 \ldots\ldots [22]$$

Similarly other abscissæ may be located.

With this subdivision of the axis of k ($A - A$), the following ordinates of the curve are found for the respective values of abscissæ:

$$\Sigma k = 3\frac{d}{d_o} = 1.038, \text{ hence } d = 1.038 \times 5.947 = 6.15 \text{ cm.}$$

$$\Sigma k = 8\frac{d}{d_o} = 1.092, \text{ hence } d = 1.092 \times 5.947 = 6.84 \text{ cm.}$$

$$\Sigma k = 16.3\frac{d}{d_o} = 1.172, \text{ hence } d = 1.172 \times 5.947 = 6.96 \text{ cm.}$$

A similar example is worked out for Q = 3400 kg. per hr., which does not materially differ from the preceding one. (*Zeitschrift für Dampfkessel und Maschinenbetrieb*, vol. 44, no. 26, July 1, 1921, pp. 201–204, 2 figs., *pa*)

Short Abstracts of the Month

AERONAUTICS

German War Aeronautical Motors

Evolution of German Aeronautical Motors During the War, Capt. Harlaut. The evolution of the aeronautical motor in Germany was governed by the following three facts: first, unanimous opinion of German engineers that aeronautical motors should have 6 cylinders, arranged in a straight line and water-cooled; second, the appearance in 1916 of the Hispano-Suiza motor; and third, the search from 1917 for a motor of constant power, and simultaneously the study of variable-speed propellers.

Because of the shortage of raw materials the early German motors were inferior to motors of the Allies from the point of view of weight per horsepower and maintenance, which led the German administration to prescribe very stringent acceptance conditions for their motors. Not being able to secure the advantage of superior lightness, they sought to compensate for it by increase of power.

In 1916 a special effort was made to increase the output per unit, Daimler trying to achieve it by the increase in the number of cylinders from 6 to 8 in straight line, and Benz by an increase in piston displacement. A demand for still greater power output was brought about in 1917 by the need of large motors for bombing planes, the power output per unit reaching as high as 260 hp.

By the winter of 1917–18 pursuit planes, such as the Spad, brought about the demand for still more powerful engines. The Benz-4 type was too heavy, but the experience with the Maybach 260-hp. motor showed that a very material improvement in the power of a motor might be brought out by an increase in piston displacement and of compression obtained at a cost of a slight increase in weight. The Bavarian Motor Works were given the task of redesigning the 160-hp. Mercedes (D-III), which led to the development of the B.M.W.-IIIa, 185-hp. motor.

The demand of bombing planes for motors of 500 to 600 hp. led to many unsuccessful attempts on the part of the German designers. The B.M.W. built a 6-cyl., 180 × 180-mm. (7.2 × 7.2 in.) which at 1300 r.p.m. developed from 300 to 400 hp. The power proved to be insufficient and overheating developed.

Benz tried the use of cylinders 225 by 300 mm. (9 × 12 in.) with six valves and four spark plugs per cylinder and pressure oil cooling of cast-iron pistons. At 1400 r.p.m. the engine developed 623 hp., but the crankcase broke on account of vibration and the cooling of the pistons proved to be unsatisfactory.

Maybach succeeded in increasing materially the power output by simply adding a flywheel weighing about 50 kg. (110 lb.), using the same 6-cyl. engine with four valves per cylinder and a compression ratio of 6.07. Notwithstanding the presence of the flywheel, however, the vibration proved to be such as to endanger the crankcase.

Daimler succeeded in developing the 260-hp. Mercedes type into a motor giving 650 hp. at 1250 r.p.m. and weighing only 1050 kg. (about 2300 lb.), but the vibrations were such as to cause fracture of the crankcase.

On the whole, therefore, the German attempts to develop a high-power aeronautical motor prior to the Armistice proved to be a failure. Not being able to do so in an engine of a small number of cylinders, they tried to increase the number of cylinders, Daimler employing as many as 18. The only motors of this character were the Benz 500-hp. Bz-VI and superinduced Bz-VIv, the first developing 500 hp. and the other up to 675 hp. at peak load. It was the only high-powered type used by the Germans and consisted practically of two of the standard Benz motors V-coupled.

The appearance of the Hispano-Suiza motor produced a tremendous impression on German engineers by showing them the value of the V-type motors. Out of a number of types developed along the same lines as the Hispano-Suiza only the Benz and the Körting were accepted by the military authorities. Benz built an 8-cyl. motor giving 214 hp. at 719 revolutions, or 200 hp. at 1400 revolutions, no gear reduction being used at this latter speed.

The Körting motor is remarkable for its short length and compactness. It is also an 8-cylinder V-type, 110-mm. bore, 140-mm. stroke, with four valves per cylinder, running at twice the speed of the propeller, and developing 183.5 hp. at 2110 r.p.m.

On the whole, however, the development of the V-type motor was not of material assistance in the war. By the time it was completed (beginning of 1918) the motors no longer answered the demands of the day and a further step was made by Körting in developing a 12-cyl. motor and by Benz in the Bz-V, 145-mm. bore 160-mm. stroke, developing at 1500 r.p.m. as high as 450 hp. In the general scheme, the motor did not differ from the other Benz motors, namely, individual steel cylinders with cast-iron liners and sheet-iron water jackets autogenously welded, aluminum pistons, double magneto ignition and separate carburetors for each group of three cylinders.

It is notable, however, that many refinements were made permitting the reduction of weight and greater compactness of design. The four carburetors and the dynamo are placed inside of the V. A single camshaft is used, with three valves per cylinder, and a triple gear-driven lubrication pump and a gear reduction along the lines similar to those used by the Rolls-Royce concern but differing in some of the minor details. (First installment of a series, *L'Aeronautique*, vol. 3, no. 27, Aug. 1921, pp. 310–315, 10 figs., *d*)

AIR ENGINEERING

Experiments on the Effects of Extremely High Pressures, T. W. Bridgman. Data of an investigation in a field of which comparatively little is known, but in which the author has been working for several years. The author states that he worked with pressures as high as 20,000 atmos. or about 300,000 lb. per sq. in. (roughly ten times as high as the explosion pressure in a large gun).

Such tremendous pressures are obtained by the use of a patented device which is said to be absolutely free of leak as long as the steel containing vessel is itself strong enough to withstand it.

In the course of this work the author found that the engineering theories of the strength of vessels do not hold good at these high pressures. A cylinder will stand much more pressure than it is ordinarily credited with, and will also stretch a good deal more than the ordinary tensile test would suggest. When it breaks the crack starts on the outside where the stretch and stress are presumably least, and travels toward the inside where they are expected to be greatest.

Pressure was produced by a small piston driven by a hydraulic press operated by a hand pump. This pressure was transmitted through a connecting pipe drilled out of a solid bar. A modification of the dead-weight gage was used and as a secondary standard, one based on the change produced by pressure in the electrical resistance of a metal (manganin alloy).

In general it was found it is not possible to force ordinary liquid into the pores of a metal, even at the above high pressures. However, hydrogen compressed to a pressure of 10,000 atmos. will eat its way through a massive steel container and blow out. Compressed air apparently behaves in the same way, although at a slower rate, while mercury behaves much like hydrogen and can be forced through massive steel walls by about 60,000 atmos. pressure.

Under high pressure liquids were found to be comparatively highly compressible. By 12,000 atmos., water may be compressed to 20 per cent less than its normal volume, and even metals showed appreciable compressions.

Under sufficient pressure a liquid can be forced to freeze at temperatures substantially higher than its freezing temperature.

instead of floating in water. Water at 180 deg. fahr. may be forced to freeze to this kind of ice by the application of about 20,000 atmos.

At 12,000 atmos. and 200 deg. cent. (923 deg. fahr.) phosphorus assumes a black form like graphite in appearance, loses its combustibility, becomes a conductor of electricity and is 50 per cent denser than yellow phosphorus. (*Compressed Air Magazine*, vol. 26, no. 9, Sept. 1921, pp. 10223–10225, 4 figs., *dA*)

BALLISTICS

The Study of Bomb Ballistics, H. L. Dryden. Description of recently developed methods for the study of ballistics of bombs launched from aircraft.

The early methods were rather crude; the more modern method is that in which the plane speed, altitude, and point of release of the bomb are determined by the use of two cameras obscura. In this method records are taken every second, and apparently reliable information is obtained regarding the trajectory of the bomb but not as to its oscillations or details of its behavior in the air. The method is used chiefly to secure approximate range data and probable dispersion due to all causes.

The second method for securing range data for bombs was worked out by Doctor Duff. A special bomb, with the source of light in the tail, was dropped at night and the part of the bomb was photographed by two cameras placed at the end of a measured base line and pointing at known angles to the horizon. From the trajectory of the cameras and the records on the plate the range may be computed.

Another method developed by Dr. F. C. Brown involves the study of bomb trajectories by means of moving pictures taken from the plane from which the bomb is dropped. If properly used, this method gives a great deal of information; for example, it permits the investigation of the oscillations of the bombs and likewise the behavior of the bombing plane. However, the method is difficult of application.

What promises to be an interesting method is the study of bomb ballistics by means of wind-tunnel measurement. Much valuable information has already been obtained in this way, and it is expected that ultimately it will be possible to predict, from wind-tunnel tests, the complete behavior of any proposed form of bomb. (*Army Ordnance*, vol. 2, no. 8, Sept.–Oct. 1921, pp. 83–85, 4 figs., *de*)

ELECTRICAL ENGINEERING

Probable Limits of Electric Generators and Superpower Plants for Germany, Prof. W. Reichel. Discussion of the problem of the most economical and the largest commercially possible sizes of electric generators for central stations. The economy of large units is generally recognized and an interesting discussion is devoted to the question as to the largest commercially possible sizes.

The most advisable speeds for various sizes are given as:

3000 r.p.m. for generators up to 25,000 kva.
1500 r.p.m. for generators up to 40,000 kva.
1000 r.p.m. for generators up to 60,000 kva.

As examples of large generators two units are cited of 60,000 kva. at 1000 r.p.m. installed during the war in Germany. The diameter of the rotor is 2.25 m. (7.40 ft.) so that the peripheral velocity at 1000 r.p.m. is about 118 m. (387.1 ft.) per sec. Such large dimensions required a very powerfully built axle and also a design in which the critical speed was higher than the operating speed. As a matter of fact, the axle weighs 36 metric tons (39.1 short tons).

The author distinctly states, however, that theoretically it is by no means impossible to go considerably beyond 60,000 kva. for such generators. In fact, he says that it has been established by calculation that generators may be built in sizes up to 160,000 kva., and the most serious obstacle in the way of accomplishing such constructions lies in the difficulty of transportation of such huge machines by railroad, necessitating their assembling and, in particular, winding at the place of installation—an operation not always attractive.

The use of such giant machines is suggested in a central station with six units, one being a standby. Such a plant would have a normal load of 400,000 kw. and a peak load of 500,000 kw., with a total output per year of, say, 2,000,000,000 kw-hr. Five such central stations would be sufficient to satisfy the entire demand for electric power in Germany.

For steam turbines to drive the 160,000-kva. generators the article suggests double units with steam admission in the middle, 16 to 17 atmos. pressure at the turbine inlet and 20 atmos. gage pressure on the boiler, with a steam temperature of 350 deg. cent. (662 deg. fahr.) at the turbine inlet valve.

In view of the great consumption of fuel and of water for condensation, it is obvious that such big plants should be located only near a large coal supply and also near a large river. Assuming coal delivered 300 days in the year, this would mean that 7500 tons per day would have to be received into the plant and be distributed either to the boiler rooms or to the bunkers.

The general conclusion to which the author comes is that at present the limit to the size of electrical generators is set mainly by the demand for power. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 35, August 27, 1921, pp. 1911–1917, 22 figs., *g*)

ENGINEERING MATERIALS

Rust Prevention by Slushing, Haakon Styri. Investigation of rust formation and prevention by slushing; of interest also because the experiments were conducted by exposure tests in humidors, similar to the method adopted by the U. S. Bureau of Mines in Pittsburgh. It was believed that if material in process could be protected from rust, cleaning before slushing would become possible.

Preliminary experiments have shown it necessary to use an aqueous washing liquid for the elimination of salts on the surface and for protection against action of the atmosphere. To do this, tests were made with washing in an emulsion of soap and mineral oil; it was expected that the aqueous solution would dissolve the salts and emulsify fats and fatty acids on the surface of the steel, and the oil particles would form a protective coating when they adhered to the surface.

Tests were made with the solutions either cold or boiling, the latter having been found preferable from the point of view of results. (Paper before the 40th Meeting of the *American Electrochemical Society*, Sept. 29–Oct. 1, 1921, abstracted from advance copy, pp. 113–128, *e*)

FUELS AND FIRING

Liquid Fuels in Internal-Combustion Engines

The Economical Utilization of Liquid Fuel, Carl A. Norman. An extensive discussion of the supplies of liquid fuel as they affect America, and their utilization in steam and internal-combustion engines. The author is Director of the Engineering Experiment Station, Ohio State University. Only a brief abstract of some parts of the investigation can be given.

The author states that the fuel situation is rendered unnecessarily complicated by trying to keep various fuel distillates apart and that a much better policy might be to mix them all together under a common name of distilled motor fuel. He advises that there are rumors that the oil industry has actually agreed on such a mixture as a standard motor fuel a few years from now.

The use of kerosene in automotive engines has been practically achieved for certain conditions, but the author considers it fortunate that no very determined efforts to adapt passenger cars and trucks for operation on kerosene have been made, because if this had been done the time would come when kerosene would sell at exactly the same price as gasoline. Indeed, the price of kerosene is now advancing much more rapidly than that of gasoline.

Passage of a Gas through a Throttle Valve. The throttling of a gas produces no temperature drop. The end temperature of compression should be the same in a throttled as in an unthrottled engine. If knock is relieved by throttling, then knock is dependent on the pressure attained rather than on the temperature.

Cooling by the Charge. The evaporation of the charge is capable of producing a cooling effect amounting to 50 or 60 deg. fahr. if the evaporation is complete. This cooling effect is naturally reduced by the imperfect evaporation of present-day fuels. It may be masked by heat from the engine parts. Experiments on a truck and tractor engine show it to be of quite the magnitude computed when the air heating is at its maximum.

Evaporation Temperatures of Liquid-Fuel Mixtures. Moisture will not condense out of atmospheric air, even if the temperature of the air is much below the boiling point of water under atmospheric pressure.

The amount of vapor that air can absorb and keep evaporated depends upon temperature of the air, pressure of the vapor in the air and boiling point of the vapor under this pressure.

A method is given to determine the amount of petroleum fuel that can be kept evaporated in air at various temperatures. It is found that for perfect evaporation of present-day gasoline a mixture temperature of about 110 to 130 deg. fahr. is necessary, while for kerosene the temperature must be raised somewhat over 200 deg. fahr.

Effect of Charge Heating on Engine Output. Charge heating reduces the ratio of the absolute temperature after combustion to the absolute temperature before combustion, and hence reduces the pressure rise.

Heat Development in Combustion Engines. The purpose of this article is to investigate the heat development with various mixtures. The nature of the chemical reactions is first discussed, and then the heat derivable from each one of the reactions ascertained.

Efficiencies Attainable in Internal-Combustion Engines. The maximum amount of work producible by a chemical reaction may be greater or less than the heat of reaction. In the case of combustion processes, it is in most cases very nearly equal to the heat of reaction. By utilizing the reaction in electrochemical primary batteries, very high factors of utilization may be attained and have experimentally been attained. If the enormous expansion ratios common in steam turbines were possible in internal-combustion engines, then this class of engines might also, in theory, turn perhaps 75 per cent of the heat energy into power.

As such expansions are not manageable with present types of engines, even ideally perfect engines of this kind could attain only very much lower heat utilizations. What these ideal standards are with actual fuels and actual combustion processes has been investigated on the theoretical side by Tizard and Pye, among others, and on the practical side by Ricardo, among others. A sample calculation of such an ideal efficiency is given.

These efficiencies are much lower than the so-called "air-standard" efficiencies. In fact, the margin of possible improvement of present-day engines at their best, is less than one might expect. For this reason, the desirability of maintaining a receptive attitude toward possible new types of prime movers is emphasized. (Bulletin No. 19 of the *Engineering Experiment Station, Ohio State University*, July 1921, 206 pp., illustr., *geA*)

Power Gas From Sewage

Power Gas from Sewage, J. D. Watson. Recent experiments at Birmingham, England, have shown that it is practical and economical to drive a suction-gas engine from gas derived from sewage sludge. Fig. 1 shows diagrammatically the experimental installation used at Birmingham. The pump installation comprises a 34-hp. horizontal gas engine of the ordinary suction type, a 5-in. diameter centrifugal sludge pump, and other parts as shown in the drawing. The gas holder indicated at *E* has not yet, however, been erected.

The engine is capable of giving 34 b.hp. at 250 r.p.m., with town gas having a heat value of 500 to 550 B.t.u. per cu. ft. In tests made with sewage gas from $27^1/_2$ to 32 hp. maximum have been obtained. The principal constituents of sewage gas are methane, hydrogen, nitrogen and carbon dioxide, the percentage of marsh gas varying in the different places investigated in accordance with local conditions.

The volume of wet sludge dealt with at Birmingham is estimated at not less than 400,000 tons per year. The author estimates that from this sludge 9000 tons of dry solid matter are available to produce 320,000,000 cu. ft. of gas equal to 16,000,000 hp-hr., an equivalent of 4400 hp. per day of 10 hr. (Paper read before Section G of the British Association at Edinburgh, Sept. 14, 1921, abstracted through *Engineering*, vol. 112, no. 2908, Sept. 23, 1921, p. 456, 2 figs., *dA*)

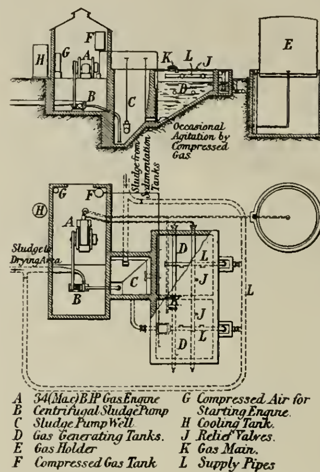

Fig. 1 Experimental Installation at Cole Hall, Birmingham, to Utilize Power Gas from Sewage

HYDRAULIC ENGINEERING

Speed Regulation of Hydraulic Turbines, John S. Carpenter. Discussion of principles and methods of calculation involved in the design of hydraulic-turbine governors. The article is not suitable for abstracting, but is of considerable interest because it gives the calculations necessary to understand the design of governors, omitting, however, the part of the calculations employing higher analysis. Therefore, to those equipped with only an elementary knowledge of mathematics, it provides a suitable basis of presenting the questions involved in water-turbine governor design. (*Power Plant Engineering*, vol. 25, no. 19, Oct. 1, 1921, pp. 947–950, 1 fig., *gp*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics; Fuels; Marine Engineering)

Distribution of Frictional Losses in Internal-Combustion Engines, E. P. Taylor. Data of tests carried out at the P. N. Russell School of Engineering in Australia. The tests were carried out by using the so-called retardation method on a 6-hp. Victor oil engine, 6-in. bore and 8-in. stroke.

The engine was of the vertical enclosed crankcase type, with plain bush bearings lubricated by the splash in the crankcase running through holes in the upper part of the bearings, the bearings being flooded by hand feeding. The engine was driven by a belt from an electric motor, a record being kept of the temperatures of the main bearings and cylinder.

In addition, two other engines were used, a National gas engine and a Crossley. The former was of the horizontal 4-stroke cycle, 11-in. bore and 19-in, stroke, only the temperature of the cylinder was observed, and the speed was attained by driving under gas in the ordinary way. The Crossley gas engine, was a 30-hp., $9^1/_2$-in. bore and 18-in. stroke. The main tests were carried out on the Victor engine.

A detailed account is given of the retardation factors for various elements of the engine. The main data are assembled in Tables 1 and 2. From these tables it would appear that even with different types of engines there is such a general agreement in the percentage of friction allotted to each part that a general table showing

justified. Limitations of the retardation method of testing are indicated. (Paper published in the Journal of Proceedings of the Royal Society of New South Wales, abstracted through *Gas and Oil Power*, vol. 16, no. 192, Sept. 1, 1921, pp. 190–192, *et*)

TABLE 1 COMPARISON OF DISTRIBUTION OF FRICTION IN VARIOUS INTERNAL-COMBUSTION ENGINES

Part of Engine	National 40-hp.	Crossley 30-hp.	Victor 6-hp.
Main bearings	15 per cent	16 per cent	11.5 per cent
Layshaft and valve gear	2	4	1.5
Gas friction	34	37	37
Connecting rod	4	3.5	5
Piston	45	40	45

TABLE 2 DISTRIBUTION OF FRICTION IN INTERNAL-COMBUSTION ENGINES

Part of Engine	Per cent Distribution
Piston	45
Gas friction	35
Main bearings	14
Connecting rod	4
Layshaft and valve gear	3

Still Oil Engine for Marine Propulsion. Description of the Still oil engine (see Mechanical Engineering, p. 627, 1919) constructed by the Scotts Shipbuilding and Engineering Co., Greenock, for use on shipboard, and tested by a deputation of engineers representing the French government and commercial interests.

The engine is said to be the largest of the type so far constructed and is of the low-speed marine type designed for merchant service. The Still engine is a combination of oil and steam engines. The main source of power is oil, consumed within a cylinder on the down stroke. The steam is generated in the cylinder jacket and forms a supplementary source of power used on the up stroke.

The present engine has a stroke of 36 in. and bore of 22 in. Efficiencies obtained in trials in May 1921 were: At full load, combustion i.hp. efficiency, 44.8 per cent; engine b.hp. efficiency, 39.4, net b.hp. efficiency, 37.7. At half load the respective efficiencies were 46.2, 38.5 and 35.8; at quarter load 46.1, 34 and 30.0. The total oil consumption per i.hp-hr. was found to be lower than in a good Diesel engine; at full load it was 0.360 lb. per b.hp-hr., at an overload of 11 per cent, 0.398 lb. per b.hp-hr. and at quarter load as high as 0.47 lb. (*Engineering*, vol. 112, no. 2905, Sept. 2, 1921, pp. 344–345, 2 figs., *eA*)

Piston-Temperature Measurements in Oil Engines

Measurements of Temperature in the Pistons of Oil Engines, Dr. Eng. W. Riehm. Description of methods developed for direct measurement of temperature of non-cooled pistons of Diesel engines under various operating conditions, and discussion

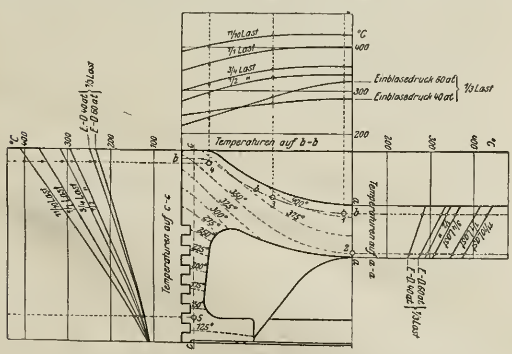

Fig. 2 Temperatures in Pston Body A at Various Loads
(*Last*, load; *temperaturen auf*, temperatures along.)

of temperature distribution in pistons of various designs. The tests were made on an experimental unit developing 70 hp. at 165 r.p.m. and working with tar oil to which a lighter oil is added at small loads. The thermoelements consisted of base metals (iron-constantan and copper-constantan), and a special two-part piston was built to provide a convenient location for the thermocouples.

air-injection pressures. In the upper part of the cylinder B the temperature lines are practically concentric to the axis of the piston, and the entire distribution in the body approaches that of a cylinder heated from the inside.

On the other hand, the piston body proper A shows a greater temperature difference between the center part and the rim and more approaches in character more the case of a plate heated in the middle. Also the maximum temperatures in the middle of the body are a good deal higher. These differences in temperature distribution are ascribed primarily to the fact that the heat is not transmitted throughout the body in a uniform manner, but is given mainly to the region where the fuel jet strikes with the higher temperature and greater velocity. Fig. 3 is of interest as showing the influence of air-injection pressure on the heat transmission and temperature distribution in the piston body.

The other parts of this interesting article cannot be abstracted owing to lack of space. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 35, Aug. 27, 1921, pp. 923–925, 7 figs., *e*)

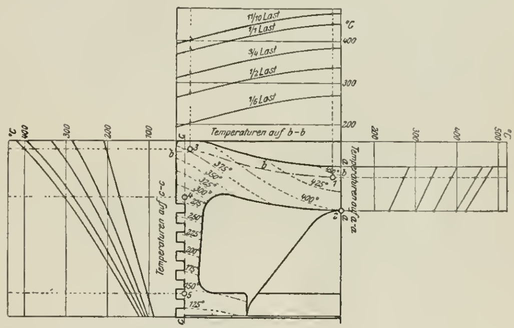

Fig. 3 Temperatures in Piston Body B at Various Loads and Air-Injection Pressures
(*Last*, load; *temperaturen auf*, temperatures along; *at.*, atmospheres; *Einblasedruck*, air-injection pressure; *E-D*, air-injection pressure.)

MACHINE DESIGN AND PARTS

Pipe Bends

Relative Values of Types of Bends and How They May Be Most Effectively Installed. In this article it is claimed that the assumption that the expansion U-bend is only twice as effective as a plain U-bend, is not correct. The derivation of an expression for the expansive value of an expansion U-bend is given.

The various kinds of bends are shown in Figs. 4, 5 and 6. In the bend in Fig. 5, the deflection at P is obtained in two steps—first, by considering the deflection in the length XY, assuming the outer leg XP to be rigid, and then considering the deflection in XP under the assumption that the portion XY is rigid.

It can be demonstrated by calculus that the horizontal component of the movement at P due to flexure of the bend in the portion XY is

$$\frac{a^3P}{EI}\left(\frac{3\pi}{4}+2\right) \qquad [1]$$

and that the corresponding movement at P due to flexure in the portion XP is

$$\frac{a^3P}{EI}\left(\frac{3\pi}{4}-2\right) \qquad [2]$$

Adding [1] and [2] and multiplying by 2 for both halves of the bend, we have $D = 3\pi a^3P \div EI$. But for the condition of maximum fiber stress, $P = SI \div ad$. Substituting this value of P, we get

$$D = \frac{3\pi a^3S}{Ed} \qquad [3]$$

which represents the total deflection of an expansion U-bend in one direction from the normal or unstrained position. The deflection of a plain U-bend may be found in the same manner to be

$$D = \frac{\pi a^2 S}{Ed} \quad \ldots\ldots\ldots\ldots [4]$$

which represents the deflection of a plain U-bend one way from the normal or unstrained position. It is thus seen that if the effect of the short tangents necessary at the ends of pipe bends for installing the flanges is neglected, the expansive value of an expansion U-bend, as shown in Fig. 4, is three times that of a

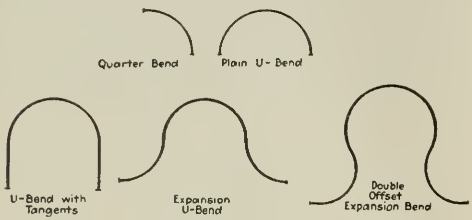

Fig. 4

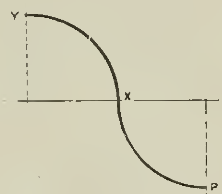

Fig. 5

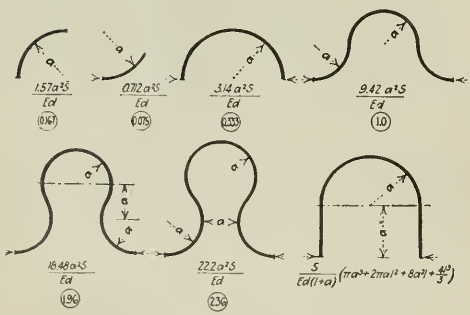

Fig. 6

Figs. 4, 5 and 6 Pipe Bends for Expansion in Pipe Line

plain U-bend with the same radius, using the same size of pipe. The expansive value is seen to be independent of the thickness of the walls of the pipe, an extra heavy bend having the same capacity as a bend made from standard-weight pipe. This is true, however, only in case the effect of the internal steam pressure is neglected. For bends composed entirely of circular arcs the allowable deflection is proportional to the square of the radius for a given maximum fiber stress, where

- D = expansive value of the bend either way from the normal or unstrained position
- a = mean radius of bend in inches
- d = outside diameter of pipe in inches
- M = bending moment
- E = modulus of elasticity of the material
- I = moment of inertia of a cross-section of the pipe
- P = thrust in lb.
- S = maximum fiber stress, lb. per sq. in.

The expansive value of a quarter bend depends upon the way it is installed in the line. The formulas for different bends are given in Fig. 6, the expansion being one way from the normal or unstrained position. From Fig. 7 the allowable expansion for any of the bends shown can be obtained by using the relative value factors shown in Fig. 6. (*Power*, vol. 53, no. 19, May 10, 1921, pp. 742–743, 4 figs., *p*)

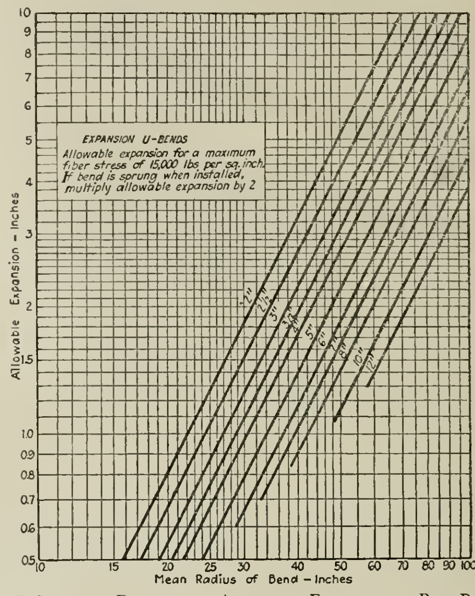

Fig. 7 Chart for Determining Allowable Expansion in Pipe Bends

MARINE ENGINEERING (See also Internal-Combustion Engines)

Turbo-Electric Propulsion. Rumors persist in British engineering circles that one of the four new battle cruisers of this year's naval program is to be fitted with turbo-electric propulsion. An editorial points out that British Admiralty engineers have very little actual experience on the subject beyond that gathered from foreign sources—in particular, from America.

Concerning this latter, it is stated that the U. S. Navy Department exhibited extraordinary boldness in passing directly from the New Mexico type (24,000 kw.) to battleships of 60,000 and cruisers of 180,000 shaft hp. The latter are to be propelled by four shafts, and the application of motors of 45,000 hp. to each will be a noteworthy feat.

The editorial does not recognize the validity of claims made for electric driving. Instead it claims that with mechanical gearing there is a greater flexibility of speed than with electric transmission, as the latter must rotate at revolutions which suit the number of cycles employed while the former may run at any odd number.

Certain alleged disadvantages of the electric system are also pointed out, such as lower economy at all except very low powers, considerably greater weight and more complexity by the full extent of the system of electrical control, the steam element remaining practically as before. It is also stated that experience of small merchant vessels with turbo-electric propulsion has been anything but satisfactory in some cases, though a number of vessels in the United States are to be fitted with it. (Editorial in *The Engineer*, vol. 132, no. 3428, Sept. 9, 1921, p. 267, *g*)

British Motor Tanker and Its Engines

The Motor Tanker "Conde de Churruca." Description of a twin-screw oil tanker recently launched at the works of Sir W. G. Armstrong, Whitworth and Company. It is propelled by

recent type of design and also being the largest engines of this type which have up to the present been fitted in a British mercantile vessel.

The deck machinery, consisting of the anchor windlass, winches, and derricks, is all steam-driven, the steam being raised in an oil-fired donkey boiler which also provides steam for the heating coils in the cargo and fuel tanks.

The engines each develop 1250 b hp. at 100 r.p.m. in four cylinders, 600 mm. bore and 900 mm. stroke. They are equipped with the Sulzer rotary sleeve valve (Fig. 8) which controls the admission of scavenge air to the cylinder. The correct position of this valve is determined for ahead and astern by a simple loose eccentric worked from the operating gear.

The starting and reversing mechanisms are so interlocked that no false start can be made. During the trials it was shown that each engine could be started and stopped twelve times consecutively without replenishing the starting receivers, of which there are eight, each of 800 liters capacity. In addition to the high-pressure receivers, there is a low-pressure receiver supplied through a reducing valve. This receiver provides air service for the service motors for the operating gear and the turning gear, and also for the air-driven lubricating-oil priming pump and the whistle.

The piston is cooled by a spray, sea water being used as the cooling medium. During the war an experiment was made to test the effect of heat stress on the delicate parts of the engine. The test engine was overloaded till the exhaust pipe was heated to redness and collapsed. When the engine was opened up the piston rings were intact and the lubrication was unimpaired, owing to the efficiency of the cooling system. The piston itself is made in two sections. The crown is only about 44 mm. thick, and is supported by five buttresses of special shape which allow the piston to take up its own position when the heat stresses come on. The piston

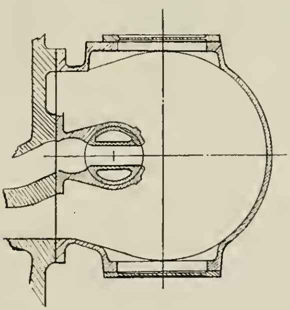

Fig. 8 Sulzer Rotary Scavenge Valve

rod is so joined to the body that the piston is free to expand radially, and it is claimed that sticking is entirely eliminated.

All control mechanism is grouped on the top platform in full sight of the valve-gear and fuel-pump mechanism. However, this is optional and the makers are also prepared to fit auxiliary control on the lower platform. The starting valve is operated by a mechanical device, so constructed that it can be readily removed and examined. This makes it possible for the engineer to assure himself that the maneuvering gear is in good working order.

Of the auxiliaries attention is called to the Hele-Shaw electric steering gear, and the combined compressor and generator built by Sulzer Brothers to be used for emergency purposes. The latter consists of a two-stage air compressor delivering air at 1200 lb. per sq. in. driven by a 12-hp. hand-started hot-bulb engine, which is also coupled to an 8-kw. 110-volt emergency generator.

The two engines, with flywheels, pumps and all fittings, weigh about 330 tons. (*The Engineer*, vol. 132, no. 3429, Sept. 16, 1921, pp. 297–301, illustrated, *d*)

MECHANICS (See Internal-Combustion Engineering)

The Alignment Chart, C. W. Crockett. Presentation of a basis for the construction of alignment charts and a method interpreting charts. Alignment charts lend themselves to the graphical representation of mathematical relations of many kinds and may save a great deal of calculation work.

The article is of a strictly mathematical character and not suitable for abstracting. As an example, a chart is given by which one may determine the diameter of the wire and the mean diameter of the coil of a helical spring formed of round steel wire if the amount of compression and extension, the maximum load, and the solid height are given, and also determine the extreme fiber stress under that load. (*Automotive Industries*, vol. 45, no. 13, Sept. 29, 1921, pp. 614–618, 5 figs., *pg*)

MOTOR-CAR ENGINEERING

Brotherhood 5-Ton Steam Wagon. Description of a steam truck of British manufacture which is unusual in some respects. The boiler is of a type which has about double the heating surface usual in steam wagons. It is of a type, too, in which the smokebox doors at each end are utilized as chambers for the exhaust steam, which thence escapes through small nozzles along the upper tubes of the central combustion chamber at the base of the chimney. In the present design each smokebox door has six exhaust nozzles

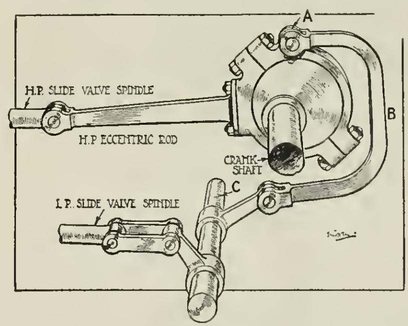

Fig. 9 Valve Gear of the Steam Engine in the Brotherhood Steam Wagon

discharging through a single row of large tubes. Incidentally, each exhaust pipe is formed with a trap for condensation. By disposing of the exhaust steam by this method, it is obvious that a steadier and gentler draft is possible. Consequently, the type affords an easy steamer, requires little or no forcing, and pulls its fire about but little. The water level is less affected on steep gradients than in any other design. The fusible plug can be fixed 8 in. to 9 in. below the water line, and so the risk of burning it out is very remote.

The engine motion is such that the D-slide valves of both high- and low-pressure cylinders in both forward and reverse directions are operated off a single eccentric. The principle of this motion is as follows: The cranks of the two cylinders are at right angles to each other. The eccentric works the high-pressure valve direct and at a point 90 deg. further round (to correspond with the position of the low-pressure crank), the eccentric strap carries a lug A, whence a link B transmits this motion to a rocker shaft C, off which the low-pressure valve is actuated. The whole arrangement is best seen in Fig. 9. Incidentally, this is the only undertype steam wagon employing a compound engine. (*Motor Transport*, vol. 33, no. 863, Sept. 12, 1921, pp. 277–279, 9 figs., *d*)

MUNITIONS (See Ballistics)

POWER-PLANT ENGINEERING (See also Electrical Engineering; Machine Design and Parts)

Electrically Operated Speed Governor for Traveling Grates

Speed Governor for Traveling Grates, Generlich. Description of a device built by Bosselmann, of Berlin, Germany,

engineer (Fig. 10). In this the factor governing the speed of progression of the grate through an electrical transmission is the temperature of the cooling water on the wiper. The principle of this device is that with a constant supply of cooling water, its temperature will be the higher the nearer the flame part on the grate approaches the wiper, which means the more poorly the coal is burned.

Referring to Fig. 11, the wiper consists of an iron plate 10 mm. (0.4 in.) thick and a water-cooled body made up of a T- and L-iron shapes properly bent and welded together.

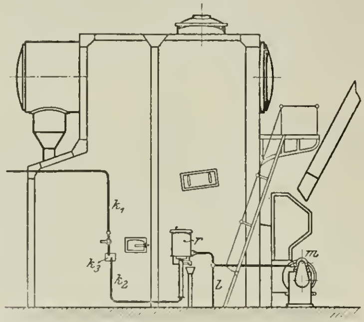

Fig. 10 Traveling Grate-Speed Governor
(k_1 cooling water inlet; k_2 cooling water outlet; l lead to motor starter; m motor; r speed governor.)

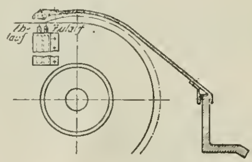

Fig. 11 Wiper with Water-Cooled Body
(*Zulauf*, water inlet; *Ablauf*, water outlet.)

The cooling water flows first to the chamber at the rear and then through that located toward the grate. The thin walls transmit well the heat to the cooling water, the temperature of which may vary between 40 and 70 deg. cent. (104 to 158 deg. fahr.).

In the unit tested by the author the wipers on a double grate have been in use for four months without showing any material signs of wear or requiring any repairs.

The most important part of the governor itself is the Samson expansion device, Fig. 12. This consists of a tube *a* filled with glycerine, in which is located a metal hose *b* and a piston with piston rod *c*. The governor is inserted into the second tube *d*, through which passes the wiper cooling water. The heat from the cooling water is transmitted to the glycerine. To make the piston stroke as great as possible, the metal hose *b* is given the length of 1 m. (39.37 in.) and its elongation per deg. cent. of rise of temperature is 1 mm. (0.02 in. per deg. fahr). To the piston rod *c* is connected the bridge *e* carrying 12 vessels *f* filled with mercury and arranged so that into these vessels may dip corresponding graduated contacts *g*.

These contacts in their turn are so arranged as to short-circuit in 13 stages the resistance inserted in series with the armature of the motor driving the grate, the entire resistance being short-circuited when all the contacts dip into the mercury, which happens when the cooling water is cold. On the other hand, when all the contacts are out of the mercury, which happens when the cooling-water temperature is high, then the entire resistance is in series. In this way the cooling-water temperature is enabled to govern the voltage on, and hence the rotation of, the motor within wide limits. To prevent sparking at the withdrawal of the contacts from the mercury and also the evaporation of the mercury, a thin layer of paraffin is spread over the surface of the mercury.

The author of the present article carried out some tests on this device in the boiler room of the Osram Co. in Berlin, and found that the voltage and speed of the motor were quite closely governed by the temperature of the water, being, for example, 220 and 1500 respectively at water temperature of 47 deg. cent., 70 and 480 at 67 deg. cent., etc.

The installation apparently requires only one additional valve in the water-cooling system, this valve having a permanent setting for each plant and each given set of operating conditions. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 65, no. 36, Sept. 3, 1921, pp. 943–944, 5 figs., *d*)

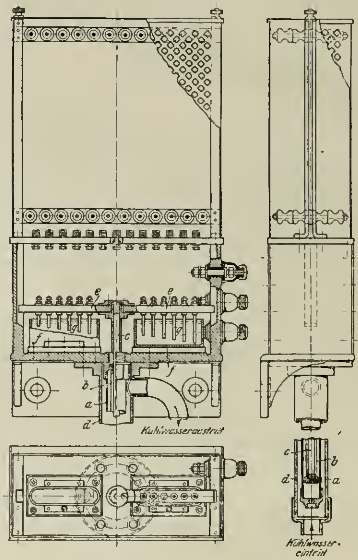

Fig. 12 Traveling-Grate Speed Governor with Samson Expansion Device
(*Kühlwasseraustritt*, water outlet; *Kühlwassereintritt*, water inlet.)

PRIME MOVERS (See Steam Engineering)

STEAM ENGINEERING (See also Internal-Combustion Engines; Motor-Car Engineering)

A Closed-Cycle Ammonia Motor

Closed-Cycle Ammonia Motor, Prof. E. Garuffa. Many attempts have been made to produce a "steam" engine employing a liquid vaporizing at a lower temperature than water, and there are numerous patents on such engines, none of which, however, have reached a stage of commercial development.

Of such engines the ammonia motor originally developed by an Italian engineer, B. Caruso, possesses certain features of interest. In this engine an attempt is made to utilize to a very high degree the latent heat of the exhaust vapor, which has never been successfully accomplished in steam engines. The thermal properties of ammonia are claimed to be such as to permit this utilization of latent heat to a greater extent than is possible with water.

The closed cycle operates essentially as follows: In the first place, there is a generator of saturated ammonia vapor doing work in a proper motor (e.g., a turbine) and constantly fed from another generator connected to it. In this second generator the exhaust vapor from the turbine gives up its heat to the liquid, and being condensed to a liquid state goes into an automatic feeder which delivers it to this second generator. Theoretically, under this cycle the only heat that has to be supplied to the ammonia in order to maintain the cycle is the heat corresponding to the work done and the heat necessary to compensate for losses—in particular, those which are not recuperated either before or after condensation. While at the same pressure, which is the maximum pressure of the cycle, the two generators which constitute the fundamental

difference in temperature being the temperature head across the turbine.

Fig. 13 illustrates the manner of actually effecting this cycle. A is a receiver or really a vapor generator heated by some fuel; M is the turbine or other kind of motor which receives the vapor from the ammonia generator after it has passed through the superheater S_A, the purpose of which is to utilize the heat in the exhaust from the furnace in the generator A. At B is a tank of liquid ammonia acting as a surface condenser; into it is immersed the coil S receiving the exhaust vapor from the turbine and condensing it. The condensate collects in the receiver C, whence it is conveyed by the pump P' to E, which, in its turn, constitutes an automatic feature of the condenser B, the latter acting as the second vapor generator.

The respective positions of the two units, A and B, (which, as has been stated above, act as two vapor generators at different temperatures) are such that they act as two communicating vessels (by pipe P) in such a manner that with equal pressures the levels of the liquid are the same.

Further, between the tank B and the dome D is inserted a special diaphragm d, and between the tank B and generator A another diaphragm R. These diaphragms permit the establishment of a uniform pressure throughout D, B and A, this being the maximum pressure of the cycle, at the same time maintaining between A and D and D and B the temperature head necessary for the motor to function.

The vapor which collects in D from surface evaporation of the

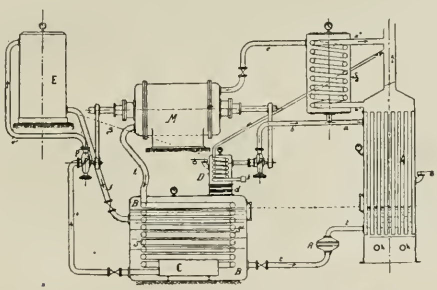

Fig. 13 Caruso Closed-Cycle Ammonia Motor

liquid in B is in a state of saturation due to its being in contact with the liquid and at a fixed temperature which may vary between 60 and 100 deg. cent. in accordance with the existing pressure. It is conveyed by the pump E as saturated vapor, into the generator A and from there, together with the vapor generated therein, is sent on its way first to the superheater S_A and eventually to the turbine M.

The purpose of the dome D is to maintain the liquid in B at a constant temperature, preventing the liquefaction of saturated vapor contained therein. To do this the dome is provided with a heating device which may or may not be connected with the furnace in A, and the heat coming therefrom helps to maintain the saturated vapor at a temperature of saturation corresponding to the maximum pressure of the cycle, 24 atmos. for 60 deg. and 60 atmos. for 100 deg. cent.

It is claimed that the efficiency of such a system is quite high. The heat content of a kilogram of superheated vapor Q is the sum of the heat content q of the saturated vapor and the superheat in the vapor, the latter being

$$q_1 = c_p\ (t_{\text{sup}} - t_{\text{sat}})$$

and hence the theoretical quantity G of steam per horsepower-hour in kilograms is

$$G = \frac{632}{Q} = \frac{632}{q + c_p\ (t_{\text{sup}} - t_{\text{sat}})}$$

(t_{sup} = temperature superheated vapor; t_{sat} = temperature saturated vapor). The actual quantity will be considerably greater, imperfect efficiencies of these units. Assuming that the heat losses are 10 per cent, efficiency of generator is 75 per cent, efficiency of turbine 70 per cent and efficiency of condenser 85 per cent, we get a total efficiency of 40 per cent and a consumption equal to 2.5 Q.

No statement is made as to whether any such engine has ever been built, and, if it has, what were the actual results of tests on it.

In his work on the ammonia motor Caruso worked out experimentally the following tables of physical quantities of ammonia.

TABLE 3 PRESSURE IN AMMONIA VAPOR AS FUNCTION OF TEMPERATURE

Temperature deg. cent.	Atmos.	Temperature deg. cent.	Atmos.	Temperature deg. cent.	Atmos.
— 20	1.84	+ 5	5.07	50	19.94
— 15	2.29	10	6.07	60	24.32
— 10	2.83	15	7.21	70	32.45
— 5	3.46	20	8.51	80	40.60
0	4.20	30	11.62	90	50.15
		40	15.49	100	61.30

TABLE 4 HEAT OF VAPORIZATION OF AMMONIA IN CALORIES AT VARIOUS TEMPERATURES

(Amount of Heat Absorbed by 1 kg. of Liquid Producing Its Vaporization at Temperature t at a Pressure of Dry Saturated Steam at that Temperature.)

Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories
— 20	327	+ 5	311	50	275
— 15	324	10	308	60	273
— 10	322	15	305	70	268
— 5	319	20	301	80	264
0	315	30	292	90	260
		40	283	100	255

TABLE 5 HEAT NECESSARV TO RAISE THE LIQUID (ANHYDROUS AMMONIA) FROM ZERO TO t DEG.

Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories
— 20	17.34	+ 5	4.45	50	51
— 15	18.13	10	9.17	60	63
— 10	8.83	15	14.87	70	75
— 5	4.47	20	19.66	80	88
0	....	30	29.49	90	105
		40	39.64	100	120

TABLE 6 TOTAL HEAT OF VAPORIZATION OF AMMONIA

(Sum of the Heats of Tables 4 and 5.)

Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories	Temp. t deg. cent.	Calories
—20	344.34	+ 5	315.45	50	326
—15	337.13	10	317.17	60	336
—10	330.83	15	319.87	70	343
— 5	323.47	20	320.66	80	352
0	......	20	321.49	90	365
		40	322.64	100	375

TABLE 7 SPECIFIC VOLUMES OF SATURATED AND DRY AMMONIA VAPOR

Temp. t deg. cent.		Temp. t deg. cent.		Temp. t deg. cent.	
—20	0.646	+ 5	0.250	50	0.073
—15	0.525	10	0.221	60	0.051
—10	0.432	15	0.183	70	0.037
— 5	0.358	20	0.161	80	0.025
0	0.298	30	0.122	90	0.018
		40	0.090	100	0.013

(*L'Industria*, vol. 35, no. 14, July 31, 1921, pp. 312–314, 2 figs., *de*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as c comparative; d descriptive; e experimental; g general; h historical; m mathematical; p practical; s statistical; t theoretical. Articles of especial merit are rated A by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Corncobs and Their Uses

Only a few years ago the farmers in the corn belt of the United States considered corncobs as useless and undesirable refuse. They used them for fuel, but only when wood or coal was scarce.

Recently many important uses have been found for the corncob, which is no longer allowed to go to waste. Cellulose, which is the principal component of the corncob, is employed in the manufacture of various explosives.

From corncob pulp certain grades of paper may be made, and a valuable substance, furfural, may be obtained which is used in the manufacture of certain adhesives and forms the basis of a beautiful green dyestuff for silk. It is also an important reagent in the chemical laboratory. (*Steam*, vol. 28, no. 4, October 1921, p. 97.)

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

Apparatus and Instruments A9-21. Ring Gage Measurements. The Bureau of Standards is using three balls of the same diameter at 120 deg. apart with a fourth ball resting on them for the purpose of measuring ring gages. A method of governing contact pressure on the precision balls is being devised. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A12-21. Colorless Waterproofing. A preliminary report is being issued on the results of six months' exposure to weather of materials treated with 19 different waterproofing compounds showiug also the appearance when applied to light-colored stones. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A13-21. Foreign Specifications for Portland Cement. A chart 16 x 22 in. has been issued by the Bureau of Standards showing the principal physical and chemical requirements of portland cement as required by specifications of various countries. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fire Prevention A1-21. Report 2262 by A. C. Fieldner and S. H. Katz to the Bureau of Mines is on the Gases Produced by the Use of Carbon Tetrachloride and Foamite Fire Extinguishers in Mines. These extinguishers were obtained in the open market. The fluid in one consisted mainly of carbon tetrachloride and small quantities of other substances to prevent freezing. The foamite extinguishers contain a solution of aluminum sulphate in a central cylindrical tube and a sodium carbonate liquor solution in the annular space around the tube. When the two liquids mix CO_2 is produced and this throws a foamy liquid stream through a nozzle for 30 or 40 ft. The tests were made in an experimental mine belonging to the Bureau.

A wood fire was kindled and after this was freely burning an attempt was made to extinguish it, six men with extinguishers being ready for this work. Extinguishers were used one after another until the fire was put out. Samples of gas were taken into vacuum tubes at different distances from the fire. The results are given in the table below:

Distance from fire	Phosgene, parts per million	Hydrogen chloride, p.p.m.	Chlorine, p.p.m.	Carbon dioxide, per cent	Oxygen, per cent
5	30	180	0	0.39	20.52
25	..	150	0	0.43	20.47
45	90	...	0	0.53	20.37
75	20	250	0	3.05	17.80

Carbon Monoxide, per cent	Methane, per cent	Nitrogen, per cent
0.18	0.01	78.90
0.16	0.03	78.91
0.15	0.03	78.92
0.31	0.01	78.83

The foamite tests produce no dangerons gases although sufficient carbon monoxide was present to cause severe headache and nausea. The tetrachloride produced in addition to the tetrachloride vapor hydrochloric acid of from 150 to 255 parts per million and phosgene from 20 to 90 parts per million. Military authorities consider 25 parts per million of phosgene sufficient to produce death in 30 minutes. Hence care must be taken in using the tetrachloride extinguishers in underground fire fighting. They are not used for extinguishing fires in and around electrical equipment because the tetrachloride is a non-conductor of electricity. In small closed rooms it is dangerons to use this extinguisher. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A15-21. Shale Oil. Report No. 2254 on the Nature of Shale Oil Obtained from Assay Retort and Report No. 2256 on the Oil-Shale Industry deal with data regarding oil shale particularly from the Rocky Mountain District. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Fuels, Gas, Tar and Coke A1-21. Steaming in Vertical Gas Retorts. The first section of the Fuel Research Board of Great Britain for the years 1920-21 has just been issued. This section is on Steaming in Vertical Gas Retorts. The heading scovered are as follows:

Program of tests
General description of plant
Conditions under which test were made
Test for determination of heat losses from setting
Description of coals used
Description of carbonizing tests

General Remarks:
- "Heat Equivalent" of the setting at the Fuel Research Station
- General observation on tests
- Thermal efficiency of carbonization
- Behavior of steam in the retorts
- Economic and practical limits of steaming
- Suggestions for consideration on practical points
- Application of graphs to any individual setting
- "Heat Equivalent" for any individual setting.

The report may be obtained at 1s.6d. from the Imperial House, Kingsway, London, WC2.

Gases, General A1-21. Pressure-Volume Deviation of Methane, Ethane, Propane and Carbon Dioxide at Elevated Pressures. G. A. Burroughs and G. W. Jones have worked on pressure-volume relations in a manner described in Technical Papers 131 and 158 of the Bureau of Mines. Methane produced by fractional distillation of natural gas at low temperatures and pressures, ethane produced by the electrolysis of sodium acetate, propane by the action of propyl iodide on a zinc copper couple and carbon dioxide produced by sulphuric acid on a solution of potassium carbonate were used. Care was taken to rid all of impurities. Fractional distillation at low pressures and temperatures was used for final purification. Starting with a pressure of 80 mm. with a correction of 0.1 per cent, the correction for the product Pv at 31,000 mm. was 12.5 per cent for CH_4. For ethane the correction at 23,000 mm. was 37.7 per cent, for propane at 5723 mm. 10.6 per cent and for carbon dioxide at 26,500 mm. the correction was 22.2 per cent. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Hydraulics A3-21. Flow in Riveted Steel Pipe. Bulletin No. 8 of the Engineering Experiment Station, Purdue University reports the investigation of the flow of water through galvanized spiral riveted steel pipe of diameters of 4 in., 6 in., 8 in., and 10 in. The Bulletin is by Prof. F. W. Greve and R. R. Martin. The friction drop was determined in 40 ft. of pipe and velocities varied from less than 2 ft. per sec. to over 20 ft. per sec. Experiments showed that the loss in head could be expressed by the equation

$$h_1 = m(v)^n$$

where v = velocity in ft. per sec.
h_1 = loss of head in ft.

The value of n is about 1.9 and the value of m varies with the diameter of pipe; n also varies slightly with the diameter of pipe. When the flow is against the laps the following relations hold for n and m:

$$n = -0.877\,d^2 + 0.832d + 1728$$
$$m = 0.0515/d^{0.926}$$

When the flow is with the laps the following hold:

$$n = -1.954\,d^3 + 2.166\,d^2 - 0.464d + 1.845$$
$$m = 0.0488/d^{0.799}$$

The values of f in the equation

$$h = \frac{f\,l}{d}\,\frac{v^2}{2g}$$

was found to vary with the velocity of flow and the size of pipe. The Bulletin gives tabulated values of this factor. The experiments show that when the flow is with the laps the resistance is practically the same as for clean cast-iron pipe. Engineering Experiment Station, Purdue University. Address A. A. Potter, Director.

Metallurgy and Metallography A16-21. Tensile Properties of Steel at High Temperatures. The investigation made at the Bureau of Standards on the test of alloyed steels at elevated temperatures will be presented at the September Convention of the American Society for Steel Treating under the title Tensile Properties of Some Structural Alloy Steels at High Temperatures. Four steels containing about 0.40 per cent carbon were tested at various temperatures between 20 deg. cent. and 550 deg. cent. The samples were of four kinds:

(*a*) Plain carbon steel; (*b*) 3½ per cent nickel steel; (*c*) steel containing 3 per cent nickel and 1 per cent chromium; (*d*) steel containing 1 per cent chromium and 0.2 per cent vanadium. The steel containing chromium showed a greater resistance to weakening by increase of temperature to about 550 deg. cent. than either of the other two steels. At high temperatures chromium-vanadium steel is preferred from the standpoint of high tensile strength and limit of proportionality. The carbon and the 3½ per cent nickel steels behave in a similar manner so that the nickel appears to have no effect. The report also refers to the type of fractures obtained in testing these steels at various temperatures. Typical microphotographs are included. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Metallurgy and Metallography A11-21. EFFECT OF HEAT TREATMENT ON MECHANICAL PROPERTIES OF CERTAIN STEELS. A report of tests made at the Bureau of Standards on heat-treated carbon-molybdenum and chromium-molybdenum steels will be presented at the September Convention of the American Society for Steel Treating. The following resnlts are obtained on a steel containing 0.20 per cent carbon and 1 per cent molybdenum:

1 For each maximum temperature there is a critical rate of cooling which will lower Ar_1. The higher the temperature the slower is the rate of cooling to produce the lower transformation. By whatever combination this is produced the position of the low point is fixed within a narrow temperature range to about 525 deg. cent. Rapid cooling will suppress this point.

2 A high temperature transformation is observed slightly above and almost merging with Ar_3 when the steel is cooled from temperatures at or above 960 deg. cent. at a rate of approximately 0.15 deg. cent. per sec. At a faster rate this is not observed.

3 Ar_2 is fixed at about 760 deg. cent. independent of maximum temperature of heating or rate of cooling.

4 The most suitable temperature from which to harden this steel is in the neighborhood of about 910 deg. cent. Free ferrite is found after quenching from 830 deg. cent. but the observed changes in mechanical properties with rise in quenching temperature within this range cannot be explained by known changes in carbon or iron, by differences in the rate at which the steel passes through the critical ranges resulting from changes in initial temperature of cooling, by unsatisfactory hardening or by the lowered Ar_1 for they are opposite to the changes found in plain carbon steel under similar conditions.

5 For the production of definite tensile strength, water quenching is preferred on account of the higher proportional limit, ductility and impact values, and hence better tensile properties are obtained for a given impact resistance.

6 Raising the quenching temperature from 910 to 980 deg. cent. does not materially alter mechanical properties when subsequently tempered at a relatively high temperature of 540 deg. cent.

Steel containing 0.27 per cent carbon, 0.9 per cent chromium, 0.5 per cent molybdenum give the following results:

1 The Ar_1 transformation is first split and lowered when cooled from 960 deg. cent. or 1000 deg. cent. at about 0.15 deg. cent. per sec. The low point is observed at 480 deg cent. In water quenching from the highest temperature a lower hardness is obtained than when similarly cooled from 960 deg. cent. In this respect chromium-molybdenum steel behaves similarly to the molybdenum steel except that the changes are produced from higher temperatures.

2 In normalizing the chromium-molybdenum steel a low limit of proportionality and impact resistance are obtained when using temperatures above 780 deg. to 845 deg. cent.

3 The fact that no material changes in tensile or impact properties are produced by oil quenching the chromium-molybdenum steel from a wide range of temperatures when subsequently tempered at 540 deg. cent has been confirmed. To produce high impact values in the hardened steel a tempering temperature in the neighborhood of 650 deg. cent. is required. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Petroleum, Asphalt and Wood Products A7-21. Fourth Semi-Annular Motor Gasoline Survey of the Bureau of Mines shows a drop of seven cents in the cost per gallon from the previous year with an increase of more than 380,000 gal. in the first five months of 1921 over the similar period of 1920, the total amount handled being over two billion gal. The 115 samples showed the specific gravity of 0.747, the same as last year, with distillation temperature practically the same as last year, the average boiling point being 268 for 1920 and 269 for 1921. The per cent recovered was 96.6 for 1921 and 96.7 for 1920. The distillation curve falls slightly below the 1920 average which was below the Federal Specifications. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

Wood Products A9-21. GLUE FOR DAMP PLACES. Casein glues are so water-resistant that plywood glued with them will stand exposure to warm damp atmospheres for many months while animal and vegetable glues will resist such atmosphere a very short time. After a long time the water-resistant glue loses its strength due to the hydrolysis of the casein brought about by sodium hydroxide. Forest Products Laboratory, Madison, Wis. Address Director.

Wood Products A10-21. DRY KILNS. Progressive dry kilns consume less heat per lb. of water evaporated and reach highest heat efficiency in drying from green state, especially when supplied continuously with green lumber of one thickness and class. Compartment type of kiln is more flexible and affords greater control over drying conditions, giving more constant temperature, humidity and circulation with variation in wind and weather. It is fitted to meet varying requirements of different materials and is useful where exact and careful drying is required. Forest Products Laboratory, Madison, Wis. Address Director.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Mechanics B6-21. FATIGUE OF MATERIALS. The first step of the investigation by Prof. H. F. Moore and others on the fatigue of materials is nearly completed and a bulletin is in preparation. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Mechanics B7-21. UNSYMMETRICAL SECTIONS. The action of angles, channels and other unsymmetrical sections in relation to tension and bending is to be investigated by Prof. A. N. Talbot. The study will be made by obtaining strain-gage measurements at various portions of the piece when subjected to load. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Properties of Engineering Materials B3-21. TENSILE PROPERTIES OF STEELS AT HIGH TEMPERATURES. The investigation of the properties of low-carbon steel used in boiler construction has been completed and the results prepared for publication. These will be presented under the title: Effect of Temperature, Deformation and Rate of Loading on the Tensile Properties of Low-Carbon Steel below the Thermal Critical Range, by H. J. French. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Railway Rolling Stock and Accessories B3-21. CHILLED CAR WHEELS. The experiments directed by Prof. J. N. Snodgrass and conducted by H. F. Goldner are almost complete. The investigation of the properties of chilled car wheels was undertaken to determine the strains arising from the mounting of the wheel on its axis, the strains resulting from the static or wheel loads, the strains resulting from the flange pressure, the ultimate breaking strength of the wheel flanges and the strains due to the temperature gradients in the wheels as caused by brake application. In making the experiments, the load was applied as nearly as possible in the same manner as the application in service; the strains were measured by the Berry strain gage and the data obtained from the tests were considered in relation to the material, design and other features of the car wheel. Address Dean C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

C—RESEARCH PROBLEMS

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

E—RESEARCH PERSONNEL

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

C. B. Roberts Engineering Company E1-21. The C. B. Roberts Engineering Company has equipped a laboratory for investigating petroleum problems on commercial-size samples. The company is preparing to handle all phases of oil-refinery developments, to make petroleum analysis and process work, to design refineries and prepare estimates for the same, to construct and operate refineries and to make report on betterment work and appraisal as well as do research work of a general nature. Address C. B. Roberts Engineering Co., 19 Milk St., Boston, Mass.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Petroleum, Asphalt and Wood Products F5-21. Serial 2269 of the Reports of Investigations of the Bureau of Mines contains a list of recent articles on Petroleum and Allied Substances compiled by E. H. Burroughs. These bibliographies are prepared monthly. Bureau of Mines, Washington, D. C. Address H. Foster Bain, Director.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this Journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

Supplementary Reading for Consulting Engineers

The January, February and May 1921 issues of MECHANICAL ENGINEERING contained correspondence concerning a list of books for supplementary reading by students in industrial management. In connection with this discussion there has been received a list arranged by The Thompson & Lichtner Co., consulting engineers, of Boston, Mass., designed to familiarize its men with existing literature on subjects of particular interest to them.

This list contains the following group of ten books which are to be read in the order given and reviewed:

How to Use Your Mind, Kitson
Industrial Leadership, Gantt
Primer of Scientific Management, Gilbreth
Scientific Management, Drury
Theory and Practice of Scientific Management, Thompson
Shop Management, Taylor
Work, Wages and Profits, Gantt
Scientific Management and Labor, Hoxie
Administration of Industrial Enterprises, Jones
Industrial Organization and Management, Diemer.

Supplementary lists on the following subjects are given, from which each man may choose according to his needs:

Production
Sales
Industrial Relations
Accounting
Construction
Plant and Lighting
General.

The Engineer's Part in Fire Protection

TO THE EDITOR:

Now that the production-at-any-cost engineer of wartimes has been superseded by the economical-production engineer, the questions of violation of the various rules of fire prevention and safety should be taken up and the effect of such violations shown.

Practically every class of engineering is affected by the degree of consideration given these questions. The architect or engineer who designed the building which was fire-resistive except for unprotected steel roof members, placed a lasting insurance charge on that building at a saving in construction cost which would have been covered in a five-year period by the difference in insurance rates.

This difference in cost of insurance is illustrated by several plants where so-called temporary ordinary-joisted brick or frame additions were built on to fire-resistive or slow-burning buildings, without fire divisions between the two sections. For instance, a fire-resistive building of the finest type had first a 300-ft. joisted-brick addition, then another 300-ft. joisted-brick addition, and finally a 150-ft. frame addition, making a total length of about 1750 ft. in one fire area. The original building would have rated at not exceeding 20 cents per hundred insurance, but now the entire building rates at $1.50, and in view of the fact that this particular building and contents is valued at about $6,000,000, the cost of this mistake is approximately $78,000 a year; three fire walls across these buildings at $5000 each would have given a rate of about 90 cents, or a saving of $36,000 a year.

The buildings of the war period have also given the highest record of losses in sprinklered risk resulting from additions which were built and not equipped with sprinkler protection. Records of insurance companies show that 22 per cent of their sprinklered-risk losses are due to fires started in unsprinklered areas not cut off by fire walls from the sprinklered areas.

Going into the matter of protection, we have a sad record of losses resulting from poor placing of fire hydrants, generally too close to buildings, and insufficient number of fire hydrants as a whole. There have also been numerous cases of protection systems which have not been equipped with adequate water supplies, mainly through lack of sufficient reserve pumps.

Many production engineers consider that the man who sends the finished material to the loading dock is the only really important factor in the plant, disregarding entirely the maintenance engineer, who keeps the plant in condition so that it may produce, and the fire-prevention and protection engineer, who keeps it in existence. The fire-prevention or protection engineer and the safety engineer are generally placed on the non-productive payroll, whereas the proper organization for any plant is to have the maintenance, the fire-prevention, and the safety engineer either on an equal with the production engineer, or closely associated with him.

The average fire loss per capita in the United States has not been below $3 in the last 10 years and was about $5 for the year 1920. This is a national overhead which of course affects all factors of production. We have also the overhead cost resulting from accidents causing decreased efficiency, decreased production and increased labor turnover. The reduction of these overhead costs depends to a great extent on the knowledge and efforts of the architect, the designing engineer, and the construction engineer, and their coöperation with the man who has specialized in fire prevention and protection, and with the safety engineer.

Detroit, Mich. W. M. WELLS.

The Fuel Situation

TO THE EDITOR:

The possibilities along the line of natural gas, fuel oil, city gas, producer gas, both raw and clean, as well as powdered coal and stokers for furnace heating, are known by only a limited number, and the activities of The American Society of Mechanical Engineers could be broadened to cover various kinds of fuel through the whole range of their application.

Natural gas is fast disappearing and cannot be considered as an industrial fuel. Even today many industries that were built around natural gas are forced to look for some other fuel to replace it. Due to the cheapness of this fuel little or no thought was given to its economical application, and many instances may still be found where furnaces are very inefficient. Fuel oil, raw gas, clean gas, powdered coal and stokers have all replaced in a greater or less degree some of the natural gas with good results, but only in a few instances have the highest, or anywhere near the highest, possible economies been obtained.

Fuel oil, because of its price and the ease with which high temperatures may be obtained, has been widely used. We know, however, that our fuel-oil supply is getting shorter every year, and there are very few shops in the country where fuel oil is used that much attempt has been made to economize on the fuel in any other way than by burner design. Where high temperatures are desired such furnaces run with flames issuing from the vents and doors. Often furnaces of this kind run with hearth temperatures of 800 to 1000 deg. above that required by the metal itself, and no thought is given to a better product to be obtained by other methods without decreasing the production. Fuel oil in low-temperature work is very wasteful, as used at present, because of the excess of air that is normally used to hold the temperatures down.

the necessarily high price of this fuel.

Raw gas has done much to reduce the cost of manufacture and increase the overall efficiency of furnace application, but there are few installations other than the open-hearth that receive the attention they should.

Clean gas has made some strides in fuel economy for furnace application and it must not be confused with the gas-power proposition.

Because of the fact that the flame temperature of clean producer gas is lower than that of many other fuels, it has been necessary to apply some effort to reach desired results with this gas, but that effort has always paid in the increased economies that may be obtained.

and the work is of such a late date and has received so much publicity that not much need be said for this method of fuel economy.

Stokers have been used for a number of years on various kinds of furnace work, and the best results obtained were in instances where the stoker and furnace were taken as a whole.

The whole point is that the fuel economies possible in all fuels are so great that increased efficiencies of 25 to 30 per cent can be obtained, rather than a few per cent under boilers. No one of the fuels now used is a cure for all ills, each having a certain field of application, but by getting together on this subject we can determine wherein added economies may be obtained and what is the best method of fuel applicatio n for various kinds of work.

Dayton, Ohio. EARL E. ADAMS.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 357 to 363 inclusive, as formulated at the meeting of June 23, 1921, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 357

Inquiry: Are the circulating pipes connecting down-draft furnaces to the shells of boilers to be considered as integral parts of the boilers themselves or as connecting piping outside of the boiler? Screwed connections as now used give both economy in space and flexibility.

Reply: It is the opinion of the Committee that such connections between boiler shells and down-draft furnaces are integral parts of the boiler, so that the requirements in Par. 268 for pipe openings leading from a boiler need not be met, and screwed connections may be used. The requirement for the minimum number of threads given in Table 8 applies to all pipe connections and should be met, as well as all other requirements which bear on the structure.

CASE NO. 358

Inquiry: Is it permissible, under the requirements of the Boiler Code, to deliver feedwater into the shell of a boiler through what is known as an induction valve or spray nozzle located in the steam space and arranged to deliver the water through a number of constricted openings in the form of a spray?

Reply: It is the opinion of the Committee that such an arrangement at the end of the feed pipe for delivery of the feedwater to the boiler will not meet the requirement of Par. 314, which requires that the feed pipe shall have an open end or ends to prevent stoppage by incrustation, unless the combined area of the passageways for the flow of the water is at least equal to the area of the feed pipe and these passageways are so arranged that it will be impossible for them to become clogged by incrustation.

CASE NO. 359

Inquiry: Is it permissible, under the requirements of the Boiler Code, with heads stayed by through rods, to attach the rod ends to the heads by a special form of gland nuts that provide for packing between them, as shown in Fig. 18?

Reply: It is the opinion of the Boiler Code Committee that this construction does not conflict with the requirements of the Boiler Code, provided that the area of the nut bearing surface against the plate is greater than the minimum cross-sectional area of the rod. The value of C for this construction shall be 135.

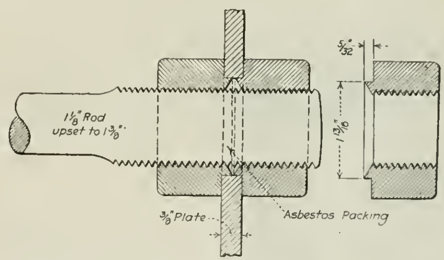

FIG. 18 SPECIAL FORM OF GLAND NUTS FOR ENDS OF THROUGH RODS

CASE NO. 360

Inquiry: Is it necessary, under Par. 254, to remove heads, open up girth seams and remove manhole frames, braces, etc., in order to remove burrs formed by drilling or reaming of rivet holes?

Reply: Par. 254 refers specifically to the plates and butt straps at longitudinal joints.

CASE NO. 361

(Annulled)

CASE NO. 362

Inquiry: (*a*) What is the minimum thickness of plates used for dome heads that is permitted under the requirements of the A.S. M.E. Boiler Code?

(*b*) Is it permissible to stay the heads of domes, where they are flat, by using angle or channel irons?

Reply: (*a*) There is no limit specified in the Code for the minimum thickness of dome heads except as given in Par. 17.

(*b*) The heads of domes, if flat, shall be stayed in accordance with Pars. 199 to 233 inclusive.

CASE NO. 363

Inquiry: Is it permissible, under the requirements of the Boiler Code, to apply a manhole in the upper head of an h.r.t. boiler over 40 in. in diameter, the area of the head surrounding the manhole to be stayed as provided in Pars. 203*e*, 214 and others applying to stayed surfaces?

Reply: In accordance with Par. 264, a manhole shall be placed in the upper part of the boiler shell, boiler head or dome head, of a fire-tube boiler over 40 in. in diameter. When applied to the head of such a boiler, the head shall be stayed in accordance with Par. 203*e*.

Impressions of Industrial Russia

Glimpses of the Workers and Factories in Moscow and Petrograd—The Present Economic Situation and the Doubtful Outlook for Russian Industries

By ROYAL R. KEELY, NEW YORK, N. Y.

The position of Russia in European reconstruction is of vital interest to American engineers and industrial executives, and there is lack of reliable information as to conditions in Russia. Mr. Royal R. Keely, Mem. Am.Soc.M.E., returned from nearly two years in Russia, as this issue of MECHANICAL ENGINEERING was about to go to press. Upon being convinced of American interest in Russian developments, he prepared this statement of some of his impressions. Coming from an engineer and an experienced observer in industrial plants, it will be accorded authority.

Mr. Keely is a graduate of Cornell University in electrical engineering and received the degree of M.M.E. in 1901. After three years' experience in power-plant and electrical railway machinery, he served as professor of engineering at the University of South Dakota for two years, as consulting engineer in Sioux Falls, South Dakota for one year, and as city engineer of Edmonton, Alberta, N.W.T., Canada, from 1906 to 1909. Since that time he has acted as professor of electrical engineering at the Nova Scotia Technical College, consulting engineer for the Tabor Mfg. Co., Philadelphia, and in 1913 he opened an office as consulting management engineer.

Mr. Keely went to Russia in 1919 and for eight months visited the industrial plants in and about Moscow. He was imprisoned for a year and upon his release he had a four-months' opportunity to observe the operation of the industries of Russia.—EDITOR.

ROYAL R. KEELY

THE Bolshevik revolution came in Russia in October 1917. I arrived in Moscow on September 18, 1919, so their organization plans and methods of industrial operation had had ample opportunity to get well under way.

The general plan of the Bolsheviki is that of wholesale centralization. There are various departments such as the departments of state, war, and education. "Means of Production and Ways of Communication" are handled by the department known under the name of the Supreme Council of National Economy.

The Metal Department with Ludwig Martens, former Bolshevik agent in this country, at its head, includes all metal-producing and working plants. One division of this department is devoted to standardization, and groups of engineers are attempting to establish ideal standards for screw threads, bolts and nuts, and chemical and physical standards for iron, steel and alloys. They also propose the standardization of an ideal form of the automobile, locomotive, etc., as a step in simplifying and standardizing manufacturing.

If Russian industries were completely destroyed and the present régime had the power to build everything anew, then a plan of standardization might be practiced. The average Russian thinks that the problem is 99 per cent solved after these idealistic fantasies are drawn up. The details necessary for effective execution are entirely ignored. When elaborate electrification plans were worked out for entire Russia, the work was looked upon as substantially ended. Electric plows are devices which cannot be of value in Russia for some generations. Yet a considerable number of engineers, clerks and stenographers are wasting immeasureable time on their development.

There are two important reasons for these fantastic schemes. One is that the simple-minded officials are pleased by these elaborate scientific projects and encourage the work. The other reason is that every individual in Russia is assigned to a particular job, from which he cannot move without official permit. Therefore engineers, scientists, and educated people find it necessary to create jobs. It is more interesting for them to work out these elaborate theoretical plans than it is to clean streets or split wood.

Central Stores Department

In the organization of industry, one particularly interesting and theoretically fine department called the "Producemet" has been set up. This corresponds in our practice to a general stores department. Here are recorded the location, quality and quantity of all raw materials in the entire nation, also the quantity and kind of finished product and its location. The records for all manufactured products are turned into this office automatically, as well as all demands for them. Under the Bolshevik scheme, each individual is to work for the government, and in return for this service he is to be supplied with the necessities of life. If one wants a typewriter he puts in his demand at the central stores department, where they decide whether he is entitled to a typewriter. If his request is granted, the machine is ordered to be shipped from the nearest point of production or storage. In the the central office is a very elaborate and complicated card system, but the staff is entirely incompetent and untrained and the records are never up to date and are entirely unreliable. In the winter of 1920 I visited this department. There were about 2000 employees, but at the time of my visit it was extremely cold, the temperature in the rooms being around the freezing point. Only a very small fraction of the total number of employees were at their desks, a few typists attempting to write on their machines with gloved hands.

The Professional Unions

The professional or trade unions are attempting to take an important part both in the educational and industrial control. The government is theoretically a government of the workers and peasants. These professional unions are therefore a part of the government and are consequently under the control of the Bolshevik party. They fix the rates of pay and also the piece rates and premiums. Their plan has been the establishment of a fixed base rate which varies according to the production and general efficiency of the workers. Bonuses for increased production have been ineffective because of the extremely difficult working conditions. There is always the demand for increase of wages, and with each increase of wages the cost of living goes up in approximately the same proportion. It is interesting to note that the market price on food, clothing and daily necessities remains about constant as compared with the American dollar. The value of the ruble drops in proportion to the increase in wages.

The workmen have their Soviets in each factory. These men, illiterate and inexperienced in executive and technical work, have power over the engineers and members of the old technical staff. This fact, in connection with the shortage of raw material, fuel, instruments and tools, makes any effective result almost unthinkable.

For any degree of success from such a gigantic centralized organization for production and transportation it would require a nation of able, honest and efficient people, all unselfishly working for the public good. Graft and corruption were proverbial under the old régime in Russia, and under the new, the adverse economic conditions have greatly increased dishonesty and thievery.

Street Railways and Telephones

The official working hours are from 10 to 5, but scarcely any one in Moscow works longer than from 11 to 4. The entire evenings are spent in repairing shoes, sawing and splitting wood, carrying water, removing ashes, and running to various departments for food rations from the government. In the winter of 1919–20 the street-car system did not operate. Last summer and winter there was a limited street-car service, but only certain employees who were able to secure official passes were allowed to ride. The telephone service is almost entirely destroyed. All telephones have been removed from private apartments.

Discontent among Employees

With the whole of Russia reduced to a state of starvation, it is painful to see great cities like Moscow and Petrograd without any useful productive effort. I was surprised to see the general discontent among all employees. The average man is only interested in making a job for himself to comply with the compulsory labor requirements. Every one in Russia who has any education, training or ability wants to leave the country, and would if the opportunity was given. I had rather a close acquaintance with the Russian-American Tool Company, made up of a few Russian immigrants to America who had a little coöperative factory here in the United States. In 1918 their patriotism led them to return to Russia, taking their American machinery and equipment with them. They established a tool factory in Moscow in the fall of 1919 which is looked upon as a most successful example of the new industry, although its production is only one-tenth of what it should be. I renewed my acquaintance with these men in the summer of this year, just before leaving Moscow. They are all extremely dissatisfied with their experience in Russia. The employees receive one and a half Russian pounds of black bread daily, a little soup for their noon lunch, and once a month four or five pounds of meat, some vegetables and fish. This is better than the workers in other factories get. Also their pay is better. Yet these men are selling their personal effects in order to provide daily necessities, and this was in the summer when the living conditions were easier. They did not dare consider the difficulties of the coming winter.

I have seen and talked personally with hundreds who returned to Russia under the patriotic impulse. I have not found a case where they were not making every effort to get back to America.

Conditions in Moscow Factories

The big Goujon factory, devoted to structural steel, wire rope, etc., and employing some six or seven thousand men before the revolution has now but a thousand employees. The old technical men who are trying to direct the work have very great difficulties. They are short of raw material, fuel, food, trained workers, etc. They have no control of discipline. I asked the chief engineer to tell me the greatest need of his plant, and he replied, "A proprietor."

The AMO automobile factory is a new plant with the very finest buildings and American equipment. Six or seven thousand men should be employed for full operation. They now have about 1000 employees, and these are engaged in trying to complete the plant, which was not entirely ready when the revolution came, and in repairing a few automobiles. Their output is about what would be expected from an American garage of 15 or 20 men. They tried all the winter of 1919–20 to make a cylinder casting for a White motor truck. In May 1920, after dozens of experiments, they had one casting which they failed to machine.

The International Harvester Company's factory near Moscow is the only factory I found which had not been "nationalized," but even here the manager's hands were tied, because for all the essentials of manufacturing he must depend on the Bolshevik government. He takes his orders from the Bolshevik government and manufactures on a cost plus 10 per cent basis, out of which he must pay his expenses and those of the executive staff. He permitted the Workmen's Committee to have charge of social matters, sanitation, hospitals, food, etc., but technical questions are decided by the technical staff. By his energy and tact he has maintained discipline and achieved some success. The government failed to supply this plant with fuel. They then allowed the manager to take a train of cars to the forests and bring back the necessary wood. For his furnaces he required coal and coke. Rickoff, president of the Supreme Economical Council, said to him, "We cannot get this coal for you. We will give you a train and you can go for the fuel yourself." The manager took the train to the mines under a soldier convoy, and came back with enough fuel to keep the furnaces going for the immediate future.

Locomotive Repairing

At one time I told Lomonossoff[1] that the fate of his country hung primarily on transport, and that transport, in turn, depended on locomotive repair. Orders were subsequently issued and locomotives were placed in all sorts of factories which lacked equipment or workmen for this kind of work, and any appearance of regular production was thereby destroyed. The men were given a bonus when a locomotive was repaired and they were allowed to go to the country and bring in food. This brought about the most inefficient results. The locomotive was turned out quickly, making a good record for the factory, but would come back shortly for another repair. At the time of the revolution there was a big wire cable factory near Moscow. Here, for several months, about 1000 men were employed getting the plant ready. In the spring of 1920 the first locomotive was completed and the men took this engine with a train of cars and went several hundred miles into the country for food, disrupting any scheme of transportation schedules.

During all this time, the big locomotive works in Russia were standing idle!

Petrograd Factories

Bad as the manufacturing conditions are in Moscow, the prospects there are better than in any other part of Russia. In Petrograd the big Tregolnik Rubber Company plant employing 38,000 men before the revolution is entirely idle. In the Baltic Shipbuilding Plant only a little repair work is being done. At the time Petrograd was threatened by the opponents of the Bolsheviki a large part of the machinery was evacuated from Petrograd, but the machines were taken apart without being marked and so "scrambled" that it was entirely impossible to reassemble them again. The Siemens-Schuckert Works, employing about 40,000 men is now essentially idle, doing only a little repairing. In the Arthur Koppel plant in Petrograd regular production was stopped, and at the time of my visit early in 1920 they were making only a few turf-excavating machines.

Classes in Russia

The whole population of the present Soviet Russia may be divided into five classes. The first includes what one may call the political idealists and these have been instrumental in laying out the general organization plan for the present government. Their number is very small. The second class is made up of a few hundred who are now ruling with an iron hand. These men are living better than they have ever lived before, occupying the best houses, having the best food and clothing and the use of automobiles. The third class comprises the remainder of the Bolshevik membership, said to number about 500,000, most of whom are not in sympathy with the party. Finding their families cold, hungry and ill clad, and seeing their Bolshevik friends better situated, they join the party. The fourth class includes the peasants, the majority of whom may be said to be strongly against the present régime. The fifth class includes former wealthy people, the educated groups, professors, scientists and engineers. It seems to be the aim of the Bolsheviki to exterminate this class. Therefore their living conditions are extremely bad. The Bolsheviki have been successful in only one thing and that is in pulling every one down to the level of the lowest of prerevolutionary times. The only exceptions to this are the first two classes named above.

Position and Problems of Engineers

The position of the engineer in Russia today under the Bolshevik régime is exceedingly difficult. Conditions do not permit constructive work by engineers.

I can refer to a great many instances where engineers of my acquaintance are procuring enough food and fuel for their families only by selling their books and instruments. They are living huddled in squalid quarters, doing their cooking on small sheet-iron stoves which also serve as heaters. They carry supplies up five or six flights of stairs, after hauling them miles from the storehouse. They are occupying minor clerical jobs in the factories or government offices to get their food allotment, or are doing menial mechanical work in smaller villages where food and fuel conditions are slightly better. The chief engineer of the AMO automobile works was theoretically in charge of production. This

(Continued on page 764)

[1] Formerly foreign representative for the Kerensky government in the purchase of railway material. At present acting in a similar capacity for the Bolshevik government.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

The Relation of the Engineer to Public Utilities

M. E. Cooley

Dr. Pritchett, President of the Carnegie Foundation, says in his recent report on the law profession:

> If organized society is to continue, the great mass of human beings who compose it must be fed and clothed and warmed and transported.

Mr. H. G. F. Spurrell, in Modern Man and his Forerunners, defines civilization as:

> ..... the mode of life in a territory which is maintaining a larger population than could live on the land if the people were not organized to develop its resources.

Spurrell's "civilization" under modern conditions becomes Pritchett's "organized society."

On the walls of the Engineering Societies Library one may read that:

> Engineering is the art of organizing and directing men, and of controlling the forces and materials of Nature for the benefit of the human race.

Thus we see that engineering is a factor in civilization—so important a factor, indeed, that modern civilization, as we know it, could not exist without engineering. That is to say, if the work of the engineer were to be wiped out of existence—annihilated—desolation would fall upon cities and adversity sweep the land. Civilized people would be pursued by famine and plague, suffering and sorrow being in proportion to their degree of culture and refinement. Only those living close to nature would be unaffected.

But more specifically what part does the engineer perform in Dr. Pritchett's conditions for the continuation of organized society, to wit, feed, clothe, warm and transport human beings? The engineer may not himself grow the materials for food and clothing, but he does provide the mechanical means for converting many of them into food and clothes; and for transporting them from source to consumer. He also provides the means for warming and transporting human beings. In short, the engineer is very largely responsible for what Dr. Pritchett says is necessary for the continuation of organized society.

Not to eulogize but to point to another kind of service for the engineer, let us consider his relations to public utilities, meaning thereby steam and electric railroads; telegraph and telephones; electric lights and power plants; water and gas plants, and the like. These are as vital to our modern civilization as the circulating and nerve systems are to the body. The engineer having done his part in designing and building them is no longer concerned except as he may be called on to help operate or extend them in the future. That is to say, engineers are not doing their duty to the public in refraining from taking part in questions affecting the cost and value of utility properties and rates to be charged for service.

Public utilities are in the main owned by public-service companies. There is, however, a distinct trend toward public ownership. Behind may be changing social conditions, but in the foreground are dissatisfaction with the service and the rates charged. Out of misunderstandings have grown quarrels and fights which have for years occupied our courts and commissions. The question here is not the merits for either side but how to bring about mutual understanding. What are the factors which should govern in determining proper rates for service? and where is the line to be drawn in questions of public ownership? Although largely engineering in character, these questions apparently have not interested engineers very much. Why?

No one will question that the engineer, having been instrumental and largely responsible in building utility properties, is, or should be, well qualified to say what items go into their building and the cost of the items. In the absence of engineers, except a few, this important field of investigation has been occupied by others, who honest though they be, are ignorant of many important things. Thus courts and commissions have been reaching conclusions and rendering opinions which are not in every case based on all the facts.

The public is not to be blamed for its attitude, when those really qualified to have an opinion are silent. Public-service corporations have been charged too many times with high-handedness in the past. But they are for the most part the sins of the fathers; for whatever the public may think about it, the responsible officers of public-service companies are not today engaged in robbery;—they are fighting for existence. Hundreds of companies have gone into receivers' hands and the end is not yet. But that is not the worst of it. The public in working out its indignation may deal itself a blow as well as the company. It should remember that Sampson in pulling the house down to avenge himself on the Philistines also killed himself.

It is common knowledge that because of the quarrels between the public-service companies and the public no more money can be had for investment in utilities at low interest rates. Such investments are now regarded as too much of a gamble. It is safe to say that had it been foreseen that the charge allowed for service would be insufficient to meet necessities capital would not have been forthcoming and the utility would not have been created. And it is also safe to say that could it now be done without too serious loss capital would be withdrawn from public utilities. Public ownership would no longer be an issue but would become a necessity.

One of the contentions has to do with the amount of capital invested in the utility. The books show one amount, the appraisal another; and the public not knowing which is right accepts neither. Considering the imperfect methods of keeping accounts in the early days, difference of opinion among engineers and accountants as to the propriety of including certain items of cost is scarcely to be wondered at. The subject of appraisal and valuation is largely the development of the past twenty years, and comparatively few have engaged in this field of research. If engineers, accountants, commissions and courts cannot agree, how reasonably expect the public to be satisfied?

Why this lethargy of engineers in a matter of such vital importance? It certainly cannot be indifference. More likely it is due to the engineer being an idealist—an idealist in the sense that he is wrapt up in his constructive work, his interest in its problems being so great as to exclude other matters. Whatever the cause it is time the engineer roused himself and took more active part in public affairs. The public wants the opinion, not of individual engineers, but of the profession. More than that, the public wants the help that engineers can, because of their professional knowledge, render as citizens.

M. E. Cooley.

THE essential unity of science is being more clearly recognized each day. Chemistry and physics merge in the study of the radioactive elements, the advances in colloid chemistry, the reactions promoted and the syntheses effected under the action of light, and in the important and expanding applications of electricity to process industry in many fields. All the experimental sciences are coming to lean more and more heavily upon the mathematician and to draw more generally upon each other to adjust or support their findings. Chemotherapy, the X-ray, radium, and synthetic drugs have placed new powers in the hands of the physician. Biology has now to reckon with vitamines, adrenalin, and the extraordinary influence upon the living organism of the chemical products of the thyroid and other glands.

With this general trend so clearly defined it is not surprising that the chemist and the mechanical engineer are finding new points of contact and developing a new sense of mutual dependence in their industrial activities. Bessemer supplies the engineer with cheap steel. Thomas and Gilchrist make available great bodies of phosphatic iron ores. As the requirements of the engineer become increasingly exacting the chemist provides tungsten, vanadium, and nickel steels. These the engineer turns to new account and by the development of high-speed tools revolutionizes the art of metal cutting. The engineer demands lightness with strength, and chemistry supplies aluminum. From its storehouse come new abrasives, better adhesives, more effective lubricants.

The burning of coal is a chemical operation, and to be carried out at high efficiency the process must be under chemical control. The whole fuel situation today is charged with impending change. It is plastic, but it cannot be shaped by the mechanical engineer alone. The problems involved in powdered coal, colloidal fuel, the Trent process, low-temperature distillation, gas enrichment, and motor fuel, to mention only a few of the factors in the complicated situation, demand for their solution the close coöperation of the chemist and the engineer. Similar coöperation is required if we are to secure the best results in the layout of piping and equipment, the selection of materials of construction, and the adaptation of structures to the needs of industry.

Chemistry is an experimental science, and chemists are trained to devise and conduct the experiments designed to secure answers to many of the questions of the mechanical engineer. The mechanical engineer deals with matter in the mass, and chemistry is concerned directly with the properties of the matter with which he deals. Here is the meeting ground on which the chemist and the mechanical engineer may coöperate to mutual advantage.

A. D. Little.

Dinner to American Deputation of Engineers

Two hundred of the elected officers of American engineering societies assembled in New York on October 10 to "welcome home" the deputations of American engineers which visited England and France this summer to convey greetings to the engineers of those countries. The names of those who went abroad and an account of the trip were published in the August issue of Mechanical Engineering, page 558.

The form of welcome was a dinner at the Pennsylvania Hotel at which Mr. J. Vipond Davies, president of the United Engineering Societies, acted as toastmaster. Distinguished guests included M. Gaston Liebert, French Consul General; Captain G. H. Armstrong, British Consul General; G. G. Clapperton, representing the British Institution of Electrical Engineers; Prof. Jacques Cavalier, spokesman for the French universities; and Governor James Hartness of Vermont.

Following speeches by Mr. Swasey, chairman of the delegation, and by Captain Armstrong, Mr. Charles F. Rand and Dr. Jewett described the functions which took place in England and Mr. John R. Freeman and Major Dwight those in France.

M. Liebert, on behalf of the French Government, presented medals commemorative of the mission's visit to that country to the presidents of the four national engineering societies, to the general chairman of the mission, and to the chairmen of the several society delegations.

Dr. J. W. Richards, professor of metallurgy at Lehigh University and one of the foremost engineers of the country, died suddenly of heart trouble on October 12. Dr. Richards was born July 28, 1864 at Oldbury, England. He was educated in the Central High School, Philadelphia, the University of Heidelberg, the Mining Academy at Freiberg, Germany, and Lehigh University. He taught at the latter institution for over thirty years.

Dr. Richards was an authority on aluminum, a legal expert in chemical and metallurgical cases, had an international reputation in various branches of metallurgical technology, and was the author of many books on metallurgical and other engineering subjects.

He was a member of the United States Assay Commission in 1897; representative of The Franklin Institute to the International Geological Congress held in Russia in 1897; member of the jury of awards, department of chemistry, of the National Export Exhibition at Philadelphia in 1899; member of the jury of awards and chairman of the metallurgical subjury, Panama-Pacific International exposition, 1915; member of the United States Navy Consulting Board, 1915–1918.

He was a charter member of the American Electrochemical Society, its first president in 1902 and 1903 and its secretary since 1907. He was a member of The Franklin Institute of Philadelphia, president of the chemical section, 1897–1899, and professor of electrochemistry of the institute, 1907–1910.

Dr. Richards was a member of the Faraday Society, Deutsche Bunsen Gesellschaft, American Chemical Society, American Institute of Mining and Metallurgical Engineers, former vice-president of the institute and chairman of the iron and steel committee since 1914, member of the Iron and Steel Institute of Great Britain, of the American Iron and Steel Institute, of Société de la Chimie (France), of the American Institute of Chemical Engineers, and honorary member of the American Electroplaters' Association. He was a member of the Board of Engineering Foundation and a member of the National Research Council. He was representative of the American Institute of Mining and Metallurgical Engineers on the joint conference committee of the F.A.E.S.

Announcements of the DeLamater Ericsson Tablet Committee

The DeLamater Ericsson Tablet Committee announces that it has had a communication from the Board of Directors of the Association of Swedish Engineers (Svenska Teknologforeningen), Stockholm, Sweden, stating that they will hold a celebration of the sixtieth anniversary of the Battle of the *Monitor* and *Merrimac* simultaneously with the celebration which the Committee will hold in New York and Washington on March 9, 1922, as announced in the September issue of Mechanical Engineering. It is expected that members of the Royal Family and the American minister to Sweden will be present at the Swedish memorial meeting.

The Committee hopes by means of these contemporaneous celebrations to still further enhance the already very cordial relations between Sweden and this country, and hopes that American engineers and other patriotic citizens will coöperate with the Committee to this end.

DeLamater Ericsson Tablets on Exhibition

America's Making, Inc., under the auspices of the New York State and City's Departments of Education, will exhibit three centuries of immigrant contributions to our national life at the 71st Regiment Armory, New York City, October 29 to November 12. At the request of the Swedish Section, the DeLamater Ericsson Tablet Committee has been asked to make arrangements for having the DeLamater Ericsson Tablet models, the medals and diplomas presented to Captain Ericsson by this and other countries, and the Ericsson models of solar engines and other mechanisms now in the possession of The American Society of Mechanical Engineers, to form a part of this exhibit. The DeLamater Ericsson Tablet Committee, whose address is Engineering Societies Building, 29 West 39th St., New York, N. Y., consists of H. F. J. Porter, *Chairman*, Oakley R. DeLamater, Fred. A. Halsey, Axel S. Hedman, Ernst Ohnell, Henry R. Towne, and Chas. Vezin.

A.S.M.E. Annual Meeting in New York, December 5 to 9, Will Stress Importance of Industrial Waste Elimination

Professional Divisions to Discuss Avoidable Wastes—Strong Sessions on Education—Students to Conduct Session—Social Events to be Emphasized—Registration Fee

THE recent report of the Committee on Elimination of Waste appointed by the American Engineering Council emphasized the great responsibilities to be borne by engineers in elimination of industrial wastes in this country. Following out the recommendations in the report that each technical society give this matter intensive treatment, the program of the 1921 Annual Meeting of the A.S.M.E. will stress the engineering phases of the problem. The leading session will point out the necessity for waste elimination and develop the principles of standardization and stabilization which are essential in the movement. The professional sessions will contribute to the strength of the program by emphasizing, in a concrete technical way, the steps that can readily be taken to more effectively utilize our national resources. The names of the speakers for the leading session cannot be announced at the present time, but the Management Division, which is arranging the program, promises that the general question of waste elimination will be discussed in a broad, constructive manner. An inspiring session is assured.

Professional Sessions

The tentative program on page 755 shows an intimate relation between the leading session and the technical sessions whose programs have been arranged by the various Professional Divisions. The complete programs for some of these sessions are given. The Aeronautic, Ordnance and Forest Products Divisions have not entirely completed their lists of speakers. The Aeronautic Division contemplates a discussion of the economic possibilities of commercial aviation and two technical papers on the materials used in airplane construction; one of these, on cables, will be given by R. R. Moore. The Ordnance Division will present a paper by Colonel J. W. Joyes, Chief of the Technical Staff of the Ordnance Department, in which avoidable wastes in ordnance manufacture will be pointed out. The Forest Products Division will demonstrate how several lumber manufacturers have successfully reduced waste in the various processes involved in the conversion of the log into forest products. The experience of the Southern and West Coast districts will be related and the need for still further reduction in wastes will be emphasized.

The limitations of the Engineering Societies Building make it exceedingly difficult to hold more than three simultaneous sessions. Accordingly, the Council has this year granted permission to extend the meeting for five days, and the leading session will be called to order at 2.00 p. m. on Monday afternoon, December 5. As a further step to properly utilize every available moment, morning sessions will begin promptly at 9.30. It is believed that this will reduce the necessity for adjourned sessions.

Education

The importance of industrial education will be developed thoroughly at this meeting. Two sessions are to be held, one under the auspices of the Committee on Education and Training in the Industries, which will present a program pointing out the great needs for education in the industries. Dean R. L. Sackett of Pennsylvania State College will present in one of the papers a résumé of the status of industrial education throughout the country. The second paper, by D. C. Buell, of the Railway Education Bureau, Omaha, Neb., will relate the steps taken by the railroads of the country for the training of their men. It is earnestly hoped that this program will bring out discussion that will enable the committee to plan a constructive program for future industrial training.

The second session on education will be a joint meeting with the Society for the Promotion of Engineering Education. Prof. Dugald C. Jackson is in charge of the program, which will give an opportunity for mechanical engineers to discuss with teachers the requirements of an adequate technical-school training in mechanical engineering.

Students' Session

A new and important development in Annual Meeting projects will be launched at the coming December convention. The Committee on Relations with Colleges has charge of a session at which the papers will be prepared and presented by students. Discussion will be limited to students and the meeting will be conducted by students.

Honorary Members

The honorary memberships which have been granted to Henry R. Towne and Nathaniel G. Herreshof will be formally bestowed on Tuesday evening, following the address of President Carman.

Business Meeting

The business meeting has been scheduled for Wednesday, December 7. The entire day will be given over to the discussion of the policies of the Society and especially of the new constitution which appeared in Sectoin II of the August issue of MECHANICAL ENGINEERING. The business meeting is the especial opportunity afforded for the membership to discuss Society matters. The program has been arranged without conflicting sessions so that there will not be the excuse that opportunity is not granted to each member to stand on his feet and comment upon what the Society is or is not doing. The strength of the A.S.M.E. has been built on the activity and interest of its members, and its future growth depends on increasing this activity and interest.

Social Events

A program of social events somewhat more elaborate than that of last year has been planned for this meeting. In addition to the presidential reception, which will be held Tuesday evening, there will be a ladies' tea and dance on Wednesday afternoon, an informal get-together dinner for the membership on Wednesday evening, and a dinner dance on Thursday evening. Friday evening will be devoted to college reunions and the following institutions are planning events: Cornell University, University of Illinois, Lehigh University, Massachusetts Institute of Technology, University of Michigan, New York University, Pennsylvania State College, Polytechnic Institute of Brooklyn, Purdue University, Rensselaer Polytechnic Institute, Stevens Institute of Technology, Worcester Polytechnic Institute, and Yale University. The ladies' tea will be served Wednesday, December 7, at 3.30 on the fifth floor of the Engineering Societies Building. The place for the informal get-together dinner on Wednesday evening has not yet been chosen. An informal program will be given during the smoker which will follow the dinner. The dinner dance will be held at the Hotel Astor. In view of the great popularity of this function in previous years it is probable that reservations will be required well in advance of the meeting. The circular, which will go out to the membership early in November, will give complete information regarding such reservations. On Thursday a luncheon is planned for members of Sigma Xi honorary scientific society.

Excursions will lead to points of technical interest about New York. The Friday afternoon excursion will be one of interest to the entire membership.

The ladies will be made especially welcome at this meeting. A reception committee will be in constant attendance and opportunities will be given to visit interesting points of the city.

Special Railroad Rates

Arrangements are being made to provide special railroad rates for members attending the meeting. Complete information regarding this will be in the Annual Meeting circular. It is requested that every member who is coming to the Annual Meeting make

TENTATIVE ANNUAL MEETING PROGRAM

New York, December 5-9, 1921

(Other subjects or changes to be announced later)

Monday Morning, December 5
Local Sections Conference
Council Meeting

Monday Afternoon, December 5
Leading Session: Elimination of Waste in Industry

Monday Evening, December 5
Session on Education and Training in the Industries

Tuesday Morning, December 6 (Simultaneous Sessions)

POWER WASTE SESSION

Heat Balance of:
- Connors Creek Station of the Detroit Edison Co., C. H. Berry
- Colfax Station of the Duquesne Light Co., C. W. E. Clarke
- Delaware Station of the Philadelphia Electric Co., E. L. Hopping
- Hell Gate Station of the United Electric Light & Power Co., J. H. Lawrence and W. M. Keenan

MACHINE SHOP WASTE SESSION

Waste in Machine Industry (two papers), J. A. Smith and J. J. Callahan
Art of Milling, John Airey

RAILROAD WASTE SESSION

Avoidable Waste in Operation of Locomotives and Cars, Wm. Elmer
Avoidable Waste in Locomotives, Jas. Partington
Avoiding Waste in Car Operation, W. C. Sanders

Tuesday Afternoon, December 6 (Simultaneous Sessions)

MANAGEMENT WASTE SESSION

Making Work Fascinating, W. N. Polakov
The Process Chart, F. B. and L. M. Gilbreth

FOREST PRODUCTS WASTE SESSION
(Authors to be announced)

Excursions

GENERAL SESSION

Testing of Emergency Fleet Boilers Using Oil Fuel, F. W. Dean
Stresses and Deformation in Flat Circular Cylinder Heads, A Mathematical Analysis, Maj. G. D. Fish
Control of Centrifugal Castings by Calculation, R. F. Wood

Tuesday Evening, December 6
Presidential Address and Reception
Conferring of Honorary Membership

Wednesday Morning, December 7
Business Meeting

Wednesday Afternoon, December 7
Business Meeting
Ladies' Tea and Dance

Wednesday Evening, December 7
Dinner and Informal Get-together

Thursday Morning, December 8 (Simultaneous Sessions)

FUEL WASTE SESSION

Boiler Plant Efficiency, Victor J. Azbe
Fuel Saving in Relation to Capital Necessary, Jos. Harrington
Developments in Boiler and Furnace Design, D. S. Jacobus
Producer Gas for Industrial Furnaces, W. B. Chapman

MATERIALS HANDLING WASTE SESSION

Industrial Waste in Handling of Material, H. V. Coes

STUDENT SESSION
(See page 754)

Thursday Afternoon, December 8
Joint Session with Society for Promotion of Engineering Education
Excursions

Thursday Evening, December 8
Dinner Dance

Friday Morning, December 9 (Simultaneous Sessions)

TEXTILE WASTE SESSION

Report on Second World Cotton Conference, Chas. T. Main
Hidden Wastes in Textile Mills, T. P. Gates
Research Results in Cotton Spinning, A. N. Sheldon
Economy in Textile Drying, B. R. Andrews

ORDNANCE WASTE SESSION
(Authors to be announced)

AERONAUTIC WASTE SESSION
(Authors to be announced)

GAS POWER WASTE SESSION

Porting and Charging of Two-Stroke Oil Engines, Louis Illmer
Paper by E. A. Sperry (title to be announced)

Friday Afternoon, December 9
Council Meeting
Excursions

himself familiar with the provisions regarding these rates so that the entire membership may receive the benefit therefrom. The awarding of the one-half fare rate on the return trip depends upon the number of members who apply for certificates before leaving their homes. These certificates are turned in at the Annual Meeting headquarters and if a sufficient number are received the one-half fare rate is awarded. It is important, therefore, that every member attending the Annual Meeting make request for the certificate.

Registration Fee

The Committee on Meetings and Program, with the approval of the Council, has authorized the levying of a registration fee of $1.00 for each member and $2.00 for each male guest. Ladies are to be registered without charge. This registration fee has been imposed only after very careful consideration of the various principles involved and knowing that the membership thoroughly believes that the meetings of the Society should be at least partially self-supporting.

Snow Removal From City Streets a Problem For Engineers

A.S.M.E. Materials Handling Division Discusses Fundamentals of the Problem and Various Methods of Melting, Compressing and Conveying Snow

The removal of snow from city streets is a problem requiring adequate machines, thorough organization and forceful administration. An engineering discussion of this problem took place on Friday evening, September 23, at a meeting of the Materials Handling Division of The American Society of Mechanical Engineers held in the Engineering Societies Building under the auspices of the Metropolitan Section.

Walter S. Finlay, Jr., chairman of the Metropolitan Section, opened the meeting and after a short business session relinquished the chair to Nathan C. Johnson, member of the Executive Committee of the Materials Handling Division.

The first speaker was Henry L. Doherty, whose interest in the problem had been aroused by his observation of removal methods used at the time of the heavy snowfall in New York on February 20, 1921. Mr. Doherty's views are expressed in an editorial in the August issue of Mechanical Engineering and in his correspondence with various officers of The American Society of Mechanical Engineers, printed copies of which are available on application at Society headquarters. In his address, Mr. Doherty pointed out the immensity of the problem of removal of a snowfall in a large city of even a few inches. In New York City a snowfall of 12 inches means a total weight of approximately 3,000,000 tons of snow on the 3500 miles of streets. Upon the assumption that snow must be handled so as to impede traffic in the least possible degree and for the shortest possible time, Mr. Doherty suggested, as first aid only, that footpaths should be made at the curb, throwing the snow toward the building line, that one-way streets be decided on, and that on two-way streets road paths should be cleared on the sides, piling the snow in the center, and sidewalks cleared at the curb. All of this should be done after a careful survey is made of every foot of New York streets and maps prepared showing where snow may be piled. To avoid hauling, which seems exceedingly expensive, Mr. Doherty suggests the making of snow briquets. He calls attention to the fact that ice is ten times as dense as snow and that with a briquetting mechanism a 12-inch snowfall on a 60-foot street may be piled in a wall three feet wide and three feet high where it will not interfere with traffic and will melt without inconvenience to vehicles or foot passengers. Mr. Doherty also discussed other methods of removal and advocated the use of the method which proved most economical for each particular locality.

John P. Leo, commissioner of street cleaning of New York City, emphasized the importance of snow removal to maintain the health and safety of the city. He described the experience in New York during the winter of 1919–20 when the traffic in the business section of the city was practically tied up, resulting in the development of a commission under the chairmanship of Fire Chief John Kenlon to suggest a solution of the problem which was tried out during the winter of 1920–21. The city was mapped out in districts, to each of which tractor plows and motor trucks were assigned and located in the fire-engine houses in these districts. Routes were laid out and the plows patrolled these routes from fixed points. Trucks were loaded from the piled snow and dumped into the nearest sewer. The cost of removal of a million and a half cubic yards was one million, eight hundred thousand dollars in 1920–21. From this experience it is now planned to clear and load the snow as it falls, using plows, conveyor loaders and trucks to get the snow into the nearest sewers. This can be done best as the snow is falling, when there is generally very little freezing. The Department of Street Cleaning is at work on a mechanical loading apparatus which will pick up the snow and deposit it in the trucks to be carted away. A number of slides were shown of the apparatus used in 1919–20 and 1920–21 for the handling of snow in New York City.

The Fundamentals of the Problem

John T. Fetherston, former commissioner of street cleaning of New York City, analyzed the snow problem into the following three elements:

1 For what depth of fall, density, rate, duration and occurrence of snow shall the city reasonably prepare each winter?

2 What are the allowable maximums for the design of the organization and apparatus?

3 The next pertinent or possibly impertinent question to ask is, how many hours or days should reasonably be allowed for the removal of the snow from the scheduled area, meantime keeping the streets free for the movement of traffic, in order that the citizens of the town may judge reasonably of the efficiency of the organization, methods, procedure, management and apparatus of the municipality?

As to the solution of the problem he made the following statement:

If the mechanical engineers would voice the sentiments of the public by setting up physical standards for snow work in New York and other cities, the people would then be in a position to judge of the real efficiency of their chosen officials, on a basis of fact.

Moreover, the officials would undoubtedly welcome a reasonable standard by which the results of their work could be judged. No such standard exists and it is unfair and unjust to condemn officials for the times they fail to vanquish a fifteen-inch snowfall followed by zero weather with six-inch equipment and underfed, poorly clothed, inadequately shod humans.

The Solution of the Snow Problem:

1 Set up the standards of quantity, quality, time and conditions as a basis for the design of organization, methods, procedure and equipment.

2 Provide the personnel and the apparatus to meet the conditions. Make the work attractive to available forces by offering pay commensurate with the work and the results secured.

3 City officials come and go. There have been eleven commissioners of street cleaning in twenty-three years since Greater New York was organized—an average official life of about two years to learn the city charter and the details of an organization comprising 7,000 men, serving 6,000,000 people scattered over an area of 140 square miles of territory.

The solution of the snow problem and other municipal problems will come nearer realization when engineers mark the targets for the officials to shoot at and exercise their duties as prospective leaders of public opinion by presenting, say to the New York Charter Revision Commission, the underlying principles of successful administration applicable to public office in such form as may readily be translated into law. Methods, apparatus and devices alone will never solve the snow problem, but organization, capable administration and effective execution with the right man behind the gun will score many bull's-eyes.

At the close of Mr. Fetherston's talk, John Kenlon, chief of the New York Fire Department, gave a dramatic account of the struggle with the snow during the winter of 1919–20. As the result of this struggle, which was led by the Fire Department, Chief Kenlon was made head of the Commission which formulated plans for handling the snow during the winter of 1920–21.

To emphasize the great fire risk developed by blocking the streets to the movement of fire apparatus, G. W. Booth, of the National Board of Fire Underwriters, gave an estimate of building valuations in New York City. In the area from the Battery north to Fortieth Street the total valuation for buildings and contents was given at two billion, two hundred and twenty-three million, four hundred thousand dollars. In the area between Fourth and Seventh Avenues from Fourteenth to Fortieth Streets there is a total of six hundred and thirty-six million dollars involved. Although there is an almost continuous line of sprinklered fireproof buildings through the center of the city, there are many old and poorly constructed buildings on both sides. It is in these buildings that fire might start which under adverse circumstances, such as snow-blocked streets, would spread to adjoining buildings and blocks and become a conflagration. In conclusion Mr. Booth pointed out that the Fire Underwriters are constantly keeping in mind that sometime impossibilities often become actualities. The prompt response of the fire department is an extremely important factor, and snow removal may be the controlling element in such response during a severe storm.

Devices for Snow Removal

The remainder of the program was devoted to the consideration of details of methods for snow removal. The chairman read a letter from Thomas A. Edison in which he pointed out that some

of it, pass it into a compressor and deliver blocks of ice into the gutter behind.

George L. Sawyer, western manager of the Barber-Greene Company, Aurora, Ill., emphasized the importance of a solution of the snow-handling problem to every city throughout the country. He grouped the processes involved in the removal of snow in two major operations. The first is that of meeting requirements of commerce and convenience by opening a lane for traffic, and the second is that of meeting the requirement of public health to the extent of entirely removing the snow. Mr. Sawyer recited some of the efforts being made throughout the country to solve the snow problem as follows: Adaption of the kerosene pressure torch, the introduction of steam into water hose to melt snow, flame throwers, and snow melters of the furnace type of similar to those used for reheating asphalt. These methods require artificial channels such as gutters, etc., for the disposal of the melted snow. The heating units must be portable and are not practical unless the fuel is cheap. In the field of purely mechanical devices Mr. Sawyer mentioned the plow, snow compressor, rotary plow, the crane and clamshell bucket, and the combination of the belt conveyor and scoop. For the transportation of the snow itself he suggested the common vehicles, used in combination with river, stream, gutter or sewer. Mr. Sawyer pointed out that in three of the largest American cities in the past winter successful demonstrations of snow removal have been made. The first procedure was to open up the principal thoroughfares for traffic as quickly as possible, lanes being cleared of snow by means of sweepers or plows and the snow being deposited in piles in the center of the street. The snow deposited was loaded mechanically into trucks and taken to streams or sewers. The snow loader used in these three cities consisted of a 32-in. belt conveyor, installed at an angle of approximately 25 deg. on a continuous-tread tractor. At the lower end the 32-in. section was increased to a scoop-shaped section having a width of 6 ft. Motive power was obtained from the 25-hp. gasoline engine which moved the entire machine as well as the conveyor. A truck could be located immediately behind the snow loader so that only the width of the machine was needed for snow removal. This machine described by Mr. Sawyer permitted trucks to be moved out at intervals of from two to six minutes. He estimated that savings over manual removal, based on reduced labor cost and increased truck "turnovers," were as high as $550 per snow loader per eight-hour shift. Mr. Sawyer recommended the use of mechanical methods during the night because of decreased traffic at that time. At the close of his talk Mr. Sawyer suggested that the A.S.M.E. would render an important service if it collected and sifted information on this subject.

Mr. D. L. Ellis, assistant engineer of the Great Northern Railroad, Seattle, Wash., presented a scheme for using a gas-electric rotary snow plow for taking up the snow, shooting it to the side of the street or dropping it in trucks alongside of the plow. Mr. Ellis' device is shown in Fig. 1.

Chairman Johnson read abstracts of contributions from Mark A. Guigou, New York, N. Y., W. Lehman, Milwaukee, Wis., and E. C. Donner, Pittsburgh, Pa.

Mr. Guigou's device, shown in Fig. 2, is an indication of a design believed to be practicable by the author, with which it is proposed to compress snow to from one-quarter to one-eighth its initial volume without the use of an excessive amount of power. The figure indicates a double-walled or jacketed tubing machine cylinder with the gasoline engine exhausting through this jacket, thus utilizing the exhaust heat to melt the snow adjacent to the walls of the machine cylinder and facilitating its passage through tubing machine in a hard column which could be delivered directly to the truck immediately in the rear of the tractor. In this way each truck could be loaded to its full-weight capacity.

Mr. Lehman's contribution suggested, first, the mapping of the city to show where snow could be piled with least inconvenience; second, a shovel of 3 cu. yd. capacity, like a steam shovel but compressing the snow in the shovel by the forward movement of the truck, so that with a fall of 1 ft. or less a truck travel of 20 to 40 ft. would be necessary to fill the dipper. The shovel would then be lifted and dumped into a truck. Mr. Lehman estimates that this device could be operated at a speed of two miles per hour, that the machine would weigh about four tons and cost from three to four thousand dollars.

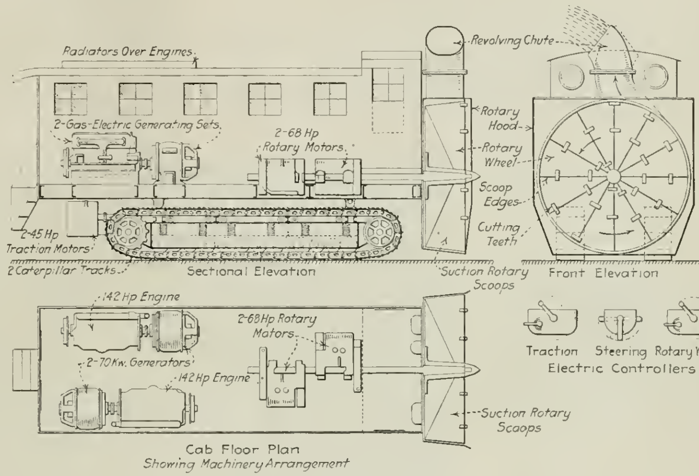

Fig. 1 Ellis Gas-Electric Rotary Snow Plow

E. C. Donner suggested a scraper of street width drawn by a tractor or trolley car and followed by two machines consisting of scoops and screw-type compressors for briquetting the snow in cylinders. These briquetting machines will be followed by trolley or gasoline trucks to collect the ice cylinders.

John Flodin, of Quincy, Mass., presented lantern slides showing a modification of loaders successfully used for handling gravel, coal, etc. The conveyor, which should be mounted on the necessary truck or tractor, has at its front end a blade or scoop attached to start the snow on the belt. Provision is made for the conveyor chute to be lowered while passing under elevated structures, trolley wires, etc. Mr. Flodin also presented a sketch of a simple power-driven snow-shoveling device. To take care of the possibility of snow remaining on the street until it forms ice, Mr. Flodin suggested an ice breaker consisting of a rotary multi-tooth clipper or breaker, a tilting and dumping scoop and a melting hopper into which the scoop is discharged. All these parts are mounted on a truck or tractor to be steam-driven, Exhaust steam and waste gas is used to melt the ice.

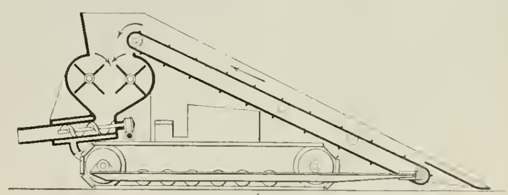

Fig. 2 Guigou's Machine for Compressing Snow to a Quarter of Its Original Bulk

Experiences in Snow Melting

A. Parker-Smith related some experiences in snow melting. On the basis of 14,000 B.t.u. per lb. of soft coal or gas-house coke, and using the latent heat of fusion of 1 lb. of snow or ice or 140 B.t.u., Mr. Parker-Smith estimated that one ton of coke at $10.50 per ton delivered should melt 100 tons of snow. Estimating a 75 per cent heating efficiency, the fuel cost of a well-packed two-horse-truck load of snow would be twenty-one cents. On the same basis Mr. Parker-Smith estimated the fuel cost of melting the snowfall on a Fifth Avenue block as $10.50.

He also told of snow melters built thirty years ago, some of which were tried out in New York City. One of these set up in Hancock Square was used to melt 86,000 lb. of snow in four hours, consuming 1000 lb. of coke. Difficulties of operation were found to be dirt in the water jacket and clinkers which clogged the draft. In conclusion Mr. Parker-Smith stated that snow can be melted more cheaply than it can be carted to the river from any but riverside sections.

In the discussion David Moffat Myers suggested melting by use of hot water in congested districts. Assuming 80 per cent efficiency and 16 per cent loss in mixing, with coal at $8 per ton, Mr. Myers estimated the cost for melting the snow would be two cents per cubic foot.

Chief Kenlon called attention to the fact that the weather in New York City may be severe, which makes the melting of snow exceedingly difficult. He emphasized the necessity for machines being compact and stated as his opinion that the problem would not be solved by the adoption of any one method but rather by the utilization of the best method for any particular locality. He believed that a sewer is the best, most practical conveyor for removing snow, although the sewers of New York south of 59th Street are generally inadequate.

Further Studies Contemplated

Upon motion by Mr. Doherty, the meeting passed a resolution that a committee be appointed by the Materials Handling Division to study the snow-removal problem and present its findings for the benefit of the cities of the country. This committee is to plan its own course and raise the money necessary for the execution of its plans.

In his closure Mr. Doherty pointed out that the removal of snow by melting is the most difficult method because it involves handling in addition to the melting process. Mr. Doherty stressed particularly the idea that there is great waste in handling snow unless it is compressed. Trucks or trailers cannot be loaded to weight capacity with snow as it falls. As an emergency measure Mr. Doherty recommended that snow should not be moved from private property into the street. He believed that it would be better to pile snow on the sidewalk and level it off as pedestrians can walk on twelve inches of snow as easily as on one inch. In the use of heat, direct contact is the most effective method. Salt and calcium chloride have proven ineffective and impractical. Snow removal seems to be a mechanical problem and from this point of view briquetting is advisable in order to get greatest effectiveness from conveying vehicles. Mr. Doherty further pointed out the advantages that sunlight has in snow removal especially when dust or other black material covers the snow thereby reducing the reflecting effect of the sun and absorbing the heat of the sun.

Devices not Presented at the Meeting

A number of devices were described by members who could not be present, some of which are worth attention. Edward A. Smith of West Englewood, N. J., suggested the application of heat to snow after the snow is separated into flakes. The device he has evolved includes a revolving wheel which will scatter into a melting chamber of 67,440 cu. ft. capacity a continuous stream of snow 42 in. wide, 12 in. high and 3.9 in. thick. The snow is kept agitated by compressed air and oil is used as fuel. Mr. Smith estimates that 76,500 cu. yd. can be melted in 28 hours. At this rate one hundred machines would be required for Greater New York costing per day twenty thousand dollars for oil, seven thousand dollars for men and one thousand dollars for electric current. Based on the total winter's snowfall of 7,400,000 yd., the season's cost would be $2,220,000, or thirty cents per cubic yard.

Messrs. Thomas Chester and Bernard Kern of Sandusky, Ohio, came to the conclusion that the only successful method of removing snow is one that can be put into operation as soon as one or one and one-half inches of snow have fallen, machines to be kept operating over the same territory during the snow storm. They suggest a sweeper and scraper which can be adjusted to drive the snow to one side where it can be loaded into trucks by hand.

Francis B. Sando, of Newark, N. J., recommended the use of a rotary brush mounted on a gasoline truck which has been used in New Jersey to open the highways.

H. S. Farquhar of Wayne, Pa. has sent in a clipping from *Engineering News* of July 27, 1905, in which his patent granted in 1901 is described. Mr. Farquhar proposed a snow-compressing machine which utilizes a screw. The article relates various attempts at compression in which Mr. Farquhar tried compression between rolls, compression between one roll and stationary plate, compression by forcing between converging surfaces and compression with a piston. The important feature of Mr. Farquhar's device was the idler which was found necessary to keep the compressor screw clean of snow, thereby preventing choking. A report made by Mr. William B. Upton upon Mr. Farquhar's device stated the capacity of the machine to be 4 cu. ft. of snow per min. The compressed block from this machine weighed 55 lb. per cu. ft. which is within $2^3/_4$ per cent of the weight of solid ice. The power consumed was about 0.33 hp.

STEAM-CONDENSING PLANTS

(*Continued from page 716*)

else at greatly increased velocities and correspondingly increased rates of condensation. The main supply of water passes directly through the upper and larger group of tubes and the remainder of the water after passing through the cooler, goes through the lower and smaller group of tubes below the deck or partition.

The rate of condensation in a condenser with all its tubes active was found to vary substantially as the rate of condensation on a single tube, which, as is well known, depends on its diameter and material and the water velocity. With only one passage necessary, an entirely new basis for selection of velocity and tube size is opened to the designer. High velocity or small tubes or both can be used without excessive pump power as would be encountered with multiple-pass construction. Paradoxically, there is more insurance against corrosion, as well as greater protection against reduction of vacuum by scaling and sliming, when working the condenser at the higher and apparently less conservative condensation rates. The author does not wish to imply that excessive pump powers should be used. High capacities and velocities may be obtained without exceeding circulating-pump powers now often used. The circulating-pump capacity is best arranged in twin units so that maximum water quantity and velocity are available in summer and can be reduced in winter by shutting down one pump. Variable or graded circulating-pump capacity is desirable in small as well as large units.

On large units having two water pumps, one of which is shut down in winter, provision can be made for preserving high velocities even with reduced water quantity. At high vacuum with cold water, the top tubes in large condensers do most of the work and therefore the smaller winter quantity should be concentrated on these tubes, thus maintaining high velocities in the tubes which tend to foul and corrode.

In the summer time both pumps supply water to the two nozzles (Fig. 14) serving sections *A* and *B*, and a small quantity of water is supplied the coolers and from them to section *C* at the bottom of the condenser. In winter one pump is shut down, the valve to section *B* shut, and the plates in the deck between *B* and *C* removed thus throwing these two tube banks in parallel so that they both receive water from the coolers. The main water supply is then concentrated on the upper section *A*. This design also has the advantage that at any time the entire capacity of the two pumps may be concentrated on section *A* or *B*, thereby producing extremely high cleaning velocities, also, that either section *A* or *B* can be shut down independently and the water-box covers removed for inspection or cleaning.

Dean Cooley New President of American Engineering Council

Election of Successor to Herbert Hoover Announced at September Meeting of Executive Board of Council—Important Committee Reports and Other Matters Brought Up for Consideration

IN THE recent election, announced at Washington September 30, of Mortimer E. Cooley, dean of the Colleges of Engineering and Architecture of the University of Michigan, as president of American Engineering Council, the executive body of The Federated American Engineering Societies, the organization secures as its leader a man widely and favorably known not only to the engineering profession but to the general public. Dean Cooley has been elected to fill the vacancy caused by the resignation of Herbert Hoover after he became Secretary of Commerce.

Mortimer Elwyn Cooley was born in Canandaigua, N. Y., March 28, 1855, and was graduated from the United States Naval Academy in 1878. Following cruises in the Mediterranean and to Newfoundland, he was ordered to the Bureau of Steam Engineering, where he remained until July, 1881, in the drafting and design department. He was then stationed at the University of Michigan for four years as professor of steam engineering and iron shipbuilding, at the end of which time, at the request of the regents, he resigned from the Navy and accepted the chair of mechanical engineering at the university. He became dean of the College of Engineering in 1904 and of the College of Architecture in 1913.

Mortimer E. Cooley

During the Spanish war Dean Cooley served as chief engineer of the *Yosemite* which acted as convoy and did blockade duty off Santiago, San Juan and the Jamaican coast. For a time following the war he was attached to the League Island Navy Yard, engaged in engineering work.

In 1899 he returned to the university and during the years following undertook a large amount of important appraisal work, the total value of the property with which he has been concerned in appraising being about a billion and a half dollars, of which 85 to 90 per cent has been for the public. From 1907 to 1912 he acted as chairman of the Block Signal and Train Control Board, Interstate Commerce Commission. At the Chicago Exposition he was a member of the Engineering Committee and at the Pan-American Exposition he served on the Committee of Awards.

Dean Cooley was vice-president of the American Association for the Advancement of Science in 1898, president of the Michigan Engineering Society in 1903, a director of the American Society of Civil Engineers from 1913 to 1916, vice-president of the Society for the Promotion of Engineering Education, 1908–1909, and its president, 1920–1921. He became a member of The American Society of Mechanical Engineers in 1884, and served as its vice-president during the year 1902–1903, as chairman of the executive committee, Detroit Section, 1916–1917, and as president of the Society during the year 1918–1919.

Concerning the election of Dean Cooley, L. W. Wallace, executive secretary of the American Engineering Council, said:

> It is indeed gratifying to have such a man as Dean Cooley as president of the American Engineering Council. Dean Cooley is a man of splendid accomplishment both professionally and personally, and is widely and favorably known to the public and to engineers. He is a man that has rendered splendid service to the engineering profession, and it is confidently expected that in his capacity as president of the Federation he will render a still greater service to the public and to the engineering profession by virtue of the larger opportunity.

Committee Reports

The September 30 meeting of the Executive Board of the American Engineering Council was the first to be held at Washington D. C., since its initial meeting, held there November 20, 1920. The presiding officers were Calvert W. Townley and J. Parke Channing of New York, vice-presidents. Approximately twelve hours were devoted to an intensive and earnest consideration of various matters of importance, including the reports of the Committee on Patents, the Committee on Employment, Committee on Government Contracts, and the Committees on Registration and on Classification and Compensation of Engineers.

The Council adopted the report of its Committee on Patents, which urged the passage of the Lampert Bill to remedy conditions in the Patent Office, and approved a resolution expressing the conviction that this bill "provides the least increases in force and salaries which can possibly stop the retrogression of the Patent Office and enable it to make progress toward recovering an efficient condition, and, by increases in the fees for patents, supplies the funds necessary to enable the Patent Office to continue to be self-supporting." The Council will also support the committee in its opposition to the passage of the Stanley Senate Bill which provides for an amendment to the Patent Act, requiring that all alien-owned American patents shall be worked in this country within two years after the granting of the patents.

After a long discussion of the report of the special Committee on Employment, a committee of the Board was appointed to draft resolutions which would crystallize the general thought brought out by the discussion. The committee reported the following resolutions which were adopted:

> Whereas, The need is pressing for a unified employment service for engineers, national in scope, local in application, and financed for adequate service; and
>
> Whereas, The contributions which the constituent societies of The Federated American Engineering Societies are able to make to the Employment Bureau have been found inadequate to provide an Employment Service such as engineers require; therefore, be it
>
> *Resolved:* That the Executive Board of the American Engineering Council endorses in principle a paid employment service but with reduced fees to members of organizations supporting said service; and be it further
>
> *Resolved:* That a Committee of five members of the Executive Board be appointed by the Chairman and that the Boards of Direction of the four founder societies be requested each to appoint a member of its board in order to form a Joint Committee of nine members on Engineering Employment with the power to organize an Employment Bureau, on a plan which will invite the coöperation of interested organizations.

The Committee on Government Contracts made a number of important recommendations. Some of the more significant recommendations approved are:

> 1 That Government work be normally carried out through unit-price or lump-sum contracts, or by the purchase and hire method. Where none of the above methods are applicable to conditions, that the cost-plus method

be used in which the contractor is refunded the actual cost of the work, plus an accorded compensation which increases if the work is done below the estimated cost of the work, and decreases if the work costs more than estimated, but never sinks below zero;

2 That there be appointed by the President an Inter-Departmental Board on Standardization of Contracts, consisting of one representative of each Government department engaged in construction. That this Board recommend policies to govern in the standardization of contracts within each department. Each department should have a small board representative of each bureau engaged in construction, and should seek to unify and standardize contract practices within the Department, and the chairmen of these Departmental Boards might preferably constitute the Inter-Departmental Board, which should be only advisory in character. That when the contracts of each department shall have been by itself thus standardized, that the Inter-Departmental Board consider these contracts and make necessary recommendations to harmonize and secure, so far as feasible, uniformity of practice in the different departments;

3 That all Government officials shall recognize the importance of exerting the utmost efforts to make prompt partial payments on Government contracts at reasonable intervals as stated in the contracts, for all services rendered and materials delivered by the contractor, on the work that has been accepted by the Government inspector;

4 That payment shall in all cases, as far as possible, be made by the official or agency directing the work, and not by an outside accounting or financial agency, in order to avoid the burden on the contractor of delays in payments when made by such an agency not directly concerned with, or responsible for the efficiency, economy and dispatch of the work.

The report of the Committee on the Registration of Engineers was considered and referred back to the Committee for revision. Following a recommendation of the Committee on the Classification and Compensation of Engineers, the Executive Board endorsed the classification of engineers as proposed by the Committee on Classification and Compensation of Engineering Council in its report of December 15, 1919, as in the judgment of the Board generally applicable to all branches of engineering. The Executive Board also authorized the chairman to appoint a sub-committee to make a comparative study of such proposed legislation on this subject for the purpose of presenting to the Council a final report and recommendation for action.

The Executive Secretary was authorized after advice with the Committee on Procedure to organize in such states as may seem to be necessary, State Administrative Committees, thus providing mediums whereby the Federation may obtain quick and direct action pertaining to any of its activities. Such committees would be organized after conference with member organizations. In those states that have an all-inclusive state organization that organization would be requested to recommend representatives on the State Administrative Committee, and in the case of a state where there is not an all-inclusive society, the national organization will be asked to make recommendations. In every instance an effort would be made to obtain representatives of the various branches of engineering and of member societies.

Miscellaneous Business

In view of the general business situation involving the probability of lessening the attendance, it was decided not to hold the engineering assembly planned for January, 1922. The committee in charge of the arrangements was converted into a program and entertainment committee for the Annual Meeting of the Council to be held in Washington in January.

Col. Arthur S. Dwight, official representative of the F.A.E.S. on the deputation of engineers to England and France in June, presented his report, in which he called attention to the active interest in the Federation manifested by British engineers, who have already taken steps to organize the engineers of the Great Britain along the lines pursued by the F.A.E.S.

The resignation of Mr. A. C. Oliphant as assistant secretary was announced. Mr. Oliphant was associated with the Engineering Council previous to the organization of the American Engineering Council and has rendered valuable service in both capacities. He is to become associated with M. O. Leighton and Company, consulting engineers, Washington, D. C.

The applications for membership of the Vermont Engineers' Society and the Associated Engineers of Spokane were approved.

A resolution was passed by the Board approving the decision of the National Board for Jurisdictional Awards in the Building Industry with respect to the award affecting the Brotherhood of Carpenters.

Progress was also reported by other committees. In general it was felt by the attending members of the Board that the work of the Federation was advancing in a satisfactory manner.

Engineering and Industrial Standardization

A Group of Standard Specifications Prepared by the American Society for Testing Materials and the Bureau of Mines Now Under Consideration by the American Engineering Standards Committee

THESE specifications are submitted in accordance with the special provision in the procedure of the American Engineering Standards Committee under which important standards in existence prior to 1920 may be approved without going through the regular process followed in new work. The Committee would be very glad to learn from those interested of the extent to which they make use of these specifications and to receive any other information regarding the specifications in meeting the needs of the industry. Copies may be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York City. Price 25 cents each.

Specifications for Drain Tile

The history of the A.S.T.M. specification for Drain Tile dates back to 1911 when the A.S.T.M. organized its Committee C-6 on Drain Tile to meet two very urgent conditions. The comparatively recent use, on an extensive scale, of very large drain tile in public drainage works for reclaiming wet lands had brought about the unexpected discovery that these large drain tile were quite subject to cracking in the ditch under the weight of the ditch refilling. Also, the extensive production of concrete drain tile, and the resulting controversy between clay-tile and concrete-tile producers as to the merits of the new material made it urgent that additional data be secured.

The first task of the newly organized committee was to plan and conduct a series of investigations covering methods of tests, the determination of desired quality and durability of drain tile, and a study of methods of manufacture and of construction and field specifications. In this work it was actively assisted by the following engineering laboratories: Iowa Engineering Experiment Station, Ames, Iowa; Municipal Testing Laboratory, City of St. Louis, Mo.; University of Wisconsin, Madison, Wis.; Lewis Institute, Chicago, Ill., and the Engineering Laboratory of Edward Orton, Jr., Columbus, Ohio.

The manufacturers of clay and concrete tile coöperated by furnishing materials for tests. The American Society for Testing Materials estimates that these investigations, which extended over five years, from 1911 to 1915, cost at least $25,000.

In 1914 Committee C-6 prepared Standard Specifications for Drain Tile covering strength tests, quality and requirements for strength of tile as used in ditches. These specifications were tentatively adopted, subject to revision. The specifications were revised in 1916 and 1921, the latter revision consisting of a modification of the methods of making the freezing and thawing test as the result of investigations which had been under way for some time. The revised specifications are contained in the 1921 volume of A.S.T.M. Standards.

Methods of Analysis of Manganese Bronze and Gun Metal

Two standard methods of analysis entitled Methods of Chemical Analysis of Manganese Bronze (B27-19) and Methods of Chemical Analysis of Gun Metal (B28-19) have been prepared by Committee B-2 on Non-Ferrous Metals and Alloys of the A.S.T.M. They were based upon several methods in use when the preparation was first undertaken in 1917. After standing as tentative for one year, they were adopted without revision as standard by

the Society in 1919. These specifications may be found in the 1919 volume of A.S.T.M. Standards.

Steel Forgings

Among the eleven standards of the American Society for Testing Materials now before the American Engineering Standards Committee for consideration and approval are:

- Specifications for Carbon-Steel and Alloy-Steel Forgings (A18-21)
- Specifications for Quenched and Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A19-21)
- Specifications for Carbon-Steel Forgings for Locomotives (A20-21)
- Specifications for Quenched and Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A63-21)

Specifications for Carbon-Steel Car and Tender Axles (A21-18).

Specifications A18-21 for Carbon-Steel and Alloy-Steel Forgings are general specifications covering the various classes of carbon-steel and alloy-steel forgings, on which the other specifications have been based with the addition of special requirements to suit the conditions of use. The preparation of these four specifications for forgings dates back to the earliest history of the American Society for Testing Materials. The predecessor of these specifications was the Standard Specifications for Steel Forgings, which were first proposed in 1900 and adopted in 1901 previous to the organization of the present A.S.T.M. by what was then the American Section of the International Association for Testing Materials. Since 1901 there have been several revisions of the work, notably in 1914 with the coöperation of other technical societies and associations, including the former Master Mechanics, Association and the Master Car Builders' Association, now the Mechanical Section of the American Railway Association. The work on alloy-steel forgings other than nickel steel was developed in 1915 as an extension of the previous work.

The specifications for Carbon-Steel Car and Tender Axles, while not included in the forgings series, were developed in connection with this work. In 1914 the Committee of the American Society for Testing Materials in charge of these specifications entered into a coöperative investigation with the Master Car Builders' Association, which led to a revision of the specifications in 1917 that harmonized the requirements in the two organizations. The revised specifications, adopted in 1918, have stood without revision since that date.

In submitting these specifications for approval by the American Engineering Standards Committee, the American Society for Testing Materials has presented data listing the companies, etc. that use them in their entirety or as general specifications upon which have been based other specifications suited to the particular needs. These specifications have been translated by the Department of Commerce into French and Spanish in connection with the development of foreign trade. The revised specifications are contained in the 1921 volume of A.S.T.M. Standards.

Two Cold-Drawn Steel Specifications

The A.E.S.C. has now before it for consideration and approval A.S.-T.M. Standard Specifications for Cold-Drawn Bessemer Steel Automatic Screw Stock (A32-14), and Cold-Drawn Open-Hearth Steel Automatic Screw Stock (54-15).

The materials covered in the two specifications are intended for use in making machine parts in automatic and other rapid-cutting machines in which the highest cutting efficiency is sought, consistent with the nature of the metal specified.

The history of the preparation of these specifications dates from 1909 when a committee was organized by the American Society for Testing Materials to prepare standard specifications for cold-drawn steel. In the discussion of specifications for automatic screw stock it became evident that considerable data were required, particularly with reference to material used for machining at very high speed. The committee accordingly undertook a series of tests to determine features which would affect the working qualities and physical characteristics of standard automatic screw stock. The various consumers represented on the committee placed orders with each of the producers for cold-drawn steel for automatic screw-machine work for test purposes, and a total of about twenty tons of material was thus furnished and tested. These tests were completed in 1913. The specifications covering bessemer stock were adopted by the society in 1914, and, after revision, the specifications for open-hearth stock were adopted in 1915. There have been no revisions since adoption.

These specifications have been translated by the Department of Commerce into French and Spanish for distribution in connection with the development of foreign trade. These specifications may be found in the 1918 volume of A.S.T.M. Standards.

Standard for Permissible Explosives

Standard Specifications for the Testing and Use of Permissible Explosives for Use in Mines, Bureau of Mines Schedule 17, are now submitted for consideration and approval as Tentative American Standards.

These standards are the result of thirteen years' experience by the Bureau of Mines in testing and in assisting manufacturers to develop explosives which offer the minimum hazard, when properly used, in gaseous and dusty mines.

In September 1908, the Bureau of Mines established laboratories, which maintain a trained corps of chemists and engineers conducting routine tests and carrying on special research work to assist in the manufacture and use of explosives. The design of these laboratories, the tests applied to the explosives, and the procedure followed in applying these tests were determined after consultation with the manufacturers and users of explosives in this country and with the officials directing similar tests in England, France, Belgium and Germany.

Standard methods of testing explosives were first published by the U. S. Geological Survey as Explosives Circular No. 1 on May 15, 1909, together with the first list of 17 permissible explosives.

By 1915 data on the testing of upward of 200 explosives had been accumulated, and 134 explosives had been placed on the permissible list. In June 1915 the Bureau of Mines called a conference of representatives of manufacturers of explosives to discuss the methods of testing employed and to determine the tolerances to be permitted in the retesting of field or of manufacturers' samples. As a result of this conference series of tolerances were issued on July 1, 1915.

In November 1920, the Bureau of Mines reviewed the rules and regulations then governing the testing and placing of explosives on the permissible list. In this review the committee took into consideration the data accumulated in the testing of 290 different explosive materials, of which 195 had been classed as permissible. The revised rules formulated as a result of this study were submitted to the explosives manufacturers of the country for their comment and criticism. With these comments in hand a final revision was made and approved as Schedule 17 on April 8, 1921.

Preferred Numbers

As an illustration of a fundamental piece of standardization work based on theoretical considerations which the Germans are attempting, a brief description of their system of "preferred numbers" may be of interest. This is a system of logically-worked-out numbers which are recommended for all new standardization work where numerical values are required. This includes dimensional work, such as the diameters of pulleys and thicknesses of plates, and also for numerical values of speeds, capacities of apparatus, such as kilowatt ratings of motors, etc.

In the accompanying table are given the more important numbers of the system. As an example of their use, if 5 sizes between 10 and 100 mm. are found to be sufficient, the numbers in the first column would be taken, viz., 10, 16, 25, 40, 64 and 100 mm. If 10 are necessary, the numbers in the second column would be chosen. For the range 1 to 10, the decimal would be shifted. A 40 and an 80-series are included in the system, but few cases requiring their use have arisen.

The numbers in each series increase by a constant percentage, i.e., they increase in geometric ratio, or logarithmically, as the diameters in the American Wire Gage. This makes the ratio of the numbers in the 5-series the fifth root of 10, in the 10-series the

tenth root of 10, etc., but rounded to give convenient numbers. The rounded numbers make the use of gage numbers unnecessary.

The Germans regard these preferred numbers as very important as they believe their use will lead to great economies in material, reduce the number of sizes, ranges, etc., simplify the carrying of stocks, facilitate interchangeability, etc.

The following examples of the use of these preferred numbers are from the electrical industry alone: kilowatt ratings of motors, turbo-generators, and transformers; dimensions of carbon brushes; diameters and speeds of pulleys.

TABLE OF PREFERRED NUMBERS

5-Series	10-Series	20-Series
10	10	10
		11.2
	12.5	12.5
		14
16	16	16
		18
	20	20
		22.5
25	25	25
		28
	32	32
		36
40	40	40
		45
	50	50
		56
64	64	64
		72
	80	80
		90
100	100	100

NEWS OF OTHER SOCIETIES

American Institute of Mining and Metallurgical Engineers

The 124th meeting of the American Institute of Mining and Metallurgical Engineers held at Wilkes-Barre, Pa., September 12 to 15, 1921, celebrated the semi-centennial of the Institute, which now has a membership of more than 10,000.

Technical sessions held the first day of the meeting included papers on mining problems, descriptions of plants and coal fields, and several presented under the auspices of the metal section of the Institute, including the following: Application in Rolling of Effects of Carbon, Phosphorus and Manganese on Mechanical Properties of Steel, by W. R. Webster, of Philadelphia; The Thacher Process for Molding and Casting Propeller Blades and Wheels, E. Touceda, metallurgist, Albany, N. Y.; and Acid Open-Hearth Process as Conducted in America, Col. W. P. Barba, Philadelphia, and Dr. H. M. Howe, New York.

The second day of the meeting was spent in an automobile trip through the Wyoming Valley to Scranton, Pa., where the afternoon was devoted to two simultaneous sessions, one dealing largely with electrical features of mining, and the other with Americanization work in connection with mining and metallurgical industries. In the evening another technical session was held at Wilkes-Barre, the subjects under discussion being the Power Installation at Cloverdale, Octagonal Ventilation Shaft of Davis-Daly Copper Co., and the Application of Pulverized Coal to Boilers.

On the following day there was a general joint meeting conducted by the Society of Economic Geologists, a session on mine accounting, a general technical session and an economic geology session, at which many interesting papers were presented.

The meeting closed on September 15 with an all-day excursion to parts of the Wyoming, Lehigh and Southern anthracite coal fields.

Association of Iron and Steel Electrical Engineers

A five-day meeting of the Association of Iron and Steel Electrical Engineers was held at Chicago, September 19 to 24. The technical sessions laid particular emphasis on fuel economy. Standardization also received considerable attention, and an exhibit of electrical devices and inspection trips formed interesting features of the meeting. Only two papers were presented at each session, so that there was ample opportunity for discussion.

The papers dealing with fuel economy were by F. E. Leahy, fuel and experimental engineer of the Carnegie Steel Co., Duquesne, Pa., W. N. Flanagan, steam engineer for the Ohio Works of the Carnegie Steel Co., Youngstown, Ohio, E. A. W. Jefferies, consulting engineer, of Worcester, Mass., and G. R. McDermott, assistant engineer of the Illinois Steel Co., South Chicago, Ill.

Mr. Leahy listed the different forms of fuel used in steel mills, giving the characteristics which fit each one to a different operation, and dealt with possibilities of economy in their transportation, storage and distribution. The discussion brought out the high efficiencies obtained through the use of waste-heat boilers.

The advantages of automatic boiler control were enumerated by Mr. Flanagan, who described one method in which electricity is the controlling medium. The coördination of power from various boilers was believed to be an important factor in conservation of fuel.

The paper by Mr. Jefferies announced his discovery of a method of producing cheap oxygen. This method is based on the idea of carrying on the distillation of the volatile nitrogen from liquid air at the pressure to which the air is originally compressed. The nitrogen, constituting about 80 per cent of the whole volume of the air, may be heated and used in a piston engine to drive the compressor, making external power for operation unnecessary. The applications of this method and the benefits to be derived were discussed.

Mr. McDermott reviewed accomplishments in the utilization of waste gases in steam generation, naming sources of waste heat, and discussed the merits of various types of boilers as absorbers of waste heat.

Other papers presented at the meeting dealt with recent developments in the design of induction-motor starters, the electrification of the steel-mill railroad, and anti-friction bearings in the steel mill.

The report of the Standardization Committee included electric overhead-traveling-crane specifications, general specifications on alternating-current motors for main-roll drives, and a report of the Sub-Committee on Illumination.

The following new officers were elected: Warren S. Hall, Illinois Steel Co., Chicago, president; R. B. Gerhardt, Bethlehem Steel Co., Sparrows Point, Md., first vice-president; L. F. Galbraith, West Penn Steel Co., Brackenridge, Pa., second vice-president; J. F. Kelly, Pittsburgh, Pa., secretary; and James Farrington, LaBelle Iron Works, Steubenville, Ohio, treasurer.

American Society for Steel Treating

At the third annual convention and exhibition of the American Society for Steel Treating, held at Indianapolis, September 19–24, over 40 papers were presented and discussed, and as many more were presented by title. Research and management were subjects placed on the program of the society for the first time.

Carbonizing was the subject of the first technical session and various processes were discussed by several speakers. Simultaneous sessions on tool steel and heat treatment of special products were held the second day, and included papers on physical tests on high-speed steel, brass forgings, and heat treatment of copper and brass.

On the morning of September 22 two simultaneous sessions were held, one on army and navy subjects, including an illustrated paper on railway gun mounts, and one on alloy steel, at which several papers of interest on the mechanical properties of various alloy steels were presented. In the afternoon another group of sessions covered the subjects of metallographic research and heat-treating equipment.

Research, management and costs, and heat-treating problems were discussed on the last day of the conference.

Of the new officers elected, Frank P. Gilligan, of the Henry Souther Engineering Co., Hartford, Conn. is president; F. C. Lau, Arrow Forging & Tool Works, Chicago, first vice-president; R. J. Allen, Rolls-Royce Co. of America, Springfield, Mass., second vice-president; J. V. Emmons, Cleveland Twist Drill Co., Cleveland, treasurer; and J. J. Crowe, Philadelphia Navy Yard, director.

In conjunction with the meeting of the steel treaters an exhibition was held in which the products of over 60 manufacturers of metallurgical equipment and heat-treating devices were presented.

Argentine National Engineering Congress

The second Argentine National Engineering Congress was held in Buenos Aires, Argentine, S. A., Sept. 23, 1921, under the auspices of the Centro Nacional de Ingenieros. The conference commemorated the centennial of the founding of the University of

ing, transportation, and general.

The hydraulic session included discussion of irrigation by pumping, and drainage systems in Buenos Aires and the interior.

Water supply, purification and transportation of water, and sanitation in unhealthy districts were discussed at the session on sanitary engineering.

One group of papers discussed at the session on industrial engineering dealt with electrotechnical subjects, including electric and hydroelectric plants, distribution of energy, industrial and domestic applications, electric traction, telegraphy and telephony, electric propulsion of ships, and power supply for electrification of suburban railways. Other groups of papers presented at the industrial session were on such subjects as textiles, woods, paper, cement, brick, glass, refrigeration, liquid and pulverized fuel, mining and metallurgy, rural water and power supplies, etc.

Aeronautical, vehicular, and rail transportation were discussed at length at the session of means of communication and the general session included questions of economics and legal engineering.

The invitation to the American National Engineering Societies in Argentina to send delegates to this conference, was a recognition of this organization which was formed early this year as a result of the activities of Local Sections of the A.S.M.E.

American Electrochemical Society

The fortieth general meeting of the American Electrochemical Society was held at Lake Placid, N. Y., Sept. 29, 30 and Oct. 1. The outstanding feature of the technical program was a symposium on non-ferrous metallurgy, at which two papers were presented the Metallurgy of Non-Ferrous Metals, by H. M. St. John, of the Detroit Electric Furnace Co., and Resistance-Type Electric Furnace in the Melting of Brass and other Non-Ferrous Metals by T. F. Baily, of the Electric Furnace Co., Alliance, Ohio. In a paper by N. K. B. Patek, works manager of Lumen Bearing Co., Buffalo, N. Y., electric-furnace practice was compared with fuel-fired-furnace practice. H. A. De Fries, consulting engineer, New York, described an electric silver-melting equipment, and Dr. E. F. Northrup, of the Ajax Electrothermic Corporation, Trenton, N. J., discussed some difficulties met in melting a large quantity of silver. Other papers in the symposium dealt with electric-furnace melting of nickel silver, recent developments in electric furnaces of the muffled-arc type, and modern developments in the British brass industry.

In the general session, a paper on Experiences with Alkaline and Alkaline Earth Metals in Connection with Non-Ferrous Alloys was presented by Charles Vickers, consulting foundry engineer, Buffalo. He stated that sodium was the best of the alkaline metals for use as a deoxidizing agent in making copper castings of superior torsional strength, and that calcium, in combination with an acid element, will produce castings of good electrical conductivity.

The theory that corrosion is started by the formation of colloidal ferrous oxide was discussed in a paper by J. Newton Friend, of Birmingham.

Rust Prevention by Slushing was the title of a paper presented by Haakon Styri, Chief of the S.K.F. Research Laboratory, Philadelphia. This paper emphasized the importance of preventing rust on steel parts which cannot be given a permanent coating of paint or metal.

LIBRARY NOTES AND BOOK REVIEWS

Aeroplane Performance Calculations. By Harris Booth. Dutton & Co., New York, 1921. (The Directly Useful Technical Series.) Cloth, 6 × 9 in., 207 pp., diagrams., $8.

This book, it is hoped, will meet the need of aeronautical engineers and designers for a practical method of calculation; it is in three sections: first, a descriptive and theoretical section explaining the points to be noticed and deriving the necessary formulas; second, an explanation of practical procedure; third, an example of the application of the method described to an actual machine.

Alternating Currents. By Carl Edward Magnusson. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 559 pp., illus., $4.50.

A presentation of the fundamental principles of alternating-current phenomena, with illustrations of their application to industrial problems, intended to aid the student in gaining clear concepts of what actually takes place in alternating-current machinery, to explain the relations between the factors involved and to express the physical facts in mathematical forms in such a manner that he shall understand the equations and be able to use them rationally in the solution of industrial problems.

America's Power Resources. By Chester G. Gilbert and Joseph E. Pogue. The Century Co., New York, 1921. Cloth, 5 × 8 in., 326 pp., illus., $2.50.

An attempt to interpret the importance attaching to the energy resources, coal, oil, natural gas and water power, to point to the shortcomings in the way they are handled, to outline the changes in the administration of energy which are bound to come into play if due social and industrial progress is to be attained, and to indicate the avenues of advance along which constructive efforts should be applied. The material presented is largely the result of investigations by the authors, brought out from time to time as special papers, emanating mostly from the Division of Mineral Technology, United States National Museum, and more popularly presented here in a unified and less technical form.

Automatic Telephony. By Arthur Bessey Smith and Wilson Lee Campbell. Second edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 430 pp., illus., diagrams, $5.

The method adopted is to describe fully the typical circuits and apparatus of the Strowger type, and to outline briefly the other important systems. By this method it has been possible to explain the principles and methods fully enough for their application to other makes of equipment, without attempting to narrate the practice of all manufacturers in detail. This edition is radically changed from the previous one by the elimination of obsolete matter and the introduction of new material.

Electric Furnace. By J. N. Pring. Longmans, Green & Co., New York, 1921. (Monographs on industrial chemistry.) Cloth, 6 × 9 in., 485 pp., plates, illus., $10.50.

Although the most noteworthy branches of the electrochemical and electrometallurgical industries have been described in a number of publications, the present rapid progress of these enterprises demands a frequent revision and extension of the literature. This volume is an additional contribution to the general technical discussion of the position and prospects of high-temperature industrial chemistry. The author reviews the history and principles of the electric furnace and describes the types in use. Current supply, transformers and the measurement of high temperatures are treated and the use of the electric furnace in the metallurgy and chemistry of the important metals is described. Attention is also given to furnace design and to the economic aspects of electrochemical processes. A useful bibliography is appended.

Etude des Mouvements Appliquee. By Frank B. Gilbreth and L. M. Gilbreth. Dunod, Paris, 1921. Paper, 5 × 8 in., 161 pp.

In 1918 Mr. Gilbreth's Motion Study appeared in French. Evidently it attracted interest, for it is now followed by a translation of Applied Motion Study, a collection of papers by Mr. and Mrs. Gilbreth which was published in this country in 1919. The publication of the book is an indication of the keen interest of French engineers and manufacturers in American methods of production.

Grundlagen und Gerate Technischer Langenmessunoen. By G. Berndt and H. Schulz. Julius Springer, Berlin, 1921. Paper, 6 × 10 in., 216 pp. illus., 48 M.

This discussion of the principles upon which our measurements of length rest and the instruments used for measurement is intended for engineers and machinists engaged in manufacturing industries. The book first explains the development of the metric system, the standard meter and the methods of reproducing it. The development of industrial measures and gages is then described fully, their exactness discussed and the physiological errors that occur are explained.

Handbook of Standard Details for Engineers, Draftsmen and Students. By Charles H. Hughes. D. Appleton and Co., New York, 1921. Cloth 5 × 7 in., 312 pp., tables, diagrams, $6.

The book is a compilation, in a volume of convenient size, of drawings, tables and formulas of standard details. Included among these are fastenings of various kinds; shafting, clutches, collars, bearings, gearing and other parts of power transmissions; pipes tubes and fittings; rope and chain fittings; structural and miscellaneous details. Much of the material has been furnished by American machine-tool manufacturers and represents their practice.

Heat Treatment of Soft and Medium Steels. By Federico Giolitti. Translated by E. E. Thum and D. G. Vernaei. First edition. McGraw Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 374 pp., illus. $5.

Contents: The Phenomena of Diffusion in Primary Solid Solution; Effects of Diffusion upon Secondary Crystallization; Diffusion in Austenite as Applied to Preliminary Heat Treatment of Steels; Preliminary Heat Treatment of Steel Castings; Preliminary Heat Treatment of Forged and Rolled Steels.

Metallurgists and metallographists, according to the translator of this volume, have only recently been impressed by the fact that various impurities and addition agents may affect the properties of finished steel far in excess of that expected by their apparent amount. Precise data along the lines are almost entirely lacking; therefore this book, containing the first systematic discussion of their effect on commercial heat treatment, should prove a stimulus toward their study as it shows the great advantages to be gained by their elimination or suppression.

Heating Systems. By F. W. Raynes. Second edition. Longmans, Green and Co., New York, 1921. Cloth 6 × 9 in., 324 pp., plates, diagrams, tables, $7.50.

This textbook on the design of heating systems presents modern English practice. A special feature is the large number of charts that have been prepared and the method adopted for calculating pipe sizes. The practical rather than the theoretical aspects of the work have been given attention. Consideration is also given to the economical aspect of heating problems, especially in the heating of industrial buildings and plants. The new edition has been brought up to date.

Induction Motor and Other Alternating-Current Motors. By B. A. Behrend. Second edition, revised and enlarged. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 272 pp., portraits, diagrams, $4.

This work appeared first in 1901 and is based on a series of lectures delivered at the University of Wisconsin during the preceding year. This second edition, twenty years later, has been expanded from 105 to 272 pages and thoroughly revised to represent the author's present opinions on its subject. The book is not meant to be encyclopedic. It is, in the words of the author, "essentially the work of an engineer who has had the good fortune to have been actively associated with the art of electrical engineering through almost three decades and who has had a part in the development of the machines about which he writes."

Traite de Dynamique. By Jean d'Alembert. Gauthier-Villars et Cie, Paris, 1921. (Les maitres de la pensee scientifique.) Paper, 4 × 7 in., 2 vol.

This edition of d'Alembert's work on mechanical philosophy is reprinted from the second edition, which appeared in 1758, and which was enlarged and corrected by the author. It fills the need for an inexpensive, accurate edition of the book.

D'Alembert (1717–1783) was the most prominent student of celestial mechanics between Newton and Laplace. His investigations prepared the way for the Analytical Mechanics of Lagrange.

IMPRESSIONS OF INDUSTRIAL RUSSIA

(Continued from page 751)

man's position was almost unbearably difficult. He was between two fires. On one side was the management committee, made up of a workman from the factory, a former draftsman and an appointee from the central office of the Metal Department. They occupied the elaborately furnished offices of the factory, and gave impractical and impossible orders. The other difficulty was the interference of orders from four automobile departments of the government. The military department gave peremptory orders, saying "Here is an automobile which must be repaired before a certain date or you will be shot."

In addition, the chief engineer was struggling with a thousand untrained, hungry, cold, dejected men; his own family, consisting of wife, two children and a lady relative, were living in two rooms heated by small sheet-iron stoves. He had no automobile and as there was no street-car service he walked to the factory every morning, about 3 or 4 miles. This man went struggling constantly with the personal problem of fuel and food, often dragging supplies home himself on a hand sled. His holidays and evenings were spent in disagreeable, trying physical labor, such as cleaning stoves, sawing and splitting wood, carrying water, etc. On many holidays he went to the factory and joined with labor parties in physical work, removing snow and refuse, and cleaning up the factory.

Education

It is often stated by supporters of the Bolshevik government that while there cannot be very much expected from the present generation of workers trained under capitalistic methods, the generation now being educated will bring about a new industrial day. It is therefore interesting to take a look at this educational system of which they speak.

When one understands the terrible difficulties in the way it is not surprising that there are no results either in education or production. They have quite a beautiful theory of education for all. However, with four years of destruction and no printing except Bolshevik propaganda, there are no schoolbooks and no educational literature. Magazines and books of general educational value are almost entirely lacking. In addition to this, there is not sufficient fuel to heat the school buildings. There is a shortage of teachers, and such simple things as notebooks, slates, lead pencils, pens, ink, etc. are very scarce or entirely lacking.

The universities are open to every one. This makes it extremely difficult for the professors, who try to suit their lectures to the average student body, with the result that they are commonplace for those with preparatory training and unintelligible to the unprepared.

The children are always cold and hungry. There is no adequate provision for taking care of the schoolrooms and keeping them heated and clean, and the students are required to prepare the fuel and clean the buildings.

The main inducement to attend the schools is a noon lunch of a little soup made from cabbage or dried fish, with sometimes a little black bread.

Bolshevik Leaders Hide Economic Failure

The Bolsheviki have been successful in diverting public attention from their economic failure. First they ascribed it to the war and blockade. Following this they lulled the people with much talk of concessions by which they hoped to lure the capitalists of the world into their country and use them as a tool for solving the very difficult situation. The next cry was that of electrification, there were wonderful schemes for electrifying the entire Russian country and an electric train made a trip from Petrograd to Moscow. This was an ordinary storage-battery train, which is, of course, impractical for such service. The latest diversion is feeding the starving. There is no doubt that entire Russia is in danger of starvation, but the Bolsheviki attempt to make it appear that the cause is entirely due to the crop failure. It is true that there has been a crop failure in the lower Volga grain-producing section. In normal times, however, Russia exported large quantities of grain, and had there been a reserve and adequate transport, Russia could have taken care of its population.

It is almost useless to speculate on what the result will be. But everybody, even the Bolshevik leaders themselves, apparently has come to the conclusion that this gigantic centralized organization scheme cannot succeed. Therefore there is the effort to decentralize and denationalize. Small private business is now permitted and there is much talk of the coming decrees which will give back to the former owners their houses and the smaller factories. But it is difficult to understand how they can be given back to private ownership. First the factory organizations have been destroyed, the stock of raw material and products consumed, and the buildings and equipment are in bad repair. To add to the difficulty of the private owner is the lack of financial machinery which he must have to do business. Lastly, all the liquid wealth of Russia has been destroyed.

In general, there seem to be only two suggested solutions for the present difficulty. One is the violent overthrow of the present government, but this seems impossible with opposition party leaders in jail and their followers under constant surveillance. The other is evolution to capitalistic private ownership. With all the talk of concessions I know of not one single effective concession which has been given. It seems almost impossible to establish a basis on which a concession could be given that would be acceptable to an outside capitalist. It also seems equally impossible to think of a plan by which the Bolshevik and capitalistic ideas can be mixed. Therefore the future of Russian industries is not bright. When reconstruction begins, manufactured products must be bought from the outside for the next one or two generations. Russia will be indeed fortunate if she can take care of her own repair and maintenance.

MAKING WORK FASCINATING AS FIRST STEP TOWARD REDUCING WASTE

(Continued from page 734)

rate of wage based on *time and class* of work and a *secondary* rate of wage based on actual *exercise of skill*, knowledge and intelligence.

A method of compensation of this character stimulates the development and exercise of creative power, encourages elimination of waste and does not suppress the desire to serve. In seeking these aims the fascination is readily found, while the interest in improvements and accomplishments is not pushed to the background by financial uncertainties or worries.

Another notable attempt to combat the evils arising from the lack of interest provided by mechanized work, may be observed in the hopes aroused by certain claims that a careful selection of workers to fit the work will eliminate dissatisfaction created by the poor fitting of men to jobs. These hopes wane as rapidly as they spring into prominence because the selection of men for jobs is an error of lowering a dimension. The correct course would be to fit the jobs to the men—in other words, to elevate the work to human dimensions, requiring not mere physical or animal power but an exercise of creative, intelligent faculties as well. The first step along this road is training the worker,[1] as opposed to securing unambitious, discouraged ones of low intelligence and further degrading them by assigning them to perform the lower functions of beasts of burden.

The next step advocated is to organize the work so that the worker's intelligence and his creative or imitative instincts will be brought into play. This requires (I) analysis of jobs and processes to bring out the interrelation of causes and effects and (2) the education of operators in conscious control of these forces and relations so that they can at will influence the results.

In order to eliminate a major part of our industrial losses, the creative, intelligent impulses of men should be given the fullest opportunity of self-expression. As an ideal we may foresee a complete abolition of monotonous, automatic, repetitive operations performed by men. These should be relegated to machines, while men should assume the part of directors and supervisors of processes. Workers by brain and by hand should unite in inducing relations between causes and effects, which are separated by the time elapsed. *Our imperfect machines, inefficient methods, wasteful processes and monotonous operations are the results of the incomplete, restricted use of our creative capacities.*

[1] Training Workmen, etc., H. L. Gantt.

It is now generally recognized in industry that idle equipment is harmful; the greatest source of waste is to be found in the idleness of our available knowledge and creative capacities of men, which are not liberated and applied productively under the mechanistic, formal organization.

The greatness of a new industrial leader will lie in his ability to liberate the creative forces within men, as against relegating them to the level of animals carrying burden and doing machine-like work.

In the author's experience in promoting and increasing industrial efficiency, he has found that the most fundamental, most successful and most enduring way to do it is in the elevation of man to his true dignity as an intelligent, creative agent. To be specific, the monotonous physical labor of a fireman is readily transfigured by special training into a fascinating game based on the exact sciences of physics and chemistry, requiring an exercise of mental capacities. Watching and interpreting a simple array of instruments (Fig. 3) provides men with interest, which is augmented as they intelligently control a process and watch the results attained.[1]

Charting the progress made in elimination of waste of material provides further source of satisfaction in observing one's own improvement in the mastery of processes through the acquisition of knowledge and skill. These charts (Figs. 4, 5, 6 and 7) are plotted on the basis of what is possible of accomplishment with a proper exercise of intelligence, knowledge, and skill, and the short bars indicate the falling short of possibility. Sometimes it is found that a playful spirit of friendly competition or just pride in self-improvement and accomplishment prompts men to draw similar records on the fronts of their boilers (Fig. 8) or elsewhere in the room. When men find themselves thinking about their job it loses its monotony. Moreover, the amount of physical labor is reduced in some inverse proportion to the intelligence applied.[2]

Similar reorganization of jobs and corresponding transformation of workers' attitude have been successfully tried in a variety of establishments—in the glass industry,[3] pulp and paper mills,[4] foundries, power plants,[5] etc.— and the further application of these principles awaits the progressive coöperation of manufacturers and industrial leaders.

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[1] "The object should surely be to make the workman in the future more of a director of instruments than a laborer, and to unite hand and brain as of necessity implying each other." Viscount Haldane of Cloan in introduction to Lord Leverhulme's Six Hour Day, Henry Holt & Co., N. Y., 1919.

[2] In such purely physical work as passing coal and ashes in power houses, this "bringing mind into labor" reduces amount of manual labor often to one half of former. In many cases work was considered so hard that labor turnover exceeded 300–500 per cent; the personnel remained on payroll unchanged for years after these principles were brought into play.

[3] In a glass and mirror factory the writer was able within a few months to develop such interest in the work that in a strictly unionized shop, the men in roughing department increased production 100 per cent and reduced expenses 34 per cent; in emery department the increase was 125 per cent and in surface polishing department 150 per cent with corresponding economies in production despite the fact that men's earnings at the same time increased by payment of 25 per cent bonus; amount of defective work was also reduced to one-fifth of the former.

[4] "This sort of creative efforts produced great changes in operating conditions." R. Wolf tells that in a pulp mill "we increased our yearly production from 42,000 tons to 111,000 tons without adding to the number of digesters for cooking the pulp, or wet machines for handling the finished product and we changed our quality from the poorest to the very best."

[5] In a typical power house of a large and progressive manufacturing concern, application of the writer's principles produced results thus reported by general superintendent to the president: "When the fact is taken into consideration that in the early part of 1918 we were paying $3.98 per ton delivered for coal, and that today our contract calls for a price of $5.15—and the market price of power-house labor has increased slightly more than 50 per cent,. . .our unit cost of power has gradually been reduced from a high cost of 1.11 in 1918 to an average less than 0.5, it can be seen that the improvement has been marked." In another instance the new spirit created was reflected in the report of an officer of the company stating that: "Not only have the results of the introduction of the new practice been most gratifying from the standpoint of reduction of expenses to the company and improvement in the conditions affecting the workman and his compensation, but it has also increased the mutual respect between management and workman and has developed the ésprit de corps which is so beneficial to both. The workman is as much interested in the success of the methods which have been established as is the management." J. C. Scholl, Pennsylvania Electric Association, 1915.

THE ENGINEERING INDEX

(Registered U. S. Patent Office and Canadian Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

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ACCIDENTS

Industrial. Accidents in Factories and Workshops. Chem. Age, vol. 5, no. 112, August 6, 1921, pp. 156–158. Notes on dangers in machinery and processes from annual report of British chief factory inspector.

Reduction of Waste Through Accident Prevention, L. A. DeBlois. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 403–406, 1 fig. Points out importance of careful analysis of industrial accidents in chemical industry.

AERIAL BOMBARDMENT

Course-Setting Bomb Sight. A Course-setting Bomb Sight. Engineer, vol. 132, no. 3425, Aug. 19, 1921, pp. 186–187, 5 figs. Describes latest type of bomb sight, invented by H. E. Wimperis, which permits attack to be delivered at any angle to the wind.

AERODYNAMICS

Stability. Graphic Investigation of Transverse and Lateral Stability (Untersuchung der Querstabilität und Seitenstabilität auf graphischem Weg), A. Baumann. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 212–220, 7 figs. Graphic method of investigation is developed based on numerical calculations of Reissner, Gehlen, and others. Importance of graphic investigation for soaring flight.

AEROPLANE ENGINES

Fuel Systems. The K L Fuel System. Aerial Age Wkly., vol. 13, no. 22, August 8, 1921, pp. 515–516, 7 figs. Designed to overcome troublesome features common in complex systems now in use and to completely meet the exacting requirements of aeroplane work.

AEROPLANE PROPELLERS

Air Moved by. Approximate Determination of the Quantity of Air Put in Motion by a Propeller Blade (Détermination Approximative de la Masse d'air que met en Mouvement une Aile d'hélice), Drzewiecki. L'Aerophile, vol. 29, no. 11–12, June 1–15, 1921, pp. 170–173, 3 figs.

AEROPLANES

Aerofoils. The Variation of Aerofoil Lift and Drag Coefficients With Changes in Size and Speed, Walter S. Diehl. Aerial Age Wkly., vol. 13, no. 22, August 8, 1921, pp. 518–520, 8 figs. General statement of principle of dynamic similarity as applied to the problem of determining variation of lift and drag of an aerofoil with size and speed.

Berline Spad. The Berline Spad-Herbemont S 33 (La Berline Spad-Herbemont S 33), E.-H. Lémonon. L'Aerophile, vol. 29, no. 11–12, June 1–15, 1921, pp. 167–169, 2 figs. A new type of six-seater aeroplane fitted with Salmson 250-hp. engine.

Bracing, Internal. The Internal Bracing of Aeroplane Wings, A. H. Stuart. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 301–302, 5 figs. Results of experiments for obtaining suitable data regarding initial tension to be put upon internal bracing wires of wings.

Rieseler. The New Rieseler Sport Monoplane (Das neue kleine Rieseler-Sportflugzeug), E. Meyer. Motorwagen, vol. 24, no. 20, July 20, 1921, pp. 411–414, 4 figs. Characteristics: Span, 7 m.; total length, 5.8 m.; weight empty, 150 kg.; engine, 30-hp. Haacke; speed, 110 km. per hr. Discusses requirements of a sport aeroplane.

Soaring Machine. The Construction of the Soaring Machine of the Baden-Baden Soaring Aeroplane Works, Ltd. (Bauart der Segelflugzeugwerke G.m.b.H. Baden-Baden), F. Wenk. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 211–212, 3 figs. Machine is a monoplane with strut and ordinary profile, but with large aspect ration and small surface load. Design is based on achievement of a high inherent stability.

10-Seater Tractor Biplane. Single-Engined Ten-Seater Tractor Biplane. Engineer, vol. 132, no. 3420, July 15, 1921, p. 73, 1 fig. Built by Bristol Aeroplane Co., Ltd., Bristol, England. Span, 54 ft.; length overall, 42, ft.; height, 11 ft.; speed at ground level, 122 mi. per hr.; ceiling, 13,500 ft.

Truss Ribs. Experimental Reinforced Plywood Truss Ribs. Air Service Information Circular, vol. 3, no. 212, April 30, 1921, 17 pp., 17 figs. Description of tests and recommendations.

AIR COMPRESSORS

Explosions. What Causes Explosions in Air Compressors? A. D. Risteen. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 35–36. Discusses carbonization of oil, ignition of carbon and removal of carbon and oil deposits.

German Types. Compressors (Kompressoren). Schiffbau, vol. 22, no. 42, July 20, 1921, pp. 1040–1043, 5 figs. Notes on Koster's valve gear, single-stage compressors; single-cylinder stage compressor for suction pipes up to 2000 cu.m. output per hr.; tandem compound compressors for suction pipes from 2500 to 5000 output per hr.; and high-speed compressors, built by Frankfort Machine Constr. Corp., Germany.

High-Pressure. A New Design of High-Pressure Compressors. Practical Engr., vol. 64, no. 1795, July 21, 1921, pp. 40–41, 5 figs. Describes Reavell "Axial" single-stage air compressor.

Lubrication. Avoiding Compressor Troubles, A. D. Risteen. Iron Trade Rev., vol. 69, no. 8, Aug. 25, 1921, pp. 489–492 and 495. Lubrication is said to be factor, and oil must have suitable properties. Explosions of external and internal origin can be prevented by cleaning accumulations periodically. Compressors usually over-lubricated.

Reavell Quadruplex. The Reavell Quadruplex Air Compressor and Some Tests Thereon. Engineer, vol. 132, no. 3421, July 22, 1921, pp. 98–100, 9 figs. Report of tests made by H. Riall Sankey on 1920 design.

AIRSHIPS

Inflation. Chart for Inflating Airships (Diagramma dei Lavaggi delle Aereonavi), Angelo Varoli-Piazza Revista Marittima, vol. 54, no. 6, July 1921, pp. 751–756, 2 figs. Discusses two ways of adding daily a certain quantity of gas and charging completely.

PL 27. The PL 27 Dirigible (Das Luftschiff PL 27). Motorwagen, vol. 24, no. 22, Aug. 10, 1921, pp. 455–460, 7 figs. Built in 1916 by the Aircraft Co. in Bitterfeld, Germany. Specifications: Max. length, 157 m.; diam. 19.6 m.; height, 26.5 m; max. circumference, 61.55 m.; volume, 31,300 cu. m.; useful lift, 18,000 kg.; speed, 27.3 m. per sec. Each nacelle is equipped with a 240-hp. Mayhach engine.

ALLOY STEELS

Electric. Three Types of Alloy Sheet Steel—I, Horace C. Kneer. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 594–596, 2 figs. Deals with investigation of three commercial types of high-strength alloy steel in sheet form, carried out at Naval Aircraft Factory, Philadelphia, to determine which was most suitable for manufacture of fittings for large aircraft.

ALUMINUM

Welding. Oxy-Acetylene Welding Cast and Sheet Aluminum. Can. Machy., vol. 26, no. 4, July 28, 1921, pp. 31–32 and 35. Describes various operations involved.

ALUMINUM ALLOYS

See DURALUMIN.

ASH HANDLING

Methods. The Removal of Ashes in Large Boiler Houses (Ueber die Aschenbeseitigung in grossen Kesselhäusern), Ph. Scholtes. Elektrische Kraftbetriebe u. Bahnen, vol. 19, no. 11, June 10, 1921, pp. 129–133, 9 figs. Account of special meeting of the Bavarian Electrical Works Engineers for study of ash-removal methods. Experiences and costs in different plants with various systems.

Plants. Modern Ash- and Slag-Removal Plants in Boiler Rooms in Rhenish-Westphalian Mines (Neuzeitliche Entaschungs- und Entschlackungsanlagen in Kesselhäusern auf rheinisch-westfälischen Zechen), M. Schimpf. Glückauf, vol. 57, no. 32, Aug. 6, 1921, pp. 761–765, 8 figs. Describes various systems in use.

Railroad Ash-Handling Plant Has Buckets and Crane. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, p. 310, 2 figs. Installation on Burlington railroad designed for economical and direct handling from pits to cars.

Pneumatic Removal of Flue Dust (Pneumatische Flugaschenförderung), F. Ohlmüller. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 3, Jan. 21, 1921, pp. 17–21, 8 figs. Describes a portable ash-removal pump of the Siemens-Schuckert Works with portable vacuum-proof collector in form of a lorry.

AUTOMOBILE ENGINES

Ignition Advance. An Analysis of the Automatic Ignition Advance Mechanism, C. H. Hindl. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 312–314, 3 figs. Description and calculation.

Intake Manifolding. Intake Manifolding. Motor Age, vol. 40, no. 7, August 18, 1921, pp. 14–15, 13 figs. Multi-cylinder manifolding as applied to six-cylinder engines.

Lapping Machines for Bearings. Lapping and Running-in Machine, A. B. Bassoff. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 5–7, 4 figs. Function of lapping machine. Design of oscillating and of reciprocating mechanism. Types of work lapped.

Starters. Electric Starting Systems for Automobiles (Los Sistemas Eléctricos de Arranque Para Automóviles), F C. Barton. Boletín de la Asociación Argentina de Electrotécnicos, vol. 7, No. 2, January-

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

bath. (To be concluded.)

Machining Auto Starter Frames, Robert Mawson. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 296–298, 15 figs. Practice at plant of Gray & Davis, Inc., Boston, Mass. Special fixtures for drilling and tapping; devices for locating and removing work; boring fixture for polepieces.

AUTOMOBILE FUELS

Exhaust-Gas Odors. Street Hygiene and Automobile Exhaust Gases (Strassenhygiene und Automobilauspuff), Georg Wolff. Gesundheits-Ingenieur, vol. 44, no. 23, June 4, 1921, pp. 271–274. Discusses means of rendering exhaust gases as odorless as possible. Deals with properties of principal automobile fuels—gasoline, benzol (C_6H_6), and benzol and alcohol mixtures—and with lubricating oils.

AUTOMOBILES

A.B.C. The A.B.C. 12 H.P. Light Car. Auto, vol. 26, no. 29, July 21, 1921, pp. 621–625, 9 figs. Made by A.B.C. Motors, Ltd., Walton-on-Thames, Surrey. General description of engine, valve gear, clutch, gearbox, etc.

Daimler. A New Daimler. Autocar, vol. 47, no. 1345, July 30, 1921, pp. 205–207, 8 figs. Describes a 20-hp. 4-cylinder model embodying original details of design.

Durant. Technical Features of New Durant Car, P. M. Heldt. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 306–308, 6 figs. Engine is of an overhead valve type and cylinders and top half of crankcase are in single castings.

Generator Armatures. Production Methods in Armature Manufacture, Norman G. Shidle. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 318–320, 6 figs. Describes generator armature made by Western Electric Company, Springfield.

Grand Prix, 1921. Prize Competition of the Automobile Club of France (Le Grand-Prix de l'Automobile-Club de France en 1921). Le Génie Civil, vol. 79, no. 6, August 6, 1921, pp. 121–124, 7 figs. Data on the course, and motors and motorcycles competing.

Headlights. Motor Car Headlights: Ideal Requirements and Practical Solutions, A. Garrard. Illuminating Engr., vol. 14, no. 4, April 1921, pp. 92–102 and (discussion) pp. 102–107, 5 figs. Discusses effect of dazzling light on eyes and defines in general terms desirable characteristics of a non-dazzle headlight.

Pilain. The 12-HP. S.L.I.M. (Pilain) (La voiture 12 HP. S.L.I.M. (Pilain)), A. Contet. La Vie Automobile, vol. 17, no. 735, August 10, 1921, pp. 279–283, 10 figs. Details of construction of automobile, a new model by the Société lyonnaise d'industrie mécanique.

Schneider. The 16–20 HP. Schneider. Auto, vol. 26, no. 32, August 11, 1921, pp. 687–690, 9 figs. A French 4-cylinder car, produced by Th. Schneider, Besançon.

Shock Absorption. The Shock Absorption of Automobiles (Bemerkungen zur Abfederung der Motorwagen), H. Reissner. Motorwagen, vol. 24, no. 17, June 20, 1921, pp. 339–343, 5 figs. Based on given calculations, writer seeks to show that light cars do not necessarily sustain greater injury or run less smoothly on poor roads than heavy cars, providing the springs are sufficiently flexible and properly placed.

Spyker. The New Six-Cylinder 30/40-HP. Spyker Automobile (Der neue Sechzylinder 30/40 PS-Spyker-Wagen). Motorwagen, vol. 24, no. 22, Aug. 10, 1921, pp. 453–455, 4 figs. Specifications of car built by The Netherlands Automobile and Aeroplane Factory Trompenburg, Amsterdam: Length of body, 2.84 m.; width, 1.04 m.; wheelbase, 3.47 m.; engine, Maybach with 95-mm. bore and 135 mm. stroke.

Transmission Gears. Machining the Wrigley Automobile Transmission Gear—III, I. William Chubb. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 333–338, 21 figs. Machining operations of gear frame and axle parts. Assembling gear frame. Methods of checking up different parts.

AVIATION

Aeronautic Roads. Aeronautic Roads, Story B. Ladd. Aerial Age Wkly., vol. 13, no. 24, August 22, 1921, pp. 563–564, 5 figs. Discusses question of road signs and explains block system illustrated by a map of U. S.

Civil. Aviation and Transport, F. H. Sykes. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 208–216 and (discussion) pp. 216–218. Discusses military and commercial importance of developing civil aviation.

High-Altitude Aircraft. The High-Altitude Aircraft of the Future (Das Höhenflugzeug der Zukunft), C. Eberhardt. Motorwagen, vol. 24, no. 20, July 20, 1921, pp. 405–408, 3 figs. Points out chief differences in use of dirigibles and giant aeroplanes for long-distance voyages, and maintains that for long trips only the dirigible is capable of traveling the shortest route without stop.

[See also FLIGHT.]

B

BALANCING

Principles. Four Years of Balancing Practice, N. W. Akimoff. Eng. & Ind. Management, vol. 6, no. 5, August 4, 1921, pp. 116–118, 4 figs. Describes principles of static and dynamic balance.

Hawkesworth. U. S. Naval Inst. Proc., vol. 47, no. 222, August 1921, pp. 1233–1249. Discusses the five points: (1) Corrections of gravity for latitude, (2) curvature of earth, (3) westerly drift of projectile, (4) drift toward equator and (5) alteration in projectile's weight.

BALLOONING

Transatlantic. Historical Study of Attempts to Cross the Atlantic in a Balloon (Étude Historique sur les Projets de Traversée de l'Atlantique en Ballon), Charles Dollfus. L'Aeronautique, vol. 1, no. 9, February 1920, pp. 380–386, 9 figs. Describes attempts of Green, Zeise, Lowe, Wise and Donaldson, Godard, Suchard, Wellman, etc.

BEAMS

Reinforced-Concrete. Reinforced-concrete Beams —III, T. C. Broom. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 108, 1 fig. Discusses chart for concrete T-beam with single reinforcement. (Concluded.)

Unsymmetrical Sections. Calculating the Strength of Unsymmetrical Sections. Machinery (Lond.), vol. 18, no. 463, August 11, 1921, pp. 575–577, 2 figs. Two methods of determining moment of inertia, together with formulas for obtaining section modulus and radius of gyration.

BEARINGS

Spherical. Boring Spherical Bearing Housing, J. Blakey and J. Shankey. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 98, 2 figs. Describes economical method of boring spherical bearing housing for shaft connection between gear box and differential gear of heavy motor transport.

BEARINGS, BALL

Friction. The Ball Bearing: In the Making, Under Test, and On Service, Henry L. Heathcote. Mech. Wld., vol. 70, nos. 1804 and 1807, July 29 and Aug. 19, 1921, pp. 79–81, 4 figs., and 140–141, 2 figs. Discusses questions of friction due to slip, position of non-slip bands, internal stresses due to alternating load. Friction and heat at contact surfaces of ball and race ways of a thrust washer. Paper before Instn. Automobile Engrs. (To be continued.)

BENDING MACHINES

Plate. Plate-Bending Machines (Abkantmaschinen). Schiffbau, vol. 22, no. 41, July 13, 1921, pp. 1000–1001, 6 figs. Details of hand-operated and power-operated machines constructed by L. Schuler Machine Works, Göppingen, Germany, for shaping plates.

BENZOL

Recovery. Present and Future of the Gas Industry. Benzol Recovery (L'Etat Actuel et l'Avenir de l'Industrie Gaziere. La Recuperation du Benzol), A. Grebel. Bulletin de la Societe d'Encouragement pour l'Industrie Nationale, vol. 133, no. 6, June 1921, pp. 602–638, 12 figs. Discusses distillation of coal, and production of by-products, and especially recovery and treatment of benzol.

BLAST FURNACES

Charging Installations. Blast-Furnace Charging Installations (Ueber Hochofenbegichtungsanlagen) Stahl u. Eisen, vol. 41, nos. 28, 29 and 31, July 14, 21 and Aug. 4, 1921, pp. 945–954, 994–999 and 1064–1071, 28 figs. July 14: Practice at the Rhenish Steel Works, Duisburg-Meiderich, by H. Lent July 21: Practice of the Bochum Assn., Bochum. Aug. 4: Blast-furnace department of the Gelsenkirchen Min. Corp. Gelsenkirchen. Report of the blast furnace committee of the Assn. German Iron-Metallurgical Engrs.

Improvement Possibilities. Secure Place of the Iron Blast Furnace, Joseph F. Shagden. Iron Age, vol. 108, no. 8, Aug. 25, 1921, pp. 465–467, 2 figs. Features of superiority not met by processes aiming at producing steel direct from ore. Several possibilities of improvements.

Rating Capacities. Rating Blast Furnace Capacities Charles R. Peebles and R. H. Sweetser. Iron Trade Rev., vol. 69, no. 7, Aug. 18, 1921, pp. 430–432. Southern Ohio Pig Iron and Coke Assn. concludes that furnace should burn 60 lb. of coke in 24 hr. for each cubic foot of working volume. Actual stack data is said to verify this figure.

BLOWERS

Gas-Engine-Driven. Gas Engines and Blowers (Les Moteurs a Gaz et Machines Soufflantes de Grande Puissance, Système Galloway). Le Génie Civil, vol. 79, no. 7, August 13, 1921, pp. 141 145, 11 figs. Discusses the Galloway type of engine (1330 hp.) and blower as applied in metallurgical works.

BOILER EXPLOSIONS

Hydraulic Tests as Safeguard. The Value of Hydraulic Tests as a Safeguard Against Explosions. C. E. Stromeyer. Eng. & Indus. Management, vol. 6, no. 7, Aug. 18, 1921, pp. 170–173. (Abstract.) Annual memorandum of Manchester Steam Users' Assn. Analysis of all reported boiler explosions and conclusions therefrom.

BOILER FEEDWATER

Distilled. Economical Production of Distilled Feedwater for Power Station Boilers (Production économique de l'eau distillée pour l'alimentation des chaudières dans les centrales thermiques), M. Lebard. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 402–404 and (discussion) pp. 405. Describes system specially studied. Discusses first cost and saving effected.

Regulators. Scientific Boiler Feed Water Regulation.

30–33, 6 figs. Discusses operation of boiler-feed regulators and their adaptation to demand for steam.

Water Levels and Boiler-Feed Regulators (Neuere Wasserstände und Wasserstandsregler für Dampfkessel), M. Kuhlmann. Glückauf, vol. 57, no. 25, June 18, 1921, pp. 581–584, 7 figs. Describes and recommends use of recently devised water gage located nearer boiler-room flow; improved water-level indicator and feed regulator.

Treatment. Modern Arrangements for the Preparation of Boiler Feedwater (Neuzeitliche Einrichtungen zur Erzeugung von Kesselspeisewasser), R. Klein. Zeit. für Dampfkessel u. Maschinenbetried, vol. 44, nos. 4, 5, 6, 7 and 8, Jan. 28, Feb. 4, 11, 18, and 25, 1921, pp. 25–28, 34–37, 41–43, 51–54 and 57–61, 59 figs. Notes on evaporation process and evaporating plant with vapor compressor; exhaust-heat and cooling-water evaporators; purification process with plate boilers; the thermal-chemical purification process; formation of rust through gaseous feedwater; cold and warm distillation; gas protection.

BOILER FIRING

Draft Systems. Natural v. Mechanical Draught for Boiler Plants—1, J. W. Rogers. Mech. Wld., vol. 70, no. 1804, July 29, 1920, pp. 81–82. Discusses natural-draft, induced-draft and forced-draft systems (To be continued.)

Oil-Fired Boilers. Oil Fuel for Boilers Viewed as a Permanent Institution. Mech. Wld., vol. 52, no. 1806, August 12, 1921, pp. 125–126, 3 figs. Discusses salient features necessary for success of oil-fuel application.

BOILER OPERATION

Control. Boiler Control and Apparatus Therefor (Le Contrôle de la Chauffe. Les Appareils de Mesure Servant a ce Contrôle), Paul Frion. Bulletin de la Societe d'Encouragement pour l'Industrie Nationale, vol. 133, no. 6, June 1921, pp. 553–575. Discusses heat balances and various measuring devices to make best possible use of fuel.

Steam-Jet Draft. Calculating a Steam Jet for the Draft of a Boiler (Calcul d'Une Trompe a Vapeur Pour Tirage de Foyer de Générateur, G. Rollet. Arts et Metiers, vol. 74, no. 7, April 1921, pp. 107–113, 6 figs. Explains principle and shows how to calculate maximum efficiency.

Steam Raising. Steam Raising, David Wilson. Elec. Rev., (Lond.), vol. 89, no. 2280, August 5, 1921, pp. 195–196. Discusses efficiency, liquid fuel, air heaters, etc. (Abstract.) Paper read before Incorporated Mun. Elec. Assn.

BOILERS

Corrosion. The Carbon Dioxide Steam as Cause of Corrosion in Steam Power Engines (Kohlensäure des Dampfes als Ursache der in den Dampfkraftmaschinen auftretenden Korrosionen), Ch. Chorower. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 7, Feb. 18, 1921, pp. 49–50. Methods for determining CO_2 content in steam and means of preventing corrosion therefrom.

Electrically Heated. Electric Steam Generators Automatically Controlled (Générateurs Électriques de Vapeur a Régulateur Automatique de Production), J. Besson-Grange. Arts et Metiers, vol. 74, no. 7, April 1921, pp. 114–116, 3 figs. Description of an electric boiler.

BOILERS, WATER-TUBE

High-Capacity. Tests with High-Capacity Boiler-Tube Nests (Versuche mit Hochleistungs-Wasserrohrbündeln), F. Ebel. Glückauf, vol. 57, no. 29, July 16, 1921, pp. 681–687. Discusses increasing of boiler surface by means of boiler-tube nest. Results of numerous tests and conclusions therefrom.

BRASS

Season Cracking. The Season-Cracking of Brass and Other Copper Alloys, H. Moore, S. Beckinsale and Clarice E. Mallison. Engineering, vol. 112, nos. 2903 and 2904, Aug. 19 and 26, 1921, pp. 297–299 and 327–331, 17 figs. Effects of corrosive and other substances on stressed brass. Action of mercury and ammonia on brass and use of mercury for detection of stress. Influence of composition of copper alloys on season-cracking. (Concluded.) (Abstract.) Paper read before Inst. Metals.

BROACHES

Design. Practical Design of Broaches, C. S. Pettit. Machinery, (Lond.), vol. 18, no. 462, August 4, 1921, pp. 538–541, 5 figs.

Theoretical Design of Broaches, C. S. Pettit. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 602–603, 3 figs. Discusses construction of a broach tooth.

BUCKET ELEVATORS

Improvements. New Types of Bucket Elevator Unloaders for Handling Coal (Neue Anwendungsformen des Becherwerkentladers für Kohlengutförderung), Hubert Hermanns. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 21, May 27, 1921, pp. 161–163, 9 figs. Details of recent developments by Heinzelmann & Sparmberg, Hannover, Germany.

BUILDING CONSTRUCTION

Structural Design. Special Structural Design for Newspaper Building. Eng. News-Rec., vol. 87, no. 10, Sept. 8, 1921, p. 412, 1 fig. Lower chord of steel roof trusses will form future floor reinforcement. Units loads varied on floors. Other details of new reinforced-concrete building for South Bend Tribune.

Wood Construction. Modern Wood Construction Methods (Ueber moderne Holzbauweisen), Hugo

Ritter. Schweizerische Bauzeitung, vol. 78, nos. 5 and 6, July 30 and Aug. 6, 1921, pp. 53–56 and 66–69, 14 figs. Describes various systems and discusses fundamental ideas on which different methods are based.

C

CABLEWAYS

Tension Device. The Tensions in Cableways and Chain-Ropeways with Several Driving Sheaves and Their Regulation by Means of the Ohnesorge Compensator (Die Zugspannungen an Seil- und Kettenbahnen mit mehrern Treibrillen und ihre Reglung durch den Ausgleicher von Ohnesorge), R. Goetze. Glückauf, vol. 57, no. 17, Apr. 23, 1921, pp. 385–391, 16 figs. Construction and operation of the Ohnesorge tension compensator.

CALORIMETERS

Testing Liquid Fuels. The Calorimetry of Liquid Fuel. Eng. & Indus. Management, vol. 6, no. 4, July 28, 1921, pp. 95–96, 1 fig. Results of tests with the Sarco calorimeter constructed on Mahler-Donkin bomb system.

CANVAS

Water Resistance of. The Water Resistance of Treated Canvas during Continuous Exposure to Weather, F. P. Veitch and T. D. Jarrell. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 672–676, 2 figs. Results of experiments with 12 oz. U. S. Standard army gray duck.

CAR LIGHTING

Electric. Electric Train Lighting By a Three-Brush Dynamo (Éclairage Electrique des Trains par la Dynamo a Trois Balai), S. Iglesis. Arts et Métiers, vol. 74, no. 7, April 1921, pp. 117–125, 17 figs. Describes Stone-Lilliput and Leitner systems.

CARBURETORS

Asmo. The Asmo Carburetor (Der Asmo-Vergaser), C. Wirsum. Motorwagen, vol. 24, no. 17, June 20, 1921, pp. 346–349, 9 figs. Carburetor invented by Gustav Erikson, Upsala, Sweden, draws up fuel automatically from a lower tank, thereby eliminating use of air pumps, pressure valves, etc. Results of tests demonstrate its economy in comparison with other well-known carburetors.

Developments. The Further Development of Internal-Combustion Engines (Beitrag zur Weiterentwicklung der Verbrennungs-Kraftmaschinen), F. E. Beilefeld. Oel- u. Gasmaschine, vol. 18, no. 7, July 1921, pp. 110–115, 23 figs. Supplementary to article on carburetor problems by Gg. Bergmann in same journal (no. 3, 1921, p. 40).

CARS

Dining. New Dining and Kitchen Carriages for the London-Glasgow Service, Midland and G. & S. W. Railways. Ry. Engr., vol. 42, no. 499, August 1921, pp. 294, 13 figs. Shows improvements in design construction and equipment.

Mine. Loading Machines for Mining Practice (Lastningsmaskiner för underjordisk gruvbrytning), Robert Höök. Jernkontorets Annaler, vol. 105, no. 2, 1921, pp. 97–109, 14 figs. Describes American car loaders, shoveling machines, etc. for underground work.

Motion Recorder. An Automatic Recorder of Vehicular Motion (Indicateur automatique du mouvement des véhicules), E. J. F. Vachet. L'Electricien, vol. 52, no. 1282, August 15, 1921, pp. 367–370, 4 figs. Describes device recording motion of railroad cars and other vehicles, made by Elliot Bros., London.

CASE-HARDENING

Compounds. Carbonizing and Carbonizing Materials, H. B. Knowlton. Trans. Am. Soc. For Steel Treating, vol. 1, no. 11, August 1921, pp. 689–698. Discusses case-hardening and case-hardening compounds.

CEMENT

Bulk. An Investigation into the Use of Bulk Cement. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, pp. 324–326. Discussion of its use on large concrete building jobs, prepared by staff of Turner Constr. Co., New York City.

CEMENT MANUFACTURE

Rotary-Grate Shaft Kilns. The Automatic Rotary-Grate Shaft Kiln, C. F. Hansen. Rock Products, vol. 24, no. 18, Aug. 27, 1921, pp. 33–40, 14 figs. How European portland-cement manufacturers are meeting rapidly increasing fuel and labor costs. Summarizes savings in cement plant with yearly output of 300,000 bbl. in using rotary-grate shaft kilns instead of rotary kiln.

CEMENT MILLS

Hungary. A Cement Mill in Torda, Hungary (Die Zementfabrik in Torda), Hugó Szèkely and Ernst Havas. Beton u. Eisen, vol. 20, nos. 4–5, 6 and 7–8, Mar. 7, Apr. 4 and May 4, 1921, pp. 41–43, 66–69 and 87–90, 35 figs. Description of cement mill operated with natural gas, and manufacturing process. Details of reinforced-concrete structures of plant.

CHUCKS

Magnetic. Electromagnetic Fastening of Large Workpieces on Planing and Surface-Grinding Machines (Elektromagnetische Aufspannung Grösserer Werkstücke auf Hobel- und Flächenschleifmaschinen), A. W. Schultz. Werkstattstechnik, vol. 15, no. 15, Aug. 1, 1921, p. 451, 2 figs. Describes magnetic holding plates of wrought iron having a tensile force of 10 to 12 kg. per sq. cm. as compared to 4 to 5 kg. with use of cast iron or steel casting.

Magnetic Chucks—IX, Ellsworth Sheldon. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 383–386, 7 figs. Supporting pieces of irregular shape on a magnetic chuck. Testing a chuck to determine its class.

COAL

Carbonization. The Carbonization of Coal at Low Temperature, John Roberts. Iron & Coal Trades Rev., vol. 103, no. 2789, August 12, 1921, pp. 193–196, and Discussion pp. 196. Discusses expansion of coal and its prevention, dealing with swelled coal; essentials of good semi-coke, etc. Paper read before North of Eng. Inst. Min. & Mech. Engrs.

Combustion and Gasification. The Combustion and Gasification of Coal on the Grate (Die Verbrennung und Vergasung von Kohle auf dem Rost), H. Schmolke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 19, May 13, 1921, pp. 145–147. Notes on development in study of phenomena in connection with combustion or gasification of coal.

Eastern U. S. How Rank of Eastern Coal Changes with Location, R. Dawson Hall. Coal Age, vol. 20, no. 7, August 18, 1921, pp. 257–259, 4 figs. Volatile matter and moisture decrease as East is approached, decline of volatile matter starts not far from Pennsylvania-Ohio line.

Preparation. Advances in Preparation of Anthracite, Dever C. Ashmead. Min. & Metallurgy, no. 177, Sept. 1921, pp. 47–48. History of development. Investigation of five methods of cleaning anthracite. (Abstract.) Paper before Am. Inst. Min. & Metallurgical Engrs.

COAL WASHING

Processes. Modern Coal Washing (La Technique Moderne du Lavage des Charbons), C. Berthelot. Chaleur & Industrie, vol. 2, no. 15, July 1921, pp. 393–401, 8 figs. Discusses importance of coal washing from economical standpoint and describes processes and apparatus for the purpose. (To be continued.)

Notes on Coal Washing By Means of "Rhéolaveurs" (Quelques Notes sur le Procédé de Lavage Par "Rhéolaveurs"), A. France-Focquet. Révue Universelle des Mines, vol. 9, no. 1, S. 6, April 1, 1921, pp. 1–13, 8 figs. Discusses operation of washing fines. (To be continued.)

COKE

Blast-Furnace. Characteristics of Blast Furnace Coke (Sur les Caracteristiques du Coke de Haut-Fourneau), Pierre Kersten. Révue Universelle des Mines, vol. 10, no. 1, Series 6, July 1, 1921, pp. 27–34. Describes physical and chemical properties. (To be continued.)

COKE OVENS

By-Product. New Coke-Oven and By-Product Plant at the Acklam Works of the North-Eastern Steel Company, Limited. Iron & Coal Trades Rev., vol. 103, no. 2788, August 5, 1921, pp. 161–164, 6 figs. Description of new plant, consisting of 60 vertical-flued ovens and recovery equipment.

COLUMNS

Eccentric Loading. Eccentric Loading of Bars and Columns, Edward Ingham. Practical Engr., vol. 64, no. 1795, July 21, 1921, pp. 39–40. Discusses formulas for calculating stresses on eccentrically loaded columns.

Pipe. Strength of Pipes as Columns, John S. Watts. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, p. 341, 1 fig. Presents chart for calculating size of pipe necessary to support a given load as a column of given length.

COMBUSTION

Control. Controlling Combustion on Basis of CO_2 Alone Unsatisfactory. Am. Mar. Engr., vol. 16, no. 11, June 1921, pp. 35–41, 4 figs. Discusses essentials in attainment of maximum economy in combustion control. (To be continued.)

Preheated Air for. The Importance of Heated Combustion Air for Conservation of Coal in Germany (Die Bedeutung der erhitzten Verbrennungsluft für Deutschlands Kohlenwirtschaft), Eugen Haber. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 23, June 10, 1921, pp. 179–181, 3 figs. Discussion of advantages of use of heated air for furnaces.

COMPASSES

Aerial Navigation. Compass for Aerial Navigation (Le Compas de Navigation Aerienne), L. Condroyer. L'Aeronautique, vol. 1, no. 9, February 1920, pp. 387–395, 20 figs. Describes Kelvin, Greach-Osborne and A.M.-1 Compasses.

Gyrostatic. The Anschütz and Sperry Gyrostatic Compasses (Sur les compas gyrostatiques Anschütz et Sperry), H. Beghin. Comptes rendus de l' Académie des Sciences, vol. 173, no. 5, August 1, 1921, pp. 288–290. Discusses equations governing their small oscillations.

CONCRETE

Centrifugally Cast. Centrifugal Machine Casts Solid Concrete Shapes, Leon Cammen. Eng. News-Rec., vol. 87, no. 9, Sept. 1, 1921, p. 366, 1 fig. Describes machine for centrifugal casting of solid concrete shapes, patented by Cammen Laboratories, New York.

Disintegration in Alkali Soils. The Disintegration of Concrete in Alkali Soils, G. M. Williams. Jl. Eng. Inst. Can., vol. 4, no. 8, Aug. 1921, pp. 446–455, 8 figs. Summary of results of laboratory studies together with details of Bur. of Standards field investigations.

Specifications. Tentative Specifications for Concrete and Reinforced Concrete. Proc. Am. Soc. Civ. Engrs., vol. 47, no. 6, Aug. 1921, pp. 60–124, 18 figs. Report of joint committee on standard specifications for concrete and reinforced concrete. Notes on proportioning and mixing, and depositing concrete; forms; details of construction; water-proofing and protective treatment; surface finish; and design.

Strength. Effect of Age on Strength of Concrete, Duff A. Abrams. Mun. & County Eng., vol. 61, no. 2, August 1921, pp. 47–49, 2 figs. Defends view that concrete does not decrease in strength with age.

CONCRETE, REINFORCED

Sea Water, Use in. The Use of Reinforced-Concrete in or Near Sea Water, Arthur S. Tuttle. Mun. Engrs. Jl., vol. 7, 2nd quarterly issue, 1921, pp. 66–84. Suggests rules to ensure reliable results with reinforced concrete in sea water. Reprint of report to Board of Estimate and Apportionment of N. Y. C.

CONDENSERS, STEAM

Leakage Detection. Simplified Chemical Method of Detecting Surface Condenser Leakage, W. E. Caldwell. Power, vol. 54, no. 4, July 26, 1921, pp. 141–142, 1 fig. Tells how to make up solutions for estimating amount of leakage of raw water into condenser.

The Electrical Method of Detecting Surface Condenser Leakage, W. E. Caldwell. Power, vol. 54, no. 6, Aug. 9, 1921, pp. 217–219, 7 figs. Method of obtaining continuous graphic record of leakage by measuring and recording electrical conductivity of condensate.

Surface. Marine Surface Condensers and Condenser Auxiliaries. Am. Mar. Engr., vol. 16, nos. 10 and 11, May and June 1921, pp. 28–33, 6 figs., and 23–27, 17 figs. May: Contains diagrams showing theoretical ratio of injection water of steam for different vacua and water temperatures, also maximum permissible air leakage for different sizes of marine turbine and reciprocating engine condensing plants. June: Discusses live-steam, back-pressure and condensate pumps.

Recent Improvements in Condensers for Steam Engines (Recents perfectionnements des appareils de condensation des machines a vapeur d'eau) L. Jauch. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 416–418, 1 fig. Discusses surface condensers, including Brown-Boveri type. (To be continued.)

CONNECTING RODS

Aluminum. Aluminum Connecting Rods (Bielles en Aluminium), A. Dat. Arts et Metiers, vol. 74, no. 8, May 1921, pp. 141–144, 9 figs. Details of construction, alloys suitable, etc.

Machining Automobile. Milling Automobile Connecting-rods, J. M. Henry. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1104–1105, 4 figs. Equipment and methods used in machining Chevrolet, Hinkley and Duesenberg connecting rods.

CONVEYORS

Belt. Belt Conveyor System in Chicago's New Parcel-Post Station. Belting vol. 19, no. 2, August 1921, pp. 17–20, 4 figs. Eighteen conveyors, compactly arranged in tiers, afford quick and efficient separation and distribution to pouches.

Metal Belts. Metal Conveyor Belts with Wide Joint Support (Metallförderbänder mit breiter Gelenkauflage). Fördertechnik u. Frachtverkehr, vol. 14, no. 1, Jan. 7, 1921, pp. 11–12, 6 figs. Describes belt patented by Louis Herrmann, Dresden, with which 95 to 97 per cent of width of link pin is utilized as supporting surface.

COPPER

Sheet. Sheet Copper and Its Sphere of Usefulness, B. Goldsmith. Raw Material, vol. 4, no. 8, August 1921, pp. 268–272, 7 figs. Discusses technical production, prices, and the many uses of sheet copper.

COST ACCOUNTING

Defects in. What is Wrong With Cost Accounting? G. Charter Harrison. Management Eng., vol. 1, no. 1, July 1921, pp. 29–32. Defects of present methods.

Manufacturing Cost. The Elements in Manufacturing Cost, Frederic H. Leland. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 87–88. Discusses three groups of manufacturing costs, namely, general plant expenses, foundry cost and expenses, and manufacturing departments costs and expenses.

COST SYSTEMS

Modern. Disclosing Waste Through Better Cost Methods, Ernest J. Wessen. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 389–393. Claims that many industrial failures are traceable to blind dependence on cost determined by rule-of-thumb methods. Modern cost systems disclose waste in unprofitable products, idle labor and machinery and erroneous methods.

CRANES

Floating. A 60-Ton Self-Propelling Floating Crane. Engineer, vol. 132, no. 3420, July 15, 1921, pp. 72–73, 2 figs. Also in Shipbldg. & Shipg. Rec., vol. 18, no. 6, Aug. 11, 1921, p. 181. Slewing and derricking type of crane built by Werf Gusto (Firma A. F. Smulders), Schiedam, Holland, for Manchester Ship Canal Co.

CRANKCASES

Machining Operations. Machining the Peerless Upper Crankcase, Fred H. Colvin. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 376–380, 20 figs. Method of handling upper or main crankcase in

CRANKPINS

Machine for Turning. A New Crankpin Turning Machine. Eng. Production, vol. 3, no. 46, Aug. 18, 1921, pp. 155-156, 3 figs. Mechanism of machine designed for economical production, constructed by George Richards & Co., Ltd., Manchester, England.

CUPOLAS

Smelting Process, Regulation of. Cupola Practice (Beiträge zur Kenntnis des Kuppelofenbetriebes), Fritz Braun and Georg Hollender. Stahl u. Eisen, vol. 41, no. 30, July 28, 1921, pp. 1021-1027, 9 figs. Shows how, with aid of diagrams obtained from self-recording blast-capacity measurements, it is possible, with use of blast-furnace-gas investigations, to regulate smelting process of cupola. A graphic method is described for determining maximum CO_2 content of blast-furnace gases.

CYLINDERS

Boring. Cylinder Boring. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 127-132, 17 figs. Discusses principles and practice.

Calculation of Wall Strength. Graphic Determination of the Strength of Walls in Hollow Bodies (Graphische Bestimmung von Wandstäaken bei Hohlkörpern), Arthur Balog. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 4, Jan. 28, 1921, pp. 28-29. Describes method applicable to hollow cylinders with internal pressure.

Thick. The Thickness of Hydraulic Cylinders, H. S. Cattermole. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 102-103, 1 fig. Discusses well-known fact that thick cylinders are not as strong relatively as thin ones.

D

DIES

Die-Sinking Machines. Keller Automatic Die Sinking Machine. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 389-390, 6 figs. All movements electrically controlled; inexpensive masters of wood or plaster used; tracer bears lightly on master, while cutter works under pressure.

DIESEL ENGINES

Appraising. Appraising the Diesel Engine Plant, Allen F. Brewer. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 172-176, 4 figs. Important features that must be considered and analyzed. Calculation and estimation of cost data and depreciation.

Damaged Shafts. Damages to Shafts in Diesel Engines (Wellenbeschädigungen an Dieselmaschinen), Arthur Balog. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 20, May 20, 1921, pp. 153-154, 9 figs. Discusses examples of breaks in shafts of Diesel engines and their causes.

German Submarine. U-Boat Oil Engines and Recent Developments of the Diesel Engine (U-Boot-Oelmaschinen und neuere Entwicklungsformen der Dieselmaschine), H. Rohwer. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 9 and 10, Mar. 4 and 11, 1921, pp. 65-67 and 74-77, 14 figs. Discussion of different types and improvements by Körting Bros., Benz, Nürnberg-Augsburg Machine Works, Germania Shipyards, etc.

Marine. Marine Diesel Engine Operation (La Condite des Moteurs Diesel Marins), Le Gallou. Bulletin Technique du Bureau Veritas, vol. 3, no. 6, June 1921, pp. 138-142, 4 figs. Continuation of discussion on causes of bad performances. (To be continued.)

Modern Marine Oil Engines—II-VI. Engineer, vol. 132, nos. 3418, 3420, 3422, 3423, and 3424, July 1, 15 and 29, Aug. 5 and 12, 1921, pp. 2-3, 4 figs., 55-57, 11 figs., 109-111, 6 figs., 136-137, 3 figs. and 174-176, 6 figs. July 1: New type 3200-i.hp. Harland & Wolff Diesel marine engine. July 15: Vickers 1250-b.hp. type. July 29: North British 2330-i.hp. type. Aug. 5: 1400-i.hp. Werkspoor type. Aug. 12: 1250-b.hp. Sulzer 2-cycle engine.

Notes on the Management of Marine Diesels, Homer McCrirrick. Marine Eng. of Can., vol. 11, no. 7, July 1921, pp. 10-14, 6 figs. Compares four-cycle and two-cycle diesels and discusses various features in detail.

Problems in the Manufacture of Marine Diesel Engines. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 513-514, 4 figs. Choice of material and methods of machining Diesel-engine parts.

DRILLING MACHINES

Portable. Portable Drilling Practice—IX. Mech. Wld., vol. 52, no. 1807, August 19, 1921, pp. 138-139, 2 figs. Discusses vertical- and horizontal-spindle machine made by W. Asquith, Ltd., Halifax. (Concluded.)

DROP FORGING

Dies. Design and Making of Drop-forging Dies. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1141-1144, and vol. 28, no. 1, Sept. 1921, pp. 33-36, 12 figs. Methods employed in modern drop-forging plants.

DRYING PLANTS

Precalculation. The Precalculation of Drying Plants with Special Regard to Duration of Drying Process (Die Vorausberechnung von Trockenanlagen, unter besonderer Berücksichtigung der Trockendauer, M. Hirsch. Gesundheits-Ingenieur, vol. 44, no. 29, July 16, 1921, pp. 357-360, 7 figs. Formulas and curves are derived based on investigations and their application is shown in numerical examples.

d'Aluminium), J. Dyrion. La Houille Blanche, vol. 20, no. 53-54, May-June 1921, pp. 109-113, 5 figs. Discusses properties, composition and manufacture of duralumin. (To be continued.)

E

ECONOMIZERS

Kablitz. The Kablitz Small-Water-Space Economizer (Der Kleinwasseraum-Ekonomiser Bauart Kablitz), Harry Fahrbach. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 12, Mar. 25, 1921, pp. 89-92, 11 figs. Notes on design and uses of the Kablitz economizer, and results of tests carried out by Kirsch in 1910-12 in the boiler laboratory of Mechanical Institute of Moscow Technical Academy.

EDUCATION, ENGINEERING

Improvements in Training. The College Trained Engineer, C. Edward Magnusson. Jl. Am. Inst. Elec. Engrs., vol 40, no. 9, Sept. 1921, pp. 730-736. Suggestions for improvement.

ELECTRIC DRIVE

Food Industry. Electrical Service Aids a Leading Western Food Industry. Jl. Elec. & Western Ind., vol. 47, no. 4, August 15, 1921, pp. 146-147, 5 figs. Shows that introduction of electric driving has improved operating conditions and lowered production costs.

Machine Tools. Electric Motor Drive for Machine Tools, Gordon Fox. Ry. Elec. Engr., vol. 12, no. 8, August 1921, pp. 317-321, 5 figs. Discusses relative advantages of different types of motors.

ELECTRIC FURNACES

Ajax-Wyatt. The Ajax-Wyatt Electric Furnace, John B. C. Kershaw. Engineer, vol. 132, no. 3423, Aug. 5, 1921, pp. 139-140, 4 figs. Details of improved type. For special work of melting yellow brass, on scale which permits continuous operation of furnace, it is said to be most efficient type.

Design. Electric Furnace Operating Experiences, Larry J. Barton. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 581-584, 6 figs. Experiments with three forms of furnace bottom. Methods of building bottoms. Experiments with roof and sidewalls. Metallurgical features.

Non-Ferrous. Melting Steel in a Non-Ferrous Electric Furnace. Iron Age, vol. 108, no. 8, Aug. 25, 1921, p. 472, 1 fig. Successful production of crucible quality steel in small Baily resistance unit.

Tagliaferri. New Italian Electric Furnace (Nuovo forno electrico italiano), Mario Marantonio. Il Forno Electrico, vol. 3, no. 4, April 15, 1921, pp. 41-50, 14 figs. Describes Tagliaferri furnace recently installed at Grandi Acciaiere e Fonderie Gio. Ansaldo.

ELECTRIC LOCOMOTIVES

Development. Possibilities in the Development of Electric Locomotives (Entwicklungsmöglichkeiten der elektrischen Vollbahnlokomotive), Egon E. Seefehlner. Schwerzerische Bauzeitung, vol. 78, nos. 2 and 3, July 9 and 16, 1921, pp. 15-18 and 30-33, 16 figs. Points out advantages and disadvantages of the three types in common use, namely, direct-drive, geared, and underslung motor geared. Discusses possibility of developing a type combining advantages of all three types with elimination of their defects.

Oerlikon. New Single-Phase Locomotives of the Swiss Railways (Les Nouvelles Locomotives Monophasées des Chemins de Fer Féderaus), Lucien Pahin. L'Industrie Electrique, vol. 30, no. 699, August 10, 1921, pp. 285-290, 7 figs. Describes the 2-6+6-2 Oerlikon type of Gothard line, its mechanical and electrical equipment.

Parallel-Crank Drive. Vibratory Phenomena of the Parallel-Crank Drive of Electric Locomotives (Ueber Schüttelerscheinungen des Parallelkurbelgetriebes elektrischer Lokomotiven), Iwan Döry. Schweizerische Bauzeitung, vol. 78, no. 6, Aug. 6, 1921, pp. 63-66, 4 figs. Supplementary remarks to author's article published in Elektrotechnische Zeit. (vol. 41, Apr. 22, 1920, p. 313) in reply to criticisms of work by A. Wichert.

Standardization. The Serialization of Electric Locomotives as a Basis for Their Standardization (Ueber Reihenbildung elektrischer Lokomotiven als Voraussetzung für ihre Vereinheitlichung), A. Wichert. Annalen für Gewerbe u. Bauwesen, vol. 88, nos. 11 and 12, June 1 and 15, 1921, pp. 93-98 and 105-113, 8 figs. It is shown that with proper reduction of frictional weight of a.c. trunk-line locomotives according to a geometrical series with increase of $\sqrt{2}$ and the same reduction of maximum speeds, outputs of from 45 to 127 km. per hr. max. speed and with 2 to six driving axles can be obtained from only 3 motor and 2 transformer basic types for all 14 types of locomotives used in Germany.

Steam vs. Mechanical Advantages of Electric Locomotives Compared With Steam Engines, V. L. R. Raven. Elec. Rev. (Lond.), vol. 89, no. 2280, August 5, 1921, pp. 194 and (discussion) pp. 194-195. (Abstract.) Paper read before Eng. Conference, 1921.

Transmissions. A New Power Transmission System Between Motors and Axles of Electric Locomotives (Norveau Systeme de Transmission de Mouvement entre les Moteurs et les Essieux des Locomotives Electriques), M. Auvert. Révue Générale des Chemins de Fer et des Tramways, vol. 40, no. 8, August 1921, pp. 88-96, 6 figs. Describes system based on connecting rods in which vibrations of locomotive have no deleterious effect.

and Motors, H. D. Wheeler. Electrician, vol. 87, no. 2254, July 29, 1921, pp. 136-138, 9 figs. Indicates briefly some of the main causes of vibration in turbo-generators and similar machines and how to overcome it.

ELECTRIC MOTORS

Overload Protection. Overload Protection of Motors Edgar P. Slack. Power, vol. 54, no. 4, July 26, 1921, pp. 132-133. Use of fuses, circuit breakers and motor starters.

ELECTRIC RAILWAYS

Starting System. New Starting System for Traction by Continuous Current; Inductive Starters (Nouveau Système de Démarrage pour la Traction par Courant Continu: Les Démarreus Inductifs), Armand Givelet. Révue Générale de L'Electricité, vol. 10, no. 4, July 23, 1921, pp. 133-137, 6 figs. Describes new, simple method for which considerable saving in current is claimed.

Three-Wire Distribution. Three-Wire Railway Distribution in Wilmington, A. P. Way. Elec. Ry. Jl., vol. 58, no. 9, August 27, 1921, pp. 307-311, 5 figs. Improves regulation and prevents electrolysis. Trial proves system best adapted to radial city districts.

Trolley Systems. Electric Overhead Line Systems (Note sur les lignes caténaires pour prise de courant aérienne destinées à l'électrification des voies d'intérêt général). Paul Leboucher. Révue Générale de l'Électricite, vol. 10, no. 6, August 6, 1921, pp. 195-201, 16 figs. Discusses pantograph trolley and feeding of current. (To be continued.)

ELECTRIC WELDING

Methods. Electric Welding Apparatus (Les Machines a Souder), Ch. Andry-Bourgeois. L'Electricien, vol. 52, no. 1282, August 15, 1921, pp. 361-367, 8 figs. Discusses various methods of electric welding and uses made of them. (To be continued.)

ELECTRIC WELDING, ARC

Electric-Railway Work. Electric Arc Welding, Henry M. Sayers. Elec. Ry. & Tramway Jl., vol. 45, no. 1091, August 12, 1921, pp. 129-132 and (discussion) pp. 132-133, 7 figs. Deals with failures, welding of lattice masts, covered and bare electrodes, etc. Paper read before Tramways & Light Rys. Assn.

Fillet and Butt Welding. Fillet and Butt Welding by the Electric Arc. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 33-34 and 53, 2 figs. Discusses welds by spreading, butt welding, double "V" weld.

Machines. A New Electric Arc Welding Machine. Engineer, vol. 132, no. 3418, July 1, 1921, pp. 18-19, 5 figs. Details and working of new machine known as cyc arc, because of regular cycle of operations on which its success depends and which it accurately performs.

ELECTRIC WELDING, RESISTANCE

Spot-Welding Machines. Spot-Welding Machines (Machine a Souder par Points), P. Saurel. Arts et Métiers, vol. 74, no. 9, June 1921, pp. 173-177, 13 figs. Describes principle, apparatus and operation.

Spot Welding Machine for Making Ships' Ventilators. Engineer, vol. 132, no. 3424, Aug. 12, 1921, p. 176, 1 fig. New type of electric machine for manufacture of large ventilating cowls for steamships, and other bulky hollow sheet-metal articles of similar nature.

ELEVATORS

Safety Devices. Electric Elevator Machinery—Car Safeties, M. A. Myers. Power, vol. 54, no. 5, Aug. 2, 1921, pp. 176-177, 6 figs. Describes heavy-duty double-eccentric, compression-type and flexible guide-clamp type safety.

EMBOSSING

Dies. Making Embossing Dies for Emblematic Work, Chas. E. Hall. Can. Mach., vol. 26, no. 7, August 18, 1921, pp. 36-38, 5 figs. Discusses hub method, "cut in" system, and their combination.

EMPLOYEES, TRAINING OF

Economic Advantages. Training as a Factor in Reducing Labor Cost, J. F. Johnson. Management Eng., vol. 1, no. 1, July 1921, pp. 5-9, 5 figs. How instructing the worker enhances his skill, increases production and lowers manufacturing costs.

Training as a Factor in Reducing Waste, J. F. Johnson. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 93-97, 6 figs. How teaching of correct working habits will develop skill, reduce labor turnover and save material.

EMPLOYMENT MANAGEMENT

Personnel, Selection and Placement of. The Personnel Problem: To Eliminate the Waste of Human Effort, L. B. Hopkins. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 385-388. States that many wastes of time and production can be attributed to improper selection and placement of personnel and to management's failure to recognize value of training, transfer and promotion of deserving employees.

Present Need of. Is Personnel Management Essential Now? Earl B. Morgan. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 89-92. Points out that pressing labor problems must be solved in periods of force reductions as well as in times of shortage of workers.

ENGINEERING LITERATURE

Classification and Indexing. Classifying and Indexing the Clipping File, Harrison W. Craver, Management Eng., vol. 1 no. 1, July 1921, pp. 49-50.

Applying use of decimal classification system to engineering literature. Adoption by Engineering Societies library. Plan of Management Engineering.

ENGINEERS

Problems Confronting. The Pioneer Spirit in Engineering, E. S. Carman. Management Eng., vol. 1, no. 1, July 1921, pp. 1–3. As developed in Federated Am. Eng. Societies. Notes on engineers' problem of future; two major influences in engineering elimination of waste in industry.

EXPANSION

Thermal. The Thermal Expansion of Certain Materials (Ueber die Wärmeausdehnung einiger Stoffe), Karl Scheel. Deutsche Optische Wochenschrift, vol. 7, no. 31, July 31, 1921, pp. 562–563. Results of experiments carried out in German National Physical-Technical Inst. with different materials according to the Fizeau and the so-called tube method.

F

FACTORIES

Design. The Design and Construction of Engineering Workshops—XXI, Ernest G. Beck. Mech. Wld., vol. 52, no. 1806, August 12, 1921, pp. 122–123, 5 figs. Continues discussion of construction of roofs. (To be continued.)

Location. Location as a Factor in Eliminating Industrial Waste, Victor V. Kelsey. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 401–402. Main factors to be considered are: Influence which proposed industry will have on community, raw materials, transportation, labor supply and power.

The Scientific Location of Manufacturing Plants, J. George Frederick. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 153–155, 1 fig. Deals with considerations that govern proper location of manufacturing plant and conditions arising due to shift of population or manufacturing centers.

Layout. Developing an Industrial Plant Layout, A. T. Doud. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 149–152, 4 figs. Points out that in complete design of new plant, it is necessary to work out together the general production system, department layout and general features of building construction in order to insure well-balanced plant.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FATIGUE

Testing. Improvements in Methods of Fatigue Testing, H. J. Gough. Engineer, vol. 132, no. 3424, Aug. 12, 1921, pp. 159–162, 13 figs. Report submitted to materials and chemistry committee of Aeronautical Research Committee. Experiments on alternating torsion; forms of test pieces; strain measurements; method of test using strain and calorimetric methods simultaneously, etc.

FIRE HAZARDS

Review of. Some Considerations on Fire Waste, Nicholas Richardson. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 397–400. Industry in general, and chemical industry in particular, is said to be in need of fuller appreciation of fire hazards and appalling waste due to destruction by fire. Review of possible fire hazards.

FIRE PROTECTION

Slow-Burning Buildings. Specifications for "Slow Burning" Office Buildings, Ira H. Woolson. Eng. & Contracting, vol. 56, no. 8, Aug. 24, 1921, pp. 178–179. Report submitted by committee on building construction of Nat. Fire Protection Assn. containing proposed specifications for rendering so-called non-fireproof class of commercial buildings reasonably slow-burning.

FIREPROOFING

Cotton Fabric. The Effect of Certain Fire-Proofing Solutions on Cotton Fabric, R. L. Sibley. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 676–677, shows that sodium, tungstate has the least weakening action and recommends it as an excellent fireproofing agent.

FLIGHT

Soaring. Mechanical Models for Soaring Flight (Mechanische Modelle zum Segelflug), Th. v. Karman. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 220–223, 4 figs. Simple mechanical devices for study of energy and speed conditions in connection with soaring flight.

Soaring (Bemerkungen über den Segelflug), L. Prandtl. Zeit. fur Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 14, July 30, 1921, pp. 209–211. Discusses possibilities of soaring; sources and utilization of energy in soaring flight of birds and men. Conditions for minimum descending speed are investigated and numerical example given.

FLOW OF WATER

Chézy Formula. Antoine Chezy. History of an Hydraulic Formula (Antoine Chezy. Histoire d'une Formule d'Hydraulique), G. Mouret. Annales des Ponts et Chaussees, vol. 59, no. 2, 11th Series, March-April 1921, pp. 165–268. His formula $U = C\sqrt{(RI)}$ for flow of water. Bibliography.

Gibson Method. Theoretical Discussion of the Hydrometric Method of N. R. Gibson (Theoretische Erörterungen zur Wassermessmethode von N. R. Gibson). Schweizerische Bauzeitung, vol. 78, no. 4, July 23, 1921, pp. 41–43. Refers to method described in Canadian Engineer (vol. 39, no. 12, Sept. 16, 1920), and points out that it is difficult to fulfill all the conditions required in application of method, which, in author's opinion, represents no progress in hydrometry.

Photographic Measurement. Use of Photography in Hydraulic Measurements in India, S. C. Majumdar Eng. News-Rec., vol. 87, no. 10, Sept. 8, 1921, pp. 414–415, 2 figs. Photographic tests made on large jets are said to check remarkably close with actual gagings by current meter.

Venturi Tubes. Nomograms for Calculating Flow in Venturi Tubes, J. W. Ledoux. Eng. & Contracting, vol. 56, no. 6, Aug. 10, 1921, pp. 138–139, 3 figs. Three nomograms are presented and their uses explained.

FLYING BOATS

Construction. Flying Boat Construction, David Nicolson. Aeronautical Jl., vol. 25, no. 128, August 1921, pp. 385–412 and (discussion) pp. 413–420, 16 figs. Gives details of construction of types F, P and N; concludes that in an aero-engine a high degree of compression is essential and that tests established the possibility of supercompression as a means of power recuperation at high altitude.

Leoning Model. The Leoning Model 23 Flying Yacht. Aviation, 11, no. 9, August 29, 1921, pp. 248–250, 5 figs. Gives data of machine and describes test recently made.

FOUNDRIES

Brass and Aluminum. Features of a Non-ferrous Metal Foundry, F. L. Prentiss. Iron Age, vol. 108, no. 9, Sept. 1, 1921, pp. 511–513, 3 figs. Outstanding features of new jobbing brass and aluminum foundry of National Bronz & Aluminum Foundry Co., Cleveland, Ohio.

Casting Costs. Promoting Economy in Iron Foundries by Means of Uniform Rules and Fundamental Principles for the Production and Evaluation of Castings (Die Erhöhung der Wirtschaftlichkeit un der Eisengiesserei durch einheitliche Leitsätze und Unterlagen für die Herstellung und Bewertung der Gusserzeugnisse), Joh. Mehrtens. Betrieb, vol. 3, no. 20, July 10, 1921, pp. 613–617, 2 figs. Includes report of work being done by expert committee for foundry products of German Industry Committee on Standards (N.D.I.), and points out importance of adopting standard terms and classifications, specially for cast-iron products.

Continuous. Continuous Foundry for Pipe Fittings, Henry M. Lane. Iron Age, vol. 108, no. 9, Sept. 1, 1921, pp. 519–524, 10 figs. Designed for minimum handling of sand, castings, cores, hot metal and flasks. Layout and details.

Electrical Equipment. Electrical Apparatus in the Foundry, F. D. Egan. Foundry, vol. 49, no. 16, August 15, 1921, pp. 646–651, 16 figs. Discusses cupola and air furnaces, transformers and motor equipment, also gives data on operation of foundries.

Mechanical Control. Mechanical Control in Foundry Problems, J. H. Hopp. Iron Age, vol. 108, no. 8, Aug. 25, 1921, pp. 456–458, 5 figs. Discusses several cases showing how application of simple mechanics produced results which chemistry alone did not. (Abstract.) Address delivered before Southern Metal Trades Assn.

FREIGHT HANDLING

Ashley Planes. Ashley Planes for Handling Freight Traffic, C. H. Stein. Min. & Metallurgy, no. 177, Sept. 1921, pp. 45–46. Notes on installation of hoisting engines of large capacity at head of each plane, which, by means of large cables, haul cars to objective point. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

FRICTION

Rolling. Measuring Accelerations and Coefficients of Rolling Friction At the Metropolitan Railway of Paris (Mesures d'accélérations et de coëfficients de roulement au chemin de fer métropolitain de Paris), R. Van Cauwenberghe. Société Belge des Électriciens, vol. 35, May-June 1921, pp. 101–118, 9 figs. Describes level and electric accelerometers and tests made with former.

FUEL CONSERVATION

Power Plants. Elimination of Waste in Industrial Power Plants, David Moffat Myers. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 413–416. Shall an industry own its power plant or buy its power? Determining factor is relation of heating and process steam to power demand. The what and why of fuel economy.

Reducing Coal Consumption from 51 to 27 Tons a Day, H. A. Ward. Power, vol. 54, no. 5, Aug. 2, 1921, pp. 172–174, 4 figs. Describes changes made in steam-generating plant to effect this reduction.

FUELS

Anthracoal. Anthracoal: A New Domestic and Metallurgical Fuel, Donald Markle. Trans. Am. Inst. Min. & Met. Engrs., No. 1086-C, August 1921, 11 pp., 1 fig. Gives comparative results of tests of anthracoal and coke, analysis of anthracoal, process of manufacture and by-products obtained. (Also in Coal Age, vol. 20, no. 8, August 20, 1921, pp. 296–299.)

Bituminous Coal. Utilization Refinement of Fuels, F. P. Coffin. Gas Age-Rec., vol. 48, no. 5, August 20, 1921, pp. 176–178. Discusses processes for conversion of bituminous coal into primary fuel and power.

Recovery from Furnace Residue. The Schilde Process for the Treatment of Furnace Residue (Das Schildesche Aufbereitungsverfahren für Feuerungsrückstände), A. Pradel. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 10, Mar. 11, 1921, pp. 73–74, 2 figs. Details of the Kolumbus separator.

Utilization. Commission for Utilization of Fuel (Commission D'Utilisation du Combustible), Revue de L'Industric Minérale, no. 14, July 15, 1921, p. 506. (Continuation of serial.)

[See also LIGNITE; PEAT.]

FURNACES, ANNEALING

Gas-Fired. Gas-Fired Annealing Furnace. Iron & Coal Trades Rev., vol. 103, no. 2786, July 22, 1921, pp. 107, 3 figs. Describes tests made with plant consisting of two self-contained twin-pot rotary flame annealing furnaces.

FURNACES, BOILER

Burning Mixed Fuels. The Burning of Fuel Mixtures (Verfeuerung verschiedenartiger Brennstoffe), Karl Schäfer. Zeit. fur Dampfkessel u. Maschinenbetrieb, vol. 44, no. 17, Apr. 29, 1921, pp. 130–133, 2 figs. Results of combustion tests carried out in 1915 in two-header water-tube boiler of the Berlin municipal gas works, in order to obtain desiderata for an expedient burning of coke and coke mixtures with other fuels. Abstracted from report of Soc. for Promotion of Moor Coal Cultivation.

French Types. Furnace Operation and Coal Conservation in France During the War (Feuerungsbetrieb und Kohlewirtschaft in Frankreich während des Krieges), A. Pradel. Feuerungstechnik, vol. 9, no. 21, Aug. 1, 1921, pp. 193–197, 16 figs. Notes on the Ratel underfeed furnaces; the Godillot furnaces for waste wood; the Serret grates for use of low-grade fuel; the Genevet forced-draft furnaces; the Prat induced-draft system; etc.

Nozzle Grate Bars. Progress in Forced-Draft Furnaces (Neues von Unterwindfeuerungen), A. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 22, June 3, 1921, pp. 169–172, 9 figs. Describes nozzle grate bars constructed by Berlin-Anhalt Machine Constr. Corp., Dessau; Dr. Hans Cruse & Co., Berlin-Charlottenburg; and Thost, Zwickau.

FURNACES, INDUSTRIAL

Egler. Adapts Blow Torch Idea To Furnace, George L. Prentiss. Foundry, vol. 49, no. 16, August 15, 1921, pp. 639–640, 1 fig. Describes Egler patent applicable to all kinds of liquid gas and fuel and powdered coal.

Efficiency. The Efficiency of Industrial Furnaces, Hugh Chambers. Can. Machy. vol. 26, no. 7, August 18, 1921, pp. 33–35, 5 figs. Increase in efficiency due to modern design.

Gas and Oil. New Gas and Oil Furnaces (Neue Gas- und Oelfeuerungen), A. Pradel. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 5 and 6, Feb. 4 and 11, 1921, pp. 33–34 and 43–44, 20 figs. Details of recent German patents.

FURNACES, METALLURGICAL

Heat Losses. The Fundamental Principles of Heat Losses of Metallurgical Furnaces (Die Grundlagen der Wärmeverluste metallurgischer Oefen), P. Rosin. Metall u. Erz, vol. 17, no. 21, Nov. 8, 1920, pp. 463–475 and vol. 18, nos. 2, 4 and 5, Jan. 22, Feb. 22 and Mar. 8, 1921, pp. 37–45, 78–88 and 99–104, 14 figs. Nov. 8: The geometrical factor. Jan. 22: The material factor. Feb. 22: The external heat conductivity; the temperature factor. Mar. 8: The time factor.

G

GAGES

Inspection. The Delco Inspection System, Erik Oberg. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1127–1130, and vol. 28, no. 1, Sept. 1921, pp. 43–47, 23 figs. Typical Examples of gaging fixtures used by Dayton Engineering Laboratories Co. in manufacture and inspection of company's product.

Plug and Ring. The Selection of Gages for Cylindrical Allowances (Auswahl der Lehrenarten für Rundpassungen), K. Gottwein. Werkstattstechnik, vol. 15, no. 13, July 1, 1921, pp. 393–400, 20 figs. Suggestions for an economical selection of gages from the two allowance systems in present use.

GAS PRODUCERS

Development. Developments in the Construction of Gas Producers (Die Entwicklung des Gaserzeugerbaues), H. R. Trenkler. Glasers Annalen für Gewerbe u. Bauwesen, vol. 89, no. 1, July 1, 1921, pp. 3–8, 14 figs. Discusses various types. It is claimed that the revolving-grate producer has replaced all older types.

Operation. Gas-Producer Practice, N. R. Rees. Mech. Wld., vol. 70, no. 1804, July 29, 1921, pp. 89–90. Discusses essential features, even distribution of coal, uniform production of good-quality gas, regulation of depth of fuel bed, removal of ashes and clinker, and low cost of operating.

GEAR CUTTING

Stevenson Multiple Shaper. The Stevenson Multiple Shaper. Machinery (Lond.), vol. 18, no. 463, August 11, 1921, pp. 578–581, 8 figs. A new type of gear-cutting machine.

The Stevenson Gear Wheel Shaping Machine. Engineer, vol. 132, no. 3422, July 29, 1921, p. 128, 2 figs. Details of multiple shaping machine for cutting gear wheels, which cuts all or large proportion of teeth simultaneously.

GEARS

Fabroil. Fabroil and Textoil—Textile Fibre Products that Give Good Service In Gears, G. L. Wilder. Raw Material, vol. 4, no. 8, August 1921, pp. 279–280, 1 fig. Discusses fabroil gears and textoil gears.

vol. 132, no. 3422, July 29, 1921, pp. 112–113, 2 figs. Describes specialist work of grinding of tooth profiles to a stated standard of accuracy performed by Gear Grinding Co., Ltd., Birmingham.

Gear Tooth Grinding. Machinery, (Lond.), vol. 18, no. 462, August 4, 1921, pp. 542–545, 8 figs. Describes system of Gear Grinding Co., Ltd.

Involute. Inspection of Involute Spur and Helical Gear Hobs—I, Carl G. Olson. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 11–13, 12 figs. Testing accuracy of hob and tooth parts; hobbing tests.

The Evolution of the Involute Gear Tooth—VII and VIII, A. Fisher. Machinery (Lond.), vol. 18, nos. 461 and 462, July 28 and Aug. 4, 1921, pp. 507–510, 4 figs., and 547–551, 14 figs. Discusses conditions of contact, lengths of contact paths and numbers of teeth.

Maag. Principles of Maag Gearing. Machy. (N. Y.), vol. 28, no. 1, Sept. 1, 1921, pp. 48–52, 9 figs. Analysis of Maag system of gearing, advantages claimed for this type of gears, and machines for their production.

Rolling-Mill Driving. Cutting Rolling Mill Driving Gears, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 1–4, 5 figs. Producing large herringbone gears by end-milling process at Woodard Machine Co.'s plant in Wooster, Ohio.

GIRDERS

Reinforced-Concrete. Construction Joints in Concrete Girders of 62½ Ft. Span. Eng. News-Rec., vol. 87, no. 9, Sept. 1921, pp. 348–350, 4 figs. Unique design is said to safeguard reinforced-concrete garage under Williamsburg bridge against cracking in event of uneven pier settlement.

GLASS MANUFACTURE

Sheet, Drawing. The Drawing of Sheet Glass. Glass Ind., vol. 2, no. 8, August 1921, pp. 190–193, 3 figs. Describes invention of Emile Gobbe developed by Emile Fourcault, and results obtained leaving no doubt as to ultimate success of process. (Abstract, Le Verre.)

GRAIN ELEVATORS

Floating Pneumatic. The Floating Pneumatic Grain Elevator at Avonmouth Dock, George F. Zimmer. Eng. & Indus. Management, vol. 6, no. 8, Aug. 25, 1921, pp. 221–225, 4 figs. Details of pneumatic plant known as the Alpha, which is mounted on pontoon of reinforced concrete divided by concrete bulkheads into separate compartments for accommodation of boiler, engine, elevators, and crew.

GRAIN HANDLING

Pneumatic Plant. Pneumatic Grain-Discharging and Sack-Handling Plant at Bordeaux. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 312–314, 19 figs., partly on p. 316 and supp. plate. Two traveling pneumatic grain-discharging installations, delivering on to elevated belt conveyors running length of wharf; these conveyors deliver in turn to others running at right angles to them, back to silos of 7500 tons capacity, whence grain may be stacked off and stored in warehouses. (To be continued.)

GRINDING

Automobile Parts. Grinding in the Automotive Industry—II, P. M. Heldt. Automotive Ind., vol. 45, no. 7, August 18, 1921, pp. 315–317, 3 figs. Development of specialized forms of grinding. (To be continued.)

Fixtures. Grinding Practice—Variety of Fixtures Used, F. Scriber. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 28–31, 14 figs. Discusses principles and shows how grinding wheel comes into contact with work.

Some Novel Grinding Fixtures, Andrew Macnab. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 309–312, 9 figs. Grinding blocks with ends parallel. A fixture that failed and how trouble was remedied.

GRINDING MACHINES

Manufacture. Building Grinding Machines. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 133–139, 19 figs. Description of products of Churchill Machine Tool Co., Ltd., Manchester, Eng.

H

HANDLING MATERIALS

Automobile Plant. Handling Materials in an Automobile Plant, Fred H. Colvin. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 292–296, 12 figs. Utilizing elevators and floors openings for carrying material from one floor to next. Continuous assembly and modern devices for facilitating work.

Methods. Moving Parts from Operation to Operation, J. M. Macrae. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 167–169, 4 figs. Discusses four methods: Moving by trucks, rolling down chutes, sliding on gravity conveyors, handling by power conveyors.

HARDNESS

Testing. Hardness Testing (Beitrag zur Härteprüfung), F. Waizenegger. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 31, July 30, 1921, pp. 824–827, 5 figs. Describes method making use of ball test and exemplifies its practicability.

HEALTH

Chemical Industry. Occupational Diseases in Chemical Industries, Frederic Dannerth. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 145–147, 4 figs. How workers in chemical plants are safeguarded.

E. Mock. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 369–374, 2 figs. Strong emphasis is placed on role of physician in industrial plants, with outline of preventive and curative medical services which can be rendered to working forces in industry.

HEAT

Conservation. Premiums for the Saving of Heat (Ersparnisprämien in der Wärmewirtschaft), Friedrich Münzinger. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 1 and 2, Jan. 7 and 14, 1921, pp. 1–3 and 9–12, 3 figs. Means and methods of calculating utilization of heat in boiler room, and instruments required for measuring consumption of coal, feedwater and condensation quantities of large turbines, amount of electric energy produced, etc. Curves showing performance of boiler system of the Golpa power station, Germany.

HEAT TRANSMISSION

Liquid to Liquid. Law of Heat Transmission Between Liquids in Heat Exchangers (Lois numériques de la Transmission de la Chaleur entre les fluides dans les Echangeurs industriels) H. Dieterlen. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 406–409, 1 fig. Mathematical discussion of speed of transmission, review of previous work on this subject. (To be continued.)

Pipe Lines. Investigations of Heat Transmission in Pipe Lines (Die bisherigen Untersuchungen des Wärmeübergangs in Rohrleitungen mit besonderer Berücksichtigung der Forschungen von Professor Nusselt), H. Schmolke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 11, Mar. 18, 1921, pp. 81–84. Special consideration of research work of Professor Nusselt.

HEATING

Gas and Electric. Gas and Electric Heating (Chauffage au gaz et chauffage à l'électricité), A. Grebel. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 426–432. Comparative analysis concerning domestic heating.

HEATING, ELECTRIC

Granular Metal. Using Granular Metal in Electric Heating (Sur l'emploi des métaux granulaires pour le chauffage électrique), Oct. Douy-Hénault. Académie Royale de Belgique—Mémoires, vol. 6, March 1921, 57 pp., 15 figs. Discusses granular resistances; comparison of carbon resistances with granular metal ones; electric properties of granular metallic masses; granular conductivity; melting point of granular metal etc. in connection with electric furnaces.

HEATING, HOT-WATER

Pipe Resistance. Calculation of the Resistance in Piping for Hot-Water Heating (Die Widerstandsberechnung der Rohrleitungen von Warmwasserheizungen), Otto Ginsber. Gesundheits-Ingenieur, vol. 44, nos. 24 and 28, June 11 and July 9, 1921, pp. 281–293 and 345–350, 9 figs. Tables giving friction values obtained from the Brabbée and other calculating methods. The Brabbée tests are said to prove that small errors in construction of pipe lines can have great influence on result, the magnitude of which however, has not yet been determined; hence the Brabbée investigations do not represent final solution of problem. Writer claims that it is possible, by deviating from theoretical accuracy, to simplify calculations, thereby effecting a great saving in time and in cost of installation, without risk of building inferior or too costly installations.

HEATING, STEAM

Methods. Methods and Basic Principles of Heating with Steam (Arten und rechnerische Grundlagen der Erhitzung mit Dampf), Rudolf Kaesbohrer. Chemiker-Zeitung, vol. 45, no. 9, Jan. 20, 1921, pp. 69–73, 1 fig. Includes table showing relations between pressure, temperature and heat content of saturated steam. Notes on direct and indirect steam heating; heating of air or gas.

HOUSING

Dense Tenement Populations, Eliminating. Population Density as a Basis for Housing Regulations, Frank B. Cartwright. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, pp. 318–322, 3 figs. Intensive Rochester study indicates that improved transit, industrial decentralization, zoning and other current changes render dense tenement populations unnecessary in most cities.

Traffic and. Traffic and Housing in Large Cities, Arthur Ertel. Elec. Ry. Jl., vol. 58, no. 6, August 6, 1921, pp. 199–201, 5 figs. Finds that there exists a definite relation between track and building development within different areas equidistant from a city center. (Abstract from Verkehrstechnik.)

HYDRAULIC PRESSES

Single-Acting. Pressing Stator Plates into Motor Casings, and Rotor Plates on Squirrel Cage Rotors on a Single-Acting Hydraulic Press, J. Blakey and J. Shankley. Eng. & Indus. Management, vol. 6, no. 4, July 28, 1921, pp. 86–87, 13 figs. Equipment designed for use in connection with single-acting hydraulic press.

HYDRAULIC TURBINES

Draft Tubes. Hydro-Electric Practice—Draft Tubes, C. Voetsch. Power, vol. 54, no. 5, Aug. 2, 1921, pp. 164–167, 10 figs. Discussion and comparison of various types of draft tubes.

High-Head Reaction. Important Features in the Design of High-Head Reaction Turbines, F. H. Rogers. Power, vol. 54, no. 7, Aug. 16, 1921, pp. 244–248, 9 figs. A 30,000-hp. unit for Big Creek, no. 8 development of Southern California Edison Co.

Draft tube, casing and relief-valve design. Lubricating of internal parts. Governor control.

Kaplan. The Economic Utilization of Water Energy by Means of the Kaplan Turbine (Die wirschaftliche Ausnutzung der Wasserenergie durch die Kaplan-Turbine), H. Donath. Elektrotechnischer Anzeiger, vol. 38, nos. 95, 96 and 97, June 16, 18 and 21, 1921, pp. 641–644, 649–650 and 659–660, 23 figs. Details and advantages of the Kaplan turbines.

Norway. The Turbines of the Vammua Hydroelectric Works, Norway (Vamma kraftanlægs turbiner), Ch. Woxholt. Teknisk Ukeblad, vol. 68, no. 18, May 6, 1921, pp. 209–212, 8 figs. Deals especially with sixth turbine which differs from older ones. With 214 r.p.m. and 27 m. head, it has output of 14,330 hp.; maximum diameter of casing is 5.7 m. Account of trial run.

Wear. Wear of Hydraulic Turbines (L'Usure des Turbines Hydrauliques)—IV, Henri Dufour. La Houille Blanche, vol. 20, no. 53–54, May-June 1921, pp. 97–104, 13 figs. Description of sand removers used at Ackersand Works.

HYDRAULICS

Eddy Flow. Eddy Flow and Hydrodynamical Conceptions in Connection Therewith (Wirbel und im Zusammenhang damit stehende Begriffe der Hydrodynamik), A. Betz. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 12, no. 13, July 15, 1921, pp. 193–198, 19 figs. Based on typical examples, conception of rotation in two-directional motion of liquid is discussed and it is shown that through the pure forces of pressure without friction no rotational motion can be produced. In general, frictional forces are only noticeable in vicinity of solid walls. Discusses law stating that circulation along eddy is constant. Examples of the most frequently occurring forms of eddy.

Recent Progress. New Results in Hydromechanics (Neue Ergebnisse der Hydromechanik), H. v. Sanden. Glückauf, vol. 57, no. 27, July 2, 1921, pp. 629–636, 12 figs. Review of progress in recent years. Notes on Newton's theory on resistance of bodies in agitated liquid; the Euler streamline theory of frictionless liquid; friction of liquids; limit-stream theory of Prandtl; resistance formula, the Reynolds coefficient.

Theory. Contribution to the Theory of Hydraulic Motion (Nuovo Contributo alla Teoria dei Moti Idraulici), P. Alibrandi. Il Nuovo Cimento, vol. 22, Series 6, July-August 1921, pp. 94–113. Navier's hydrodynamic equations are valid for instantaneous velocity and pressure, but not for "hydraulic" velocity and pressure, which author develops mathematically.

HYDROELECTRIC PLANTS

Spain. Hydroelectric Plants of Guadiaro River, Spain (Les usines hydro-électriques du Guadiaro), Adolphe Weber. Schweizerische Bauzeitung, vol. 77, no. 26, June 25, 1921, pp. 299–301, 12 figs. (Concluded.)

Waterwheel Design and Setting. Advances in the Art of Waterwheel Designs and Settings, W. M. White. Jl. Am. Inst. Elec. Engrs., vol. 40, no. 8, Aug. 1921, pp. 668–682, 23 figs. Notes on speed regulation; runners and runner materials; draft tubes; shaft and bearings; guide vanes; governors; turbine casing; vertical vs. horizontal units; control valves; and power house setting.

I

IGNITION

Adjustments. Different Ignition Adjustments and Their Effect on Performance of Engine and Consumption of Fuel (Verschiedene Zündeinstellungen und ihre Wirkung in bezug auf die Motorleistung und den Kraftstoffverbrauch), C. Wirsum. Motorwagen, vol. 24, no. 16, June 10, 1921, pp. 323–327, 21 figs. Discusses various adjustments of spark plugs, and gives chart showing output curves and fuel consumption with different ignitions.

INDUSTRIAL MANAGEMENT

Administrative Planning. Planning Applied to Administration. Eng. & Indus. Management, vol. 6, no. 7, Aug. 18, 1921, pp. 174–177. Indicates to what extent field of industrial administration has been entered by scientific management. Notes on planning of sales, relationship between stock and finished products, and finances.

Budgets and Production. The Expense and Finance Budgets, Park Mathewson. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 109–113, 3 figs. How they concern production.

Charts. Managing an Industry by Graphic Charts, Arthur T. Burnet. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 83–87, 2 figs. Typical charts and their use. How current facts are quickly and economically supplied to executive.

Standardizing the "Z" Chart, Arthur R. Burnet. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 153–158, 4 figs. Discusses standardizing type of management engineering chart known as the "Z" chart to permit of its production in quantity.

The Ratio Chart and Its Application—II and III, Percy A. Bivins. Indus. Management, vol. 62, nos. 2 and 3, Aug. 1 and Sept. 1, 1921, pp. 99–104 and 166–171, 19 figs. Based on memo notes of an office manual for guidance of draftsmen unfamiliar with ratio plotting. Advantages and disadvantages of ratio charts compared with charts on arithmetic basis.

[See also GANTT CHARTS.]

Efficiency. The Final Measure of Industrial Efficiency, A. L. DeLeeuw. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 141–146, 1 fig. Notes on how to obtain maximum efficiency. Consideration of equipment and plant efficiency. Influence of capital charges. An application of index numbers.

Engineering Students, Training in. Existing Courses in Management Engineering, Collins P. Bliss. Management Eng., vol. 1, no. 1, July 1921, pp. 43–48, 1 fig. Gives make-up of eight courses and time allotted to each general group of subjects and to each study. Summary and chart showing number of hours devoted to individual subjects.

Gantt Charts. The Gantt Chart, Wallace Clark. Management Eng., vol. 1, nos. 2 and 3, Aug. and Sept., 1921, pp. 77–82, 9 figs., and 161–166, 6 figs. Advantages, principle, technique and application to man records and layouts.

Inspection. Inspection. Mech. Wld., vol. 52, 1806, August 12, 1921, pp. 118–119, 5 figs. Discusses necessity for inspection and the tact required by an inspector.

Marketing. The Elimination of Waste in Marketing, William R. Basset. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 420–422. States that marketing from point of view of manufacturer can be made more profitable by application of better methods of distribution and by establishment of improved selling policies.

Material Specifications. Material Specifications, E. A. Allcut. Eng. & Ind. Management, vol. 6, no. 5, August 4, 1921, pp. 114–115. Emphasizes necessity for complete specifications of materials in case of small users.

Overtime, Influence of. The Influence of Overtime on Costs, B. C. Sloat. Management Eng., vol. 1, no. 1, July 1921, pp. 9–10. Wage costs and shop maintenance as influenced by overtime; effect on shop morale and on workmanship.

Planning. Precalculation in the Factory (Aufgaben einer Betriebsvorkalkulation), Paul Bischoff. Werkstattstechnik, vol. 15, no. 15, Aug. 1, 1921, pp. 448–450, 5 figs. Points out advantages of predetermination of time required for finishing a workpiece.

Production Control. Production Control. P. J. Darlington. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 95–98, 2 figs. Its strong and weak points. Author sets forth purposes and requirements and emphasizes permanent management's vital relationship to system.

Production, Economics of. The Economics of Production—III, D. A. McCabe. Am. Mach., vol. 55, no. 10, Sept. 8, 1921, pp. 381–382. Costs and price and production.

Production Increase. Accumulative Skill As a Factor in Production, Hugo Diemer. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 111–112. Proof that group experience and pride in work increase output.

Scientific Management—XXIX, Henry Atkinson. Eng. & Indus. Management, vol. 6, no. 4, July 28, 1921, pp. 97–98. Incentives to economical production.

Six Ways of Increasing Production, G. D. Halsey. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 97–98. (1) Introduction of labor-saving machinery; (2) specialization; (3) aggregation (combination with any other department); (4) standardization of parts; (5) elimination of wastes of materials; and (6) increasing individual efficiency.

Program for. What is Management in Industry? C. E. Knoeppel. Management Eng., vol. 1, no. 1, July 1921, pp. 23–28, 1 fig. Placing blame and fixing responsibility. A program for management.

Routing. Cutting Out Waste in the Shop. Elec. Ry. Jl., vol. 58, no. 6, August 6, 1921, pp. 193–198, 24 figs. Discusses minimizing of lifting operations, effective routing of machine jobs and permanent repair of defective parts.

The Group System of Process Planning, W. J. Hiscox. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 600–601. Discusses routing of jobs through the shop.

Small Factories. Management Problems of the Small Factory, Ernest Cordeal. Indus. Management, vol. 62, nos. 2 and 3, Aug. 1 and Sept. 1, 1921, pp. 114–119 and 182–187, 4 figs. Aug.: Costs and their use. Sept.: Supervision and inspection.

Storeskeeping. The Essentials of Storeskeeping, Wallace Clark and C. E. Davies. Management Eng., vol. 1, no. 1, July 1921, pp. 11–16, 9 figs. Notes on storeskeeper's responsibilities; marking the order points; keeping records of stock; safeguarding stores; disposing of unneeded material; and selection and training of personnel.

Production and the Stores Department, H. G. Harley. Eng. Production, vol. 3, no. 46, Aug. 18, 1921, pp. 150–154, 12 figs. Describes combined production and stock-recording system.

Woodworking Shops. Production Control in Wood-Working Shops, F. B. Sampson. Wood-Worker, vol. 40, no. 6, August 1921, pp. 30–32, 8 figs. Outline of fundamentals of production control. Gives time allowance and operations layout charts.

[See also FATIGUE; TIME STUDY.]

INDUSTRIAL ORGANIZATION

Large Contract Plants. Organization of Large Contract Plants, George H. Shepard. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1100–1103, 3 figs. Deals with organization of plants making variety of products, and establishment of planning, dispatching, and recording systems.

Small Shops. Organization and Management of the Small Shop—IV, E. W. Leach. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 338–341. Financing company; coöperating with investor; advantages and disadvantages of partnerships and corporations.

INDUSTRIAL RELATIONS.

Americanization. Industrial Americanization, Luther D. Burlingame. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 30–32. Policy of Brown & Sharpe Mfg. Co. in assisting alien employees to become American citizens.

Human Elements in. Human Elements in Engineering, J. J. Flather. Bul. Minn. Federation Architectural & Eng. Societies, vol. 6, no. 7, July 1921, pp. 21–32. Discusses hours of work, pleasant surroundings, etc. and their influence on production. Lays stress on the point that philanthropy has no part in industrial management.

INDUSTRIAL TRUCKS

Lifting. The Edgar Brandt Elevator-Truck (Le Chariot élévateur Edgar Brandt), M. d'About. La Vie Automobile, vol. 17, no. 735, August 10, 1921, pp. 285–286, 2 figs. Description of hand-operated truck for loading and unloading boxes up to 400 kg. into and from delivery wagons.

INDUSTRY

Arbitration Courts. Wastes in Litigation, Wellington Gustin. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 423–427. Losses arising from litigation said to be potential factor in success or failure of any industry or business. Lack of knowledge of technical terms and standards on part of courts a strong argument for establishment of arbitration courts within industry.

INTERNAL-COMBUSTION ENGINES

Adapting to Rarefied Atmospheres. Adapting Explosion Engines to Rarefied Atmospheres (Le Problème de l'Adaptation des Moteurs a Explosions aux Atmosphères Raréfiées). L'Aeronautique, vol. 1, no. 9, February 1920, pp. 399–402, 6 figs. Reduces all methods to form fundamental ones and discusses these.

Cycle Evaluating Chart. A Nomographic Chart for Gases, T. B. Morley. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 302–304, 5 figs. Chart developed by author for evaluating with ease and rapidity internal-combustion-engine cycles, which yields approximate results, claimed to be preferable to "air standard" values.

Exhaust-Gas Analysis. A Further Application of Diagrams to the Analysis of Exhaust Gases (Eine weitere Anwendung von Schaubildern zur Abgasanalyse), K. Kutzner. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 33, Aug. 13, 1921, pp. 871–873, 1 fig. Chart is developed for simple determination of that part of carbon content of coal which is not consumed in combustion. Use of chart, employed by Neufeldt & Kuhnke, Kiel, for testing hot-bulb motors, is described with aid of examples.

Installation. Practical Notes on the Installation and Running of Petrol, Petrol-Paraffin, and Semi-Diesel Engines, D. P. Lamb. Mech. Wld., vol. 70, no. 1804, July 29, 1921, pp. 91–92. Discusses reverse gear, exhaust pipe, circulating pumps, gear pumps and fuel-supply system. (To be continued.)

Large-Cylinder. Internal Combustion Engines with Large Cylinders, James McKechnie. Gas & Oil Power, vol. 16, no. 191, August 4, 1921, pp. 173–174. Discusses requirements of mercantile ships, electric drive, two-stroke design, and gives table of test data of 1000-b.hp. single-cylinder engine. From paper read before Instn. Civil Engrs.

Operation. Practical Notes on the Installation and Running of Petrol, Petrol-Paraffin, and Semi-Diesel Engines, D. P. Lamb. Mech. Wld., vol. 52, no. 1805, August 5, 1921, pp. 112–115. Discusses carbureters, lubrication, magnetos, water circulation.

Vegetable Oils for. Vegetable Oils for Internal Combustion Engines, R. E. Mathot. Engineer, vol. 132, no. 3423, Aug. 5, 1921, pp. 138–139. Author gives results of his investigations and makes suggestions for improvements in design of engines to fill requirements of colonial service.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES; SEMI-DIESEL ENGINES.]

IRON

Foundry. Foundry Irons for Particular Uses, Y. A. Dyer. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 585–588. Differentiating characteristics of gray iron, mottled, chilled or white. Analyses of certain castings.

IRON ALLOYS

Iron-Nickel. Making a 5-per cent. Nickel-cast-iron Alloy in an Electric Furnace, D. N. Witman. Trans. Am. Inst. Min. & Met. Engrs., no. 1087-S, August 1921, 4 pp., 1 fig. Discusses different alloys used for production of electrical-resistance grids.

Iron-Silicon System. On the Equilibrium Diagram of Iron-Silicon System, Takejiro Murakami. Science Reports Tôhoku Imperial Univ., vol. 10, no. 2, June 1921, pp. 79–92, 26 figs. Description of experiments carried out resulting in a revision of the equilibrium diagram by Guertler and Tammann.

IRON CASTINGS

Chill Castings. Chill Castings (Le Moulage en Coquille), A. Dat. Arts et Métiers, vol. 74, no. 9, June 1921, pp. 167–170, 11 figs. Discusses making of mold, pouring under pressure, etc.

Nickel and Cobalt in. Nickel and Cobalt in Iron, O. Bauer and E. Piwowarsky. Iron Age, vol. 108, no. 9, Sept. 1, 1921, p. 513. German experiments on iron castings; nickel improves physical properties. Translated from Stahl u. Eisen, Sept. 30, 1920.

IRON INDUSTRY

Brazil. Historical Data on the Brazilian Iron Industry (Några blad ur den brasilianska järnhandteringens historia), Harald Carlborg. Jerkontorets Annaler, vol. 105, no. 3, 1921, pp. 125–143. Contains also data on recent smelting practice.

L

LABOR

Hours of Work and Output. Hours of Work and Output. Eng. & Ind. Management, vol. 6, no. 5, August 4, 1921, pp. 122–124. Annual report of British Chief Inspector of factories and workshops.

Loss, Sources of. The Sources of Labor Loss, J. Burk LeClere. Indus. Management, vol. 62, no. 3. Sept. 1, 1921, pp. 177–181. How they affect production through man power.

LABOR TURNOVER

Accidents In Relation to. The Unexpected Trend in Accident Prevention, C. B. Auel. Management Eng., vol. 1, no. 1, July 1921, pp. 35–41, 2 figs. Long service, good health, contentment, cleanliness, and carefulness are said to be more important than mechanical devices.

LATHES

Automatic. The Barker Two Period Alternating Automatic. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 124–125, 4 figs. Description of four spindle automatic lathe for bar work constructed by The Victor Engineering Co., Ltd., Glasgow, Eng.

LIGHTING

Canneries. Solving Special Lighting Problems in the Modern Cannery, Warren Alden. Jl. Elec. & Western Ind., vol. 47, no. 4, August 15, 1921, pp. 145, 1 fig. Describes illumination in plant of Pratt-Low Preserving Co., Santa Clara, Cal.

Industrial. Elimination of Waste in Industry Due to Poor Lighting, Ward Harrison. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 407–409, 6 figs. Points out importance of installation and proper maintenance of adequate illumination in avoidance of industrial accidents and resulting wastes of man power, losses of time, materials and production.

LIGNITE

Briquetting. The Economy of Briquetting (Die Wirtschaftlichkeit der Briketterzeugung), Otto Schöne. Braunkohle, vol. 19, nos. 50 and 51, Mar. 22 and 29, 1921, pp. 632–638 and 651–652, 2 figs. Writer demonstrates that in a properly equipped lignite briquet factory the actual loss through briquetting amounts to only 7.7 per cent.

The Loss of Fuel Through the Briquetting of Lignite (Der Brennstoffverlust durch die Brikettierung der Braunkohle), H. Berner. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 14 and 16, Apr. 8 and 15, 1921, pp. 108–110 and 116–117. Report of the expert committee of the Lignite Syndicate, showing that the original consumption of fuel in briquet factories amounting to 17 to 31 per cent represents an actual loss of only 8 per cent.

LOCOMOBILES

Robey. A 500-Horse-power Combined Engine and Boiler. Engineer, vol. 132, no. 3421, July 22, 1921, p. 88, 9 figs. on supp. plate and p. 94. Plant built by Robey & Co., Ltd., London, consists of compound engine mounted over circular boiler, having circular furnace and tubes which are withdrawable, and is provided with a superheater in smoke-box and a feedwater heater.

LOCOMOTIVE BOILERS

Tubes. Steel vs. Brass Locomotive Boiler Tubes. (Le Tube de Chaudière de Locomotive acier ou laiton?), O. Hock. Revue Universelle des Mines. vol. 10, no. 3, August 1, 1921, pp. 261–269. Discusses experiences in various countries and shows that steel tubes are more economical.

LOCOMOTIVES

4-8-0. New 4-8-0 Type Locomotives for the Jamaica Government Railways. Ry. Gaz., vol. 35, no. 6, August 5, 1921, pp. 249–250, 3 figs. These engines were specially designed to work various classes of traffic on hilly sections of main line where heavy and long grades occur, with many curves of small radius.

Oil-Burning. Liquid-Fuel Burning Locomotives on British Railways—I. Ry. Engr., vol. 42, no. 499, August 1921, pp. 304–310, 11 figs. Describes recent developments with various companies. (To be concluded.)

Poppet-Valve Gear. A New Type of Poppet-Valve Gear in the Consolidation Locomotive no. 740. 324 F.S. (Su di un nuovo tipo di distribuzione a valvole applicato sulla locomotiva "Consolidation" no. 740.324 F.S.), Guido Corbellini. Rivista Tecnica delle Ferrovie Italiane, vol. 19, no. 6, June 15, 1921, pp. 152–170, 13 figs. Description of Caprotti type, and theoretical results expected from it. (To be continued.)

Shop Practice. Methods Employed in the Locomotive Shops of the Great Western Railway Co., Swindon—VII. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 497–502, 16 figs. Discusses piston rings, piston crossheads, slippers, guidebars, etc.

Superheater, Oil-Fired. New Baldwin Locomotives For Cuba. Ry. Gaz., vol. 35, no. 8, August 19, 1921, pp. 315–316, 3 figs. Describes 0-8-0 shunting tank engine, 2-8-0 freight engine and 4-6-2 passenger locomotive, with superheater boilers and liquid-fuel-burning apparatus.

Western Railway. Ry. Engr., vol. 12, no. [illegible] August 1921, pp. 285–288, 7 figs. Capable of exerting a tractive force of 34,000 lb., at 85 per cent of boiler pressure.

Tires, Machining. Tools for Boring and Turning Locomotive Tires—II, Fred H. Colvin. Am. Mach., vol. 55, no. 8, Aug. 25, 1921, pp. 313–317, 21 figs. Rough and finish turning tools. Solid tools and tools in holders. Angles of rake and clearance are said to vary greatly in different shops.

Winterthur Type. The New Locomotive of the Sumatra State Railway [Die neue Lokomotiven der Staatsbahnen auf Sumatra (Westküste)]. Siegfried Abt. Schweizerische Bauzeitung, vol. 77, no. 7, Aug. 13, 1921, pp. 75–77, 5 figs. Specifications of Winterthur-type 0-D-1 wet-steam and 0-E-0 superheated-steam compound locomotives: Gage, 1067 mm.; cylinder bore, 450 mm.; piston stroke, 480 and 520 mm. respectively; wheelbase, 6.4 and 5 m. respectively; total heating surface, 103.2 and 102.36 sq.m. respectively; coal supply, 1200 kg.; weight empty, 38.54 and 41.92 tons respectively.

LUBRICANTS

Friction. The Theory of the Friction of Lubricants (Zur Theorie der Schmiermittelreibung), A. Sommerfeld. Zeit. für technische Physik, vol. 2, nos. 3 and 4, 1921, pp. 58–63 and 89–93, 6 figs. No. 3: Notes on dry and liquid friction; tests of the law of similarity. No. 4: Fundamental principles and quantitative results of the hydrodynamic theory of lubricants. Report of work by Lord Rayleigh.

LUBRICATING OILS

Specifications. Lubricating Oil Temperature Charts. Gas Age-Rec., vol. 48, no. 5, August 20, 1921, pp. 201–202, 2 figs. Show effect of viscosity on lubricating oils; gives specifications for selecting oils.

M

MACHINE DESIGN

Errors, Causes of. Common Causes of Errors in Machine Design, R. H. McMinn. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 38–39. Instructions and standards. Convenient form for data. Attitude toward errors. (Concluded.)

MACHINE GUNS

Barrels, Life of. Some Factors Affecting the Life of Machine-Gun Barrels, W. W. Sveshnikoff. Dept. Commerce, Technologic Papers Bur. Stand. no. 191, June 4, 1921, 27 pp., 19 figs. Results of experiments show that deterioration is due to combination of abrasive action of bullet and abrasion by hot gases.

MACHINE SHOPS

British. The Works of Messrs. Edgar Allen and Co., Limited, Sheffield. Engineering, vol. 112, nos. 2903, 2904 and 2905, Aug. 19, 26 and Sept. 2, 1921, pp. 272–274, 304–307 and 335–338, 32 figs. partly on supp. plates. Describes plant for making of manganese steel, tool steel, files, circular saws, twist drills, steel castings, railway and tramway special track work, crushing and grinding machinery, cement and powdered fuel plant, etc.

Famous British Works. Eng. Production, vol. 3, no. 45, August 11, 1921, pp. 122–123, 1 fig. Description of Rolls-Royce, plant at Derby, Automobile manufacturers.

Famous British Works. Eng. Production, vol. 3, no. 46, Aug. 18, 1921, pp. 146–149, 5 figs. Details of machine-tool works of Alfred Herbert, Ltd., Coventry.

Famous British Works. Eng. Production, vol. 3, no. 47, Aug. 25, 1921, pp. 170–172, 4 figs. Details of works of Robey & Co., Ltd., Lincoln, for manufacture of agricultural machinery, steam wagons, and all kinds of engines, including uniflow and semi-Diesel engines, air compressors, etc.

MACHINE TOOLS

Manufacture. Well House Foundry, Leeds. Engineer, vol. 132, no. 3424, Aug. 12, 1921, pp. 166–168, 11 figs. partly on pp. 164 and 170. Plant for construction of heavy machine tools and testing machines. Details of the different shops and some of machines constructed.

MACHINERY

Vibration. Elimination of Machine Vibration. Indian Industry & Power, vol. 18, no. 10, June 1921, pp. 529–531, 5 figs. Explains origin of vibrations and shows how to overcome them.

MALLEABLE IRON

American Foundry Practice. American Malleable Cast Iron—XIV–XVIII, H. A. Schwartz. Iron Trade Rev., vol. 69, nos. 2, 4, 6, 8 and 10, July 14, 28, Aug. 11, 25 and Sept. 8, 1921, pp. 98–101, 2 figs., 233–238, 8 figs., 354–359, 4 figs., 496–499, 3 figs., and 611–616, 9 figs. July 14: Cupola and open-hearth melting. July 28: Annealing practice. Aug. 11: Metallurgy of annealing. Aug. 25: Pattern-making and molding. Sept. 8: Cleaning and finishing.

MANUFACTURING

Special Tools vs. Standard Equipment. Manufacturing With Special Machines vs. Standard Equipment—IV, F. Jenks and M. H. Christopherson. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 349–353, 13 figs. Portable devices for plain and thread milling. An angular drilling fixture. Special machine for milling sinuous oil grooves.

MARINE STEAM TURBINES

Geared. Geared Marine Turbines, C. R. Waller. Am. Mar. Engr., vol. 16, no. 10, May 1921, pp. 11–13, Steam Turbine Co.

MATERIAL HANDLING

Modern Methods. The Moving of Materials in Industry, R. M. Gates. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 65–70, 9 figs. Suggestions for better and greater application of mechanical material-moving devices.

MATERIALS

Testing. Material Testing in the German Material-Testing Bureau (Materialprüfung im Staatlichen Materialprüfungsamt). Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 12, 13 and 16, Mar. 25, Apr. 1 and 22, 1921, pp. 93–94, 101 and 124–125. (Abstract.) Report of State Material-Testing Bureau, Berlin-Lichterfelde, on work carried out in 1919–20.

MATTER

Changes of Form. Crystals, Solids and Vitreous Matter, A. Portevin. Sci. Am. Monthly, vol. 4, no. 2, Aug. 1921, pp. 137–141, 6 figs. Basic principles and general phenomena relating to changes of form in matter. Translated from La Revue de l'Ingénieur, April 1921.

MEASURING INSTRUMENTS

Electric Sensitive. Sensitive Measuring Apparatus, J. B. Moran. Machy. (N. Y.), vol. 28, no. 1, Sept. 1921, pp. 36–37, 2 figs. Describes electrical measuring device which is sensitive to one two-hundred millionths of an inch.

METAL SPRAYING

Meurer-Hopfelt Process. Metal-Spraying Machines (Die Metallspritzmaschine), M. Meurer. Autogene Metallbearbeitung, vol. 14, no. 11, June 1, 1921, pp. 159–166, 6 figs. Describes two types of the Meurer-Hopfelt machines, the one, used for cleaning as well as metallization, operates without heating of parts; the other, for metallization only, requires heating of metallizing drum and preheating of workpieces.

METALS

Calorizing. Protection of Metals by Calorizing (La Protection des Metaux Par la Calorisation). Le Génie Civil, vol. 79, no. 6, August 6, 1921, pp. 131–132, 3 figs. Discusses principles, advantages and difficulties of process.

MILLING MACHINES

Pressures Exerted by Cutters. Determining Pressures Exerted by Cutters. Can. Machy., vol. 26, no. 4, July 28, 1921, pp. 33 and 35, 3 figs. Describes device indicating pressures exerted on various parts of milling machine.

MINE HAULAGE

Rope Testing. Testing Rope and Driving Pulleys During Inspection Journey on the Volkenroda and Pöthen Potash Mines (Prüfung von Seil- und Treibscheibe während der Betriebsfahrt auf den Kalizechen Volkenroda und Pöthen), E. Jahnke and W. Heilmann. Kali, vol. 15, no. 14, July 15, 1921, pp. 229–231, 8 figs. Results of measurements made in March 1921, are shown in diagrams.

MINE HOISTING

Electric. Determination of Electrical Equipment for a Mine Hoist, Graham Bright. Min. & Metallurgy, no. 177, Sept. 1921, pp. 49–50. Discusses hoist calculation methods and selection of proper type of electrical equipment. (Abstract.) Paper read before Am. Inst. Min. & Metallurgical Engrs.

Electric Winding: Its Advantages and Economy A. B. MacLean. Mech. Wld., vol. 52, no. 1807, August 19, 1921, pp. 149–150. Discusses two cases in which cost of steam winding has been accurately obtained and wherein the steam conditions are typical of the locality. Abstract paper read before Assn. Min. Elec. Engrs.

Koepe Sheave. A Special Method of Replacing the Rope on a Koepe Sheave (Ein besonderes Verfahren des Auswechselns eines Koepe-Seils), A. Noack. Berghau, vol. 34, no. 23, June 9, 1921, pp. 651–654, 2 figs. Describes method which can be employed with aid of steam cable and friction-gear winches, the only machine equipment required being the hauling engine and a small hand winch.

Rope Joints and Clamps. Rope Joints and Clamps (Seilverbindungen und Seilklammern), Karl Micksch. Bergbau, vol. 34, no. 24, June 16, 1921, pp. 685–688, 14 figs. Discusses various types.

MOLYBDENUM STEEL

Uses. Molybdenum Steel Uses Increase, M. H. Schmid. Iron Trade Rev., vol. 69, no. 9, Sept. 1, 1921, pp. 559–561. Use in manufacture of automobiles and other applications. Tests show properties of various alloys. (Abstract.) Paper presented before Am. Soc. for Steel Treating.

MONEL METAL

Impact Tests. Note on Notched Bar Impact Tests and Toughness of Monel Metal, R. G. Waltenberg, Chem. & Met. Eng., vol. 25, no. 8, August 24, 1921, pp. 322–323. Gives details of Charpy and Izod tests.

MOTOR BUSES

Railway-Track. Motor Omnibus For Railway Service. Tramway & Ry. Wld., vol. 50, no. 9, August 18, 1921, pp. 70–71, 4 figs. Built by J. G. Brill Co. for Chesapeake Western R. R. Is a one-man bus.

MOTOR-TRUCK TRANSPORTATION

Comparison with Railways. The Motor Truck and the Railroad, Rollin W. Hutchinson. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 131– [illegible]

MOTOR TRUCKS

English. A Remarkable New Transport Vehicle. Motor Transport, vol. 33, no. 860, August 22, 1921, pp. 200–201, 2 figs. Describes a transport truck made by Haulage Improvements & Constructions, Ltd., Lond.

Steam. The Clarkson Steam Lorry. Engineering, vol. 112, no. 2903, Aug. 19, 1921, pp. 275–278, 12 figs. New type of vehicle which burns coke. Details of engine, boiler, etc.

N

NITROGEN

Fixation. Commercial Production of Atmospheric Nitrogen, by the Flaming Electric Arc (Lo Sfruttamento Industriale dell'Azoto Atmosferico, per Mezzo dell'Arco Elettrico a Fiamma). Il Forno Elettrico, vol. 3, no. 4, April 15, 1921, pp. 51–56, 3 figs. Describes arrangement using high-tension a.c. and d.c. electromagnet. (Concluded.)

Supplementary Report on Nitrogen Products. Chem. Age, vol. 5, no. 112, August 6, 1921, pp. 148–151. Discusses progress of fixation of nitrogen in various countries.

Recovery by Activated Sludge Process. Nitrogen—with Special Reference to Activated Sludge, Gilbert J. Fowler. Eng. News-Rec., vol. 87, no. 8, Aug. 25, 1921, p. 311. (Abstract.) Monograph entitled The Conservation of Nitrogen with Special Reference to Activated Sludge, comprising Dec. issue of Jl. Inst. of Sci., Bangalore, India.

O

OIL ENGINES

Double-Acting Two-Stroke Marine. The First Motor Ship with Double-Acting Two-Stroke Engines, R. Dreves. Engineer, vol. 132, no. 3425, Aug. 19, 1921, pp. 191–192, 1 fig. Describes engines installed on twin-screw cargo vessel, Fritz, having three working cylinders of 480 mm. diam. and 710 mm. stroke, and developing 830 brake hp. at 120 r.p.m. Account of trial trips with ship which was delivered to England in November 1919, according to terms of Peace Treaty.

Marine. Some Observations on Marine Oil Engines, D. M. Shannon. Mech. Wld., vol. 52, no. 1807, August 19, 1921, pp. 143–144, 11 figs. Discusses Diesel and hot-bulb engines. (To be continued.) From paper read before Inst. Mar. Engrs.

Opportunity of. Waste of Coal and Oil Fuel. Gas & Oil Power, vol. 16, no. 191, August 4, 1921, pp. 165–167, 2 figs. Discusses opportunity of the small oil and the Diesel engine.

OIL FIELDS

Mexico. Mexican Oil Fields, L. G. Huntley and Stirling Huntley. Min. & Metallurgy, no. 177, Sept. 1921, pp. 27–32, 3 figs. Survey of producing, areas, known reserves, and geological factors which point to important development.

OIL SHALES

Esthonia. The Oil Shales in Esthonia (Ueber die Oelschiefer in Estland), C. Gäbert. Braunkohle, vol. 19, nos. 48 and 49, Mar. 12 and 17, 1921, pp. 597–610 and 613–625, 26 figs. partly on supp. plate. Large stretches of bituminous shales occur in slight depths in the rock foundations of Esthonia. Bibliography. General geological and topographical conditions. Chemical and technical conditions.

Rocky Mountains. Notes on the Oil-Shale Industry With Particular Reference to the Rocky Mountain District, M. J. Gavin, H. H. Hill and W. E. Perdew. Reports of Investigations Dept. of Interior Bur. of Mines, Serial no. 2256, June 1921, 36 pp., 2 figs. Discusses mining, retorting, refining in Scotland and in U. S.

Thermal Decomposition. The Thermal Decomposition of Oil Shales—II, Ralph H. McKee and E. E. Lyder. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 678–684, 3 figs. Determination of heat of reaction involved in their thermal decomposition. Results of experiments show that decomposition takes place between 400 and 410 deg. cent.

OIL WELLS

Production. Some Principles Governing the Production of Oil Wells, Carl H. Beal and J. O. Lewis. Petroleum Times, vol. 6, no. 135, August 6, 1921, pp. 183–185. Discusses natural and artificial influences in yield of wells. (To be continued.)

OILS

Soy-Bean. Soy-Bean Oil: Factors Which Influence Its Production and Composition, Carl R. Fellers. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 689–691. Discusses physical and chemical properties, oil and protein content, and effect of planting date on composition.

OPEN-HEARTH FURNACES

Gas-Fired. The Heating of Open-Hearth Furnaces with a Mixture of Lignite-Briquet and Blast-Furnace Gas (Die Beheizung von Martinöfen mit einem Gemisch von Braunkohlenbrikett- und Hochofengas), Fritz Boettcher. Stahl u. Eisen, vol. 41, no. 30, July 28, 1921, pp. 1027–1030, 4 figs. It is shown that smelting with such mixture is possible under given conditions. The producer must be operated

as slowly and as cold as possible, and the furnaces must permit of transmission of larger quantities of gas through furnace space with greater speed.

OXY-ACETYLENE CUTTING

Radiograph and Oxygraph Machines. Oxy-Acetylene Cutting Machines. Engineering, vol. 112, nos. 2903, 2904 and 2905, Aug. 19, 26 and Sept. 2, 1921, pp. 274–275, 307–311 and 356–357, 30 figs. Constructed by Davis-Bournonville Co., Jersey City N. J. Aug. 19: Details of the radiograph machine for cutting metal up to 20 or 22 in. thick in straight lines or to circular profiles. Aug. 26 and Sept. 2: The oxygraph machines nos. 1A and 2A.

P

PAINTS

White Lead. White Lead in Painting. Engineering, vol. 112, no. 2904, Aug. 26, 1921, pp. 323–324. Outline of statement issued by London Chamber of Commerce entitled Case Against Prohibition, in connection with subject to be discussed at Int. Labor Conference at Geneva, Oct. 25 on the prohibition of use of white lead in painting.

PATENT LAWS

Needed Improvements. The Patent Situation, Edwin J. Prindle. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 417–419. Claims that inadequate salaries and insufficient personnel are causes of waste in patent office for which industry must pay in costly delays and burdensome litigation. Analysis of legislation designed to remedy situation.

PEAT

Production and Refinement. New Methods and Future Problems in the Peat Industry (Neue Wege und Zukunftsaufgaben der Torfindustrie), H. R. Trenkler. Feuerungstechnik, vol. 9, no. 20, July 15, 1921, pp. 185–186. Discussion of modern processes for recovery and refinement of peat, based on papers by Karl Birk presented before Soc. for Promotion of Moor Coal Cultivation.

PETROLEUM

Distillation. Mineral Oil Distillation. Petroleum Wld., vol. 18, no. 251, August 1921, pp. 313–320, 4 figs. Discusses questions of dephlegmation and preheating. (To be continued.)

Galicia. Galician Oil (Il Petrolio Galiziano), L. Maddalena. Revista Tecnica delle Ferrovie Italiane, vol. 19, no. 6, June 15, 1921, pp. 171–180, 2 figs. Discusses geology and resources, conditions of industry, and Italian interests in Galician oil.

Refining. Minimizing Heat Losses in Oil Refining. Min. & Oil Bul., vol. 7, no. 9, August 1921, pp. 537–539 and 563, 4 figs. Discusses high-temperature heat insulators as applied to various stills.

The Refining of Petroleum, C. K. Francis. Min. & Oil Bul., vol. 7, no. 9, August 1921, pp. 524–528 and 563, 2 figs. Discusses fractional distillation, gasoline, naphtha, lubricating oils, wax, petrolatum, etc.

PHOTOMETERS

Reflectometers. The Ball Photometer as Reflectometer (Das Kugelphotometer als Reflektometer), R. Ulbricht. Zeit. für Beleuchtungswesen, vol. 27, no. 13–14, July 15–31, 1921, pp. 51–54, 3 figs. Notes on Taylor's portable reflectometer described in Elec. World (Sept. 4, 1920, p. 467), and author's own work, entitled the ball photometer, published by R. Oldenbourg, Münich and Berlin.

PIPE

Flange Joints. Jointing Material for Pipe Flanges (Etwas über Flanschen-Dichtungsmaterial). Elektrotechnischer Anzeiger, vol. 38, no. 93, June 14, 1921, pp. 627–630. Deals with different kinds of jointings for pipe flanges for steam and gases of high and low pressure and different temperatures, as well as for such liquids as water, oil, tar, acids, alkalis, etc.

PIPE LINES

Wood-Stave. Wood Pipe Lines in New England Hydroelectric Development. Elec. Rev. (Chicago), vol. 79, no. 8, August 20, 1921, pp. 265–268, 8 figs. Also in Eng. Wld., vol. 19, no. 2, Aug. 1921, pp. 77–80, 8 figs. Some data on recent wood-stave construction.

PISTONS

Light-Metal. Light Metal Pistons for Engines (Leichtmetallkolben für Motoren), R. Krüger. Oel- u. Gasmaschine, vol. 18, no. 7, July 1921, pp. 105–110, 7 figs. Notes on material, manufacture and life of aluminum pistons; pressing and casting processes; Dow-metal pistons.

Machining. Machining One Hundred Engine Pistons per Hour, J. H. Moore. Can. Machy., vol. 26, no. 6, August 11, 1921, pp. 25–27, 12 figs. Examples of work produced including valve stem guide, engine valve cage, etc.

PLANERS

Mechanical Reversing Drive. A Mechanical Reversing Drive for Planing Machines. Engineer, vol. 132, no. 3422, July 29, 1921, pp. 124–125, 3 figs. Details of the Newton-Derby patented reversing drive.

Newton Planer Reversing Drive. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 515–517, 4 figs. Application of epicyclic reduction gearing.

POWER PLANTS

Developments. Developments in Power Station Design—V. Engineer, vol. 132, no. 3425, Aug. 19, 1921, pp. 190–191, 4 figs. Details of the Bettington boiler arranged for burning pulverized coal, constructed by Fraser & Chalmers, Ltd.

Hershey Chocolate Co. Hershey Chocolate Company's New Power Plant. Power, vol. 54, no. 4, July 26, 1921, pp. 124–131, 8 figs. Plant laid out for 7500 kw. at 80 per cent power factor, in four 2300-volt units, and ten water-tube boilers each having 7444 sq. ft. of heating service. Two 1250-kw. 80-per cent power-factor turbo generators and four boilers installed. Bleeder-type turbines are used and equipped with surface condensers.

Industrial. Industrial Power-Plant Data. Power, vol. 54, no. 4, July 26, 1921, pp. 139–140. Census figures from 26 states covering primary power in manufacturing establishments.

Seward, Pa. Power Plant Designed to Meet Conditions in Coal-Mining District, W. P. Gavit. Power, vol. 54, no 8, Aug. 23, 1921, pp. 278–286, 12 figs. Seward power station of Penn Public Service Corp. designed for 100,000 kw.; 40,000-kw. installed in two 20,000-kw. units. Boilers contain 16,000 sq. ft. of heat surface each. Automatic control of boiler operation.

PRECIPITATION

Electrical. Eliminating Waste and Nuisance in Smoke, Fume and Gas, P. E. Landolt. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 428–432, 6 figs. Notes on electrical-precipitation methods in metallurgical, and chemical industries, and in other fields. Costs. Bibliography.

Extracting Flue Dust Electrically, N. H. Gellert. Iron Trade Rev., vol. 69, no. 2, July 14, 1921, pp. 102–105, 3 figs. Describes principle involved in precipitating dust by Cottrell process and method of operating an electrolytic cleaner. Comparison of various types of gas-cleaning equipment. (Abstract.) Paper presented before Assn. Iron & Steel Elec. Engrs.

PRESSES

Safeguarding. Safety Devices for Power Presses. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1106–1109, and vol. 28, no. 1, Sept. 1921, pp. 40–42, 16 figs. Guards and safety measures provided for power-press equipment in Cleveland Metal Products Co.'s plant, Cleveland, Ohio.

PRESSWORK

Tools. An Interesting Press Job. Eng. Production, vol. 3, no. 47, Aug. 25, 1921, pp. 173–174, 10 figs. Tools for producing curtain holders.

PROFIT SHARING

British Plan. British Plan of Profit Sharing, T. Sington. Am. Gas Jl., vol. 115, no. 8, August 20, 1921, pp. 165–166. Discusses method adopted by gas companies.

PULVERIZED COAL

Advantages and Disadvantages. Pulverized Coal Firing (Allgemeines über Staubkohlenfeuerung), H. Richarz. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 15, Apr. 15, 1921, pp. 113–116. Nature and useful scope, advantages and disadvantages. Bibliography. (Abstract.) Address before Soc. German Engrs.

Boiler Firing. Firing With Pulverized Coal (Le Chauffage au Charbon Pulvérisé), Paul Frion. Chaleur et Industrie, vol. 2, no. 15, July 1921, pp. 433–439. Discusses application of pulverized coal for furnaces and steam generator, also its drawbacks and dangers. (Concluded.)

Use of Pulverized Coal in Steam Power Plants, H. A. Reichenbach. Elec. Rev. (Chicago), vol. 79, no. 8, August 20, 1921, pp. 261–264, 5 figs. Method employed in handling and preparing fuel for delivery to furnace. Pipe line used to convey pulverized coal 1000 ft. Some tests results with anthracite silt and bituminous coal.

Work of the Commission For Fuel Utilization (Travaux de la Commission d'Utilisation des Combustibles), Paul Frion. Bulletin de la Société d'Encouragement pour L'Industrie Nationale, vol. 133, no. 5, May 1921, pp. 477–507. Report of third sub-committee. Firing with powdered coal. Report on investigation for and against use of powdered coal, recommending its use where suitable.

Gasification. A New Method for the Gasification of Pulverized Coal (Ein neues Verfahren zur Staubkohlenvergasung), K. M. Balley. Chemiker-Zeitung vol. 45, no. 99, Aug. 18, 1921, pp. 789–790, 2 figs. Describes method, its application and operation of plant.

Power Stations. Developments in Power Station Design. Engineer, vol. 132, nos. 3420, 3421, 3423 and 3424, July 15, 22, Aug. 5 and 12, 1921, pp. 70–71, 90–91, 142–144 and 162–163, 11 figs. Notes on by-products and waste heat, and pulverized coal. Different types of pulverized fuel plants, installed in English and American power plants.

Pulverizing Machine. The "Atritor" Coal Drying and Pulverizing Machine. Engineer, vol. 132, no. 3423, Aug. 5, 1921, p. 150, 1 fig. Details of new machine recently installed in cement works in Midlands, England. Advantages.

PUMPS, CENTRIFUGAL

Electrically Driven. Recent Installation of Centrifugal Pumps in Brockton Sewage Pumping Station, E. F. Leger. Am. City, vol. 25, no. 3, Sept. 1921, pp. 185–190, 2 figs. Transition from original pumping equipment of triple-expansion, steam-driven reciprocating pumps to electrically driven centrifugal pumps for pumping city sewage.

PYROMETERS

Optical. A Simple Optical Pyrometer (Ein einfaches optisches Pyrometer), H. Lux. Glasers Annalen für Gewerbe u. Bauwesen, vol. 89, no. 1, July 1, 1921, pp. 13–14, 2 figs. The Lummer-Kurlbaum pyrometer.

R

RAILS

Rerolling Discarded Steel. Rerolling Discarded Steel Rails, John D. Knox. Iron Trade Rev., vol. 69, no. 4, July 28, 1921, pp. 226–231, 10 figs. Practice as followed by Sweet's Steel Co. in preparing broken sections for mills. Description of plant.

RAILWAY ELECTRIFICATION

Advantages. The Electrification of Main Line Railways in Relation to Traffic Working, Philip Nash. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 194–202 and (discussion) pp. 202–207. Discusses pros and cons of electricity and steam for freight haulage.

Germany. History of the Electrification of the Former Prussian-Hessian State Railways (Geschichte der elektrischen Zugförderung auf den ehemaligen preussisch-hessischen Staatseisenbahnen), Karl Trautvetter. Archiv für Eisenbahnwesen, nos. 3 and 4, May-June and July-Aug., 1921, pp. 582–595 and 793–812, 10 figs. History of development and progress since 1896.

RAILWAY MOTOR CARS

Gasoline. Petrol Rail Cars for India. Engineer, vol. 132, no. 3419, July 8, 1921, pp. 44–45, 5 figs. Describes 2-ft. 6-in.-gage 50-hp. petrol cars built for Kalka-Simla Railway by Drewry Car Co., Ltd., London.

RAILWAY OPERATION

Automatic Train Control. Problems of Automatic Train Control. Ry. Engr., vol. 42, no. 499, August 1921, pp. 311–315. Discusses various problems and cost of installation, principles of communication, etc.

Ceylon. The Ceylon Government Railways—II. Ry. Gaz., vol. 35, no. 6, August 5, 1921, pp. 257–258. Abstract from British government report on administration and working of railroad. (To be concluded.)

Economics. Economics of Railway Transport, and Methods of Raising Revenue, J. George Beharrell. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 218–232, 7 figs. Discusses density of traffic, revenue and costs, rate-fixing machinery, commodity ton miles, etc.

Slow-Freight Traffic. On the Question of Slow Freight Traffic, U. Lamalle. Bul. International Ry. Assn., vol. 3, no. 7, July 1921, pp. 857–884, 10 figs. Discusses freight wagons, organization of train services, influence of rating on working capacity of rolling stock.

Trains over One-Way Divisions. The Operation of Trains over One-Way Divisions (Der Zuglauf bei Bahnen mit nur in einer Fahrrichtung benutzten Streckengleisen), H. Gaede. Archiv für Eisenbahnwesen, nos. 1, 2, 3 and 4, Jan-Feb., Mar-Apr., May-June and July-Aug., 1921, pp. 52–95, 358–386, 535–563, and 765–792, 38 figs. Author seeks to formulate the most important laws governing operation of trains on one-way divisions. Bibliography.

RAILWAY REPAIR SHOPS

Methods. Railway Machine Shop Practice. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1098–1099, 5 figs. Methods of procedure in making common types of repairs that are required on passenger and freight cars.

Tools. Forge Shop and Other Railroad Shop Tools, Frank A. Stanley. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 354–356, 11 figs. Tools and methods in use in western railroad shop. Special equipment to utilize air. Modern method of cleaning castings.

RAILWAY SHOPS

Lincoln, England. The Works of Clayton Wagons Limited, at Lincoln. Ry. Gaz., vol. 35, no. 6, August 5, 1921, pp. 251–255, 7 figs. Describes new works laid out for economical construction of railway rolling stock.

RAILWAY SIGNALING

Automatic. The Automatic Signaling Installation of the Berlin Electric Underground Railway and Certain Types of Pilots (Die selbsttätige Signalanlage der Berliner Hoch- und Untergrundbahn nebst einigen Vorläufern), G. Kemmann. Zeit. für Kleinbahnen, vol. 27, nos. 11 and 12, Nov. and Dec. 1920, pp. 392–402 and 438–457, 24 figs. partly on supp. plates. Nov.: Details of the separate parts of interlocking plant (Westinghouse system): illuminated signal boards; the d.c. relay; and the d.c. lamp signal box. Dec.: Safety installations in the Spittelmarkt station.

RAILWAY TRACK

Maintenance. Note on Mechanical Permanent Way Repairing Plant, M. Cartault. Engineering, vol. 112, no. 2903, Aug. 19, 1921, pp. 281–282. Describes use and mechanical equipment of the Collet system, in use since 1901 on Paris, Lyons & Mediterranean Ry. permanent way. Reprinted from Bul. Int. Ry. Assn.

Roadbed. On the Question of the Construction of the Road Bed and of the Track, Charles H. Ewing. Bul. International Ry. Assn., vol. 3, no. 7, July 1921, pp. 835–856, 11 figs. Discusses questions of ballasts, rails, tie plates, etc. and gives list of replies received from railway companies to a question blank

ENGINEERING INDEX (Continued)

RAILWAY YARDS

Illumination. Correct Illumination of Railway Freight Yards, J. H. Kurlander. Ry. Elec. Engr., vol. 12, no. 8, August 1921, pp. 299–306, 13 figs. Also in Ry. Age, vol. 71. no. 8, Aug. 20, 1921, pp. 337–340, 9 figs. Mounting height of lighting units is of prime importance in eliminating glare and obtaining best results. Bibliography.

REDUCTION GEARS

Heliocentric. The Heliocentric Reduction Gear. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 598–599, 3 figs. Describes new type of speed-reducing gear invented by W. C. Pitter and manufactured by Central Gear Co., Lond.

REFRACTORIES

Jointing Materials for. Notes on Jointing Materials for Refractories, L. Bradshaw and W. Emery. Gas Jl., vol. 155, no. 3036, July 20, 1921, pp. 157–159, 1 fig. Discusses jointing materials for refractories and influence of oxidizing and reducing atmospheres on refractory materials.

REFRIGERATING PLANTS

Electric-Motor Drive. Electric Motors for Driving Refrigeration Plants—Their Types, Characteristics, and Selection. W. H. Motz. Power, vol. 54, no. 6, Aug. 9, 1921, pp. 208–211, 5 figs. Discusses use of compound and synchronous motors.

Fish Refrigeration. New and Convenient Arrangement for Refrigerating Large Quantities of Fish (Un Dispositif Pratique et Nouveau Pour la Congélation de Grandes Masses de Poissons), Georges Delhoste. L'Outillage, vol. 219, no. 31, August 4, 1921, pp. 841–843, 7 figs. Describes unique installation, property of British Government.

REFRIGERATING MACHINES

Carbon-Dioxide. Refrigerating Machines (Machines Frigorifiques), A. Rullier. Arts et Métiers, vol. 74, no. 8, May 1921, pp. 150–153, 5 figs. Describes recent improvements in CO_2 machines.

ROLLING

Non-Metallic Products. The Rolling of Non-Metallic Products, Morris A. Hall. Raw Material, vol. 4, no. 8, August 1921, pp. 273–278, 9 figs. Discusses kinds of rolls in use in paper, textile and other non-metallic industries.

ROLLING MILLS

Homecourt, France. Completes French Rolling Mills. Iron Trade Rev., vol. 69, no. 8, Aug. 25, 1921, pp. 480–483, 5 figs. Pittsburgh company builds 44-in. reversing blooming mill, 48-in. universal plate mill and auxiliary machinery to be installed in plant at Homecourt. Description and layout of equipment.

Roll Making. How Steel Mill Rolls Are Made—II, H. E. Diller. Foundry, vol. 49, no. 16, August 15, 1921, pp. 631–638, 15 figs. Discusses metallurgy, melting and casting practice.

Making Rolls for Steel Mills, H. E. Diller. Iron Trade Rev., vol. 69, nos. 7 and 9, Aug. 18 and Sept. 1, 1921, pp. 419–424 and 432 and 547–554, 25 figs. Aug. 18: Different types of melting furnaces preferred for steel, chilled-iron hot, and chilled cold rolls. Sept. 1: Methods of molding steel and sand-cast rolls. How proper allowance for shrinkage is made in determining size and shape of chills.

Sheet Mills. Builds New Sheet Mill in East, E. C. Kreutzberg. Iron Trade Rev., vol. 69, no. 2, July 14, 1921, pp. 89–91, 5 figs. Plant in Baltimore designed for annual output of 70,000 tons of full finished stock. Labor-saving devices.

ROOFS

Tile. The Neupert Cantilever Tile Roof (Das Neupertsche freitragende Ziegeldach), H. Nitzsche. Beton u. Eisen, vol. 20, nos. 9–10 and 11, June 4 and July 4, 1921, pp. 108–111 and 127–128, 14 figs. Brief description of construction system with hollow brick, supporting capacity of which was confirmed by test load carried out by author in 1919. Static calculation of roof.

RUBBER

Technology. Rubber—From the Sap to the Finished Product, W. H. Holmes. Raw Material, vol. 4, no. 8, August 1921, pp. 281–289, 8 figs. Discusses principal rubber products: washing, drying and grinding machines; rubberized cloth; waterproofing, etc.

Vulcanization. Accelerators for Vulcanizing (Les Accélérateurs de la Vulcanisation), A. Neef. Révue Universelle des Mines, vol. 9, no. 1, S. 6, April 1, 1921, pp. 51–56. Discusses variety of organic accelerators in vulcanizing of rubber, their action, and future of process.

Vulcanized, Hardness of. The Modulus of Hardness of Vulcanized Rubber, H. P. Gurney. Jl. Ind. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 707–712, 11 figs. Describes spring type and dead weight type of instruments for determining hardness.

S

SAFES

Reinforced-Concrete. The Thörig Reinforced-Concrete Safes Without Iron or Steel Casing (Kassenschränke aus bewehrtem Beton ohne Eisen- oder Stahlummantelungen nach "Bauweise Thörig"). Beton u. Eisen, vol. 20, no. 7–8, May 4, 1921, pp. 81–84, 14 figs. Describes patented system, according to which body of safe and door are made in iron forms as a monolithic whole, whereby outside and inside iron or steel linings are entirely eliminated and use of iron is otherwise reduced to a minimum. Use of reinforced concrete in place of iron is said to greatly increase safety against burglary.

SAND BLAST

Automobile Construction. The Use of Sand Blasts in the Construction of Automobiles and Engines (Die Verwendung von Sandstrahlgebläsen im Kraftwagen- und Motorenbau), W. Kaempfer. Motorwagen, vol. 24, no. 15, May 31, 1921, pp. 297–302, 13 figs. Enumerates purposes for which sand-blasting can be used in construction of automobiles and engines; and describes three different systems, the suction, gravity and pressure system.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCRAP

Losses, Regulating. Regulating Losses from Scrap, Herbert R. Simonds. Iron Trade Rev., vol. 69, no. 3, July 21, 1921, pp. 157–161, 10 figs. Distinguishing between avoidable and unavoidable waste. Change in design often reduces scrap loss. Proper marketing.

SEAPLANES

Fairey Type III D. The Fairey Type IIID Seaplane. Flight, vol. 13, no. 33, August 18, 1921, pp. 552–557, 27 figs. Describes 360 hp. Rolls-Royce "Eagle" engine.

[See also FLYING BOATS.]

SEARCHLIGHTS

Anti-Aircraft. Tactical Organization and Employment of Anti-Aircraft Searchlights, John S. Pratt. Jl. U. S. Artillery, vol. 55, no. 2, August 1921, pp. 102–170, 24 figs. Discusses desirable characteristics, protection and concealment, night bombing flights, anti-aircraft defense, etc.

SEMI-DIESEL ENGINES

Operation. Semi-Diesel Engines (Les Moteurs Semi-Diesel). La Nature, no. 2463, June 18, 1921, pp. 395–398, 2 figs. Describes method of working generally and combustion chamber in particular.

SLAG

Blast-Furnace. Methods of Preparing Blast Furnace Slag. Iron Age, vol. 108, no. 8, Aug. 25, 1921, pp. 461–463, 4 figs. Divided into four classes by Carnegie Steel Co. according to specific use to which it is to be put.

SLOTTING

Machines for. Slotting Operations on Production Work. Machinery, (Lond.), vol. 18, no. 464, August 18, 1921, pp. 604–609, 12 figs. Discusses vertical planing, shaping, slotting and keyseating operations.

Slotting Operations on Production Work, Edward K. Hammond. Machy. (N. Y.), vol. 27, no. 12, Aug. 1921, pp. 1117–1122, 11 figs. Tooling up slotters and keyseaters for performance of vertical planing, shaping, slotting, and keyseating operations.

SPRINGS

Leaf. Formulas for Calculating Leaf Springs (Détermination de Formules Pratiques Pour le Calcul des Ressorts a Lames), H. Chaullet. Arts et Métiers, vol. 74, no. 8, May 1921, pp. 145–149, 7 figs. Works out formulas for various kinds.

STANDARDIZATION

German N. D. I. Report. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 20, July 10, 1921, pp. 299–315, 23 figs. Proposals of Board of Directors for cotters; round threads; hexagonal and square-head bolts and nuts, carriage and countersunk bolts, lag screws, etc. Proposed standards for double anchor plates for T-head anchor bolts; wall anchor plates; T-head bolts; square nuts for anchor bolts, paper sizes, etc.

STANDARDS

Limit Dimensions. Determination of the Required Allowance Dimensions for Various Cylindrical Machine Parts (Feststellung der erforderlichen Passmasse für die verschiedenen Fabrikate), W. Kühn. Werkstattstechnik, vol. 15, no. 14, July 15, 1921, pp. 421–426, 7 figs. Notes on practical application of limit dimensions established by German Industry Committee on Standards (NDI).

STEAM

Dissociation. Steam Dissociation and Steam Jet Blowers in Theory and Practice (Wasserdampfzerfall und Dampfstrahlgebläse in Lehre und Anwendung), Hch. Doevenspeck. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 14, Apr. 8, 1921, pp. 105–108, 2 figs. Points out that from practical standpoint the problem of turbo-blowers has not yet been solved, whereas the electric motor in boiler-room operation has proved to be both safe and economical.

Flow in Pipes. Convenient Tables for Steam Flow in Pipes, V. F. Davis. Power, vol. 54, no. 4, July 26, 1921, pp. 144–145. Table giving steam flow in pounds per minute for 100-ft. pipe and 1-lb. pressure drop; and factors to be applied to table for various lengths and pressure drops.

Specific Heat. Measurements of the Specific Heat of Steam and Its Technical Importance (Die bisherigen Messungen der spezifischen Wärme des Wasserdampfes und ihre technische Bedeutung), H. Schmolke. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 1 and 2, Jan. 7 and 14, 1921, pp. 3–4 and 12–13. History of development of investigations culminating in work of G. Eichelberg published in 1920.

STEAM ENGINES

Still Steam-Gas Type. The Still Engine (Der Still-Motor), H. Schuster. Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 16, Apr. 22, 1921, pp. 121–123, 3 figs. Discusses the Still combination internal-combustion and steam engine and prospects of its use for locomotive drive.

Uniflow. A Uniflow Engine Set at Slough. Elec. Times, vol. 60, no. 1556, August 11, 1921, pp. 123–124, 2 figs. Consists of Sulzer horizontal single-cylinder Uniflow direct-coupled to Oerlikon three-phase a.c. generator.

STEAM PIPING

Flange Blanks. Safety Flange Blanks (Sicherheitsflanschstücke). Der praktische Maschinen Konstrukteur, vol. 54, no. 23, June 9, 1921, p. 181, 3 figs. According to arrangement devised by Eisenberg & Schmöger, Dortmund, Germany, the cleaning or repairing of a battery can be effected without removing connecting pipe between boiler and collector, by adjusting between boiler and collector a pipe section as valve casing.

Reducing Costs of. Saving Effected Through Use of Valves with Low Resistance (Ersparnisse durch Verwendung von Absperrvorrichtungen mit geringem Einzelwiderstand), Karl Schmidt. Zeit, für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 13, Apr. 1, 1921, pp. 97–101. It is shown how, under otherwise uniform conditions, installation and operating costs of pipe lines can be reduced when the separate resistance of the installed construction parts (especially the valves) are diminished.

STEAM TURBINES

Heating Steam from. Non-Condensing Turbine Operation on Heating Load, R. D. DeWolf. Power, vol. 54, no. 6, Aug. 9, 1921, pp. 220–221, 2 figs. Decentralized plants or units to recover electrical energy from heating steam. It is proposed to limit attendance for these machines to periodic inspection. Paper presented before Nat. Dist. Heating Assn.

STEEL

Alloy. See ALLOY STEELS.

Classification Code. Universal Steel Classification Code, Horace C. Knerr and Arthur L. Collins. Iron Age, vol. 108, no. 9, Sept. 1, 1921, pp. 515–517. Proposed new code to supplant present S.A.E. system. Claimed to be simpler, more elastic and easily expanded.

Drill. Manufacture of Drill Steel from Hollow Ingots. P. A. E. Armstrong. Iron Age, vol. 108, no. 10. Sept. 8, 1921, pp. 596–598, 2 figs. Process used by Ludlum Steel Co. and its advantages. Abstract of paper read before Am. Inst. Min. & Metallurgical, Engrs., with additional details and illustrations.

Endurance. Relations Between The Physical Properties of Steels and Their Endurance of Service Stresses, James E. Howard. Trans. Am. Soc. for Steel Treating, vol. 1, no. 11, August 1921, pp. 673–682. Discusses state in which steel best meets the conditions of service.

Ingots, Welding Defective. Welding Defective Steel Ingots, H. Brearley. Iron Trade Rev., vol. 69, no. 5, Aug. 4, 1921, pp. 289–292. Discusses blow-holes and segregate effect. Explains test method for determining extent of interior influences. Method of casting ingot is said to regulate imperfections. Paper read before Iron & Steel Inst.

Molybdenum. See MOLYBDENUM STEEL.

Silicon Additions. Silicon Additions to Steel. Iron Age, vol. 108, no. 8, Aug. 25, 1921, p. 458l. Effect of early and late introduction on gas content and rolling discard. Translated from article by Piwowarsky in Stahl u. Eisen, June 10, 1920.

Tool. See TOOL STEEL.

STEEL CASTINGS

Electric vs. Open-Hearth Furnaces. Compares Costs of Melting Steel. Iron Trade Rev., vol. 69, no. 3, July 21, 1921, pp. 167–170, 3 figs. Producer of steel castings operating both an electric and an open-hearth furnace gives data covering the two processes from which estimated costs are calculated.

STEEL FOUNDING

Converter Flame Examination. Spectroscopic Examination of Converter Flame, W. J. Campbell. Engineer, vol. 132, no. 3423, Aug. 5, 1921, pp. 137–138. Notes on the spectroscope and advantage of its use for many classes of small foundry work. Table giving outline of average blow and its spectroscopic examination.

STEEL, HEAT TREATMENT OF

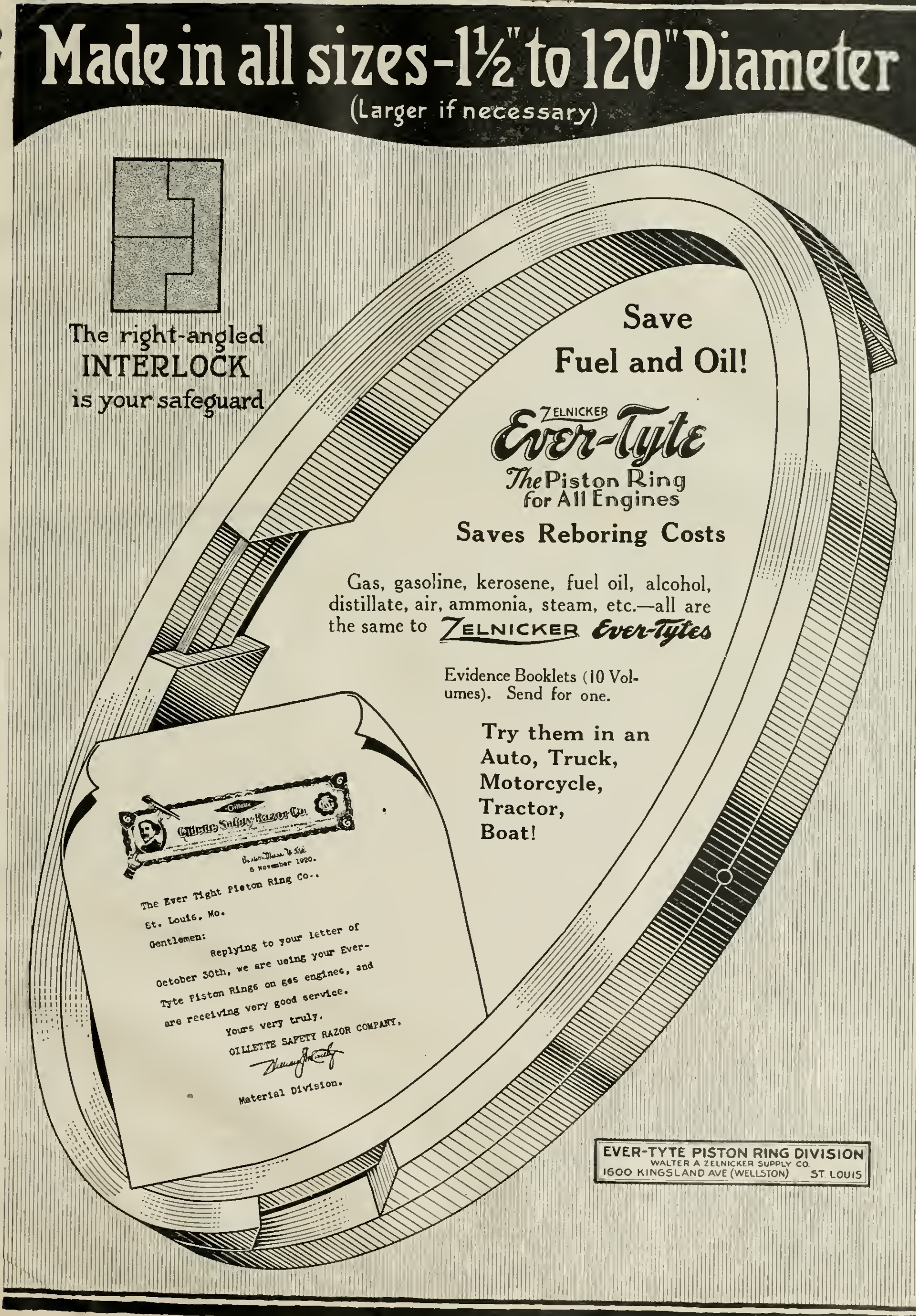
Effect on Fatigue Strength. Effect of Heat Treatment on the Fatigue-Strength of Steel, E. P. Stenger and B. H. Stenger. Trans. Am. Soc. Steel Treating, vol. 1, no. 11, August 1921, pp. 617–635 and (discussion) pp. 635–638, 15 figs. Discusses effect of cold rolling and cold drawing, also effect of carbon content.

Temperature and Quality. The Carbonizing Process—Relation of Temperature to Quality of Cast and Core, Theodore G. Selleck. Trans. Am. Soc. Steel Treating, vol. 1, no. 11, August 1921, pp. 655–666, 9 figs. Gives a number of heat-treatment curves.

STEEL MANUFACTURE

American vs. English Practice. British View of American Steel Making, R. Percival Smith. Iron Age, vol. 108, no. 10, Sept. 8, 1921, pp. 589–591. Blast-furnace and open-hearth practice compared. Coke-oven gas as a fuel. Rolling mills in United States and England. (Abstract.) Paper read before West of Scotland Iron & Steel Inst.

Bessemer Process. The Bessemer Process For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ENGINEERING INDEX (Continued)

Making Steel, Arthur P. R. Wadlund. Trans. Am. Soc. for Steel Treating, vol. 1, no. 11, August 1921, pp. 682–689, 1 fig. Shows that the basic process is much more expensive than the acid process.

STEEL WORKS

Economic Location. Chicago's Relation to the Future American Steel Industry, Gerard de Geer. Chem. & Met. Eng., vol. 25, no. 8, August 24, 1921, pp. 325–328. Analysis of economic location of a steel industry in view of modern practice in coal economy, diminishing ore territory, increasing amount of scrap used, and greater influence of freight on finished product.

SUPERHEATERS

Performance. Steam Superheaters, Arthur D. Pratt. Jl. Engrs. Club of Phil., vol. 38, no. 200, August 1921, pp. 291–299 and Discussion pp. 299–308. Discusses construction and performances.

SWAGING

Cold. Methods Employed in Making Swaging Dies. Machinery (Lond.), vol. 18, no. 461, July 28, 1921, pp. 503–505, 8 figs. Subject of cold swaging.

T

TANKS

Collapse of Boston Molasses Tank. Eng. News-Rec. vol. 87, no. 9, Sept. 1, 1921, pp. 372–373. It is claimed that collapse was due to great overstress of tank shell.

TEMPERATURE CONTROL

Apparatus. The "Samson" Automatic Temperature Regulator. Engineering, vol. 112, no. 2904, Aug. 26, 1921, p. 307, 1 fig. Applied for operating, steam, gas, oil or water valves, or for controlling electric switches, and for regulation of room temperatures.

TESTING MACHINES

Alternating-Stress. The Haigh Alternating Stress Testing Machine. Engineer, vol. 132, no. 3422, July 29, 1921, pp. 116–117, 6 figs. Details of improved form.

TEXTILES

Microscopy of. The Microscopy of Textiles, Frederick J. Hoxie. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 592–593, 3 figs. Notes on imbedding, sectioning and photographing. Points out that many irregularities in textile spinning, weaving and finishing, now a matter of mystery, can by photomicrographic records, be brought into realm of fact.

TIME STUDY

Drop-Forge Shop. Eliminating Unproductive Time in Industry. Eng. & Indus. Management vol. 6, no. 8, Aug. 25, 1921, pp. 205–207, 2 figs. Possible increase in production is emphasized by example of the drop-forge shop at Mare Island Navy Yard.

Human and Mechanical Elements of Work. Measuring the Human and Mechanical Elements in Manual Work, L. Arthur Sylvester. Indus. Management, vol. 62, no. 3, Sept. 1, 1921, pp. 141–144. Discusses natural relation between time and human labor.

Organization. How to Conduct a Time Study Organization, Chester D. Buoy. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 104–105. Notes on purpose of time-study department, and qualifications for a time-study man.

Standard Time. "Standard Time" in Planning and Production, Waldo Lyon. Management Engrg. vol. 1, no. 2, Aug. 1921, pp. 105–108, 5 figs. How it is used to eliminate delays, estimate output and compare results of machine and department operation.

Wooden Knife Handles. Time Studies on Wooden Knife Handles, Philip Bernstein. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 76–82, 11 figs. Author analyzes in detail operations on knife handles of various woods, data and conclusions being derived from actual experience.

TOOL STEEL

Specifications. Standardizing Specifications For Tool Steel, Charles M. Brown. Trans. Am. Soc. for Steel Treating, vol. 1, no. 11, August 1921, pp. 666–672. Discusses specifications in use, also content of tungsten, vanadium, phosphorus, sulphur, etc.

TRACTORS, FARM

Types. Mechanical Power in Agriculture (La Motoculture) F. Mirès. La Vie Technique & Industrielle, vol. 2, no. 23, Aug. 1921, pp. 401–409, 14 figs. Describes various types of tractors.

TRAIN HEATING

Electric Trains. Steam-Heating Electric Trains in Switzerland, William A. Rosenberger. Elec. Ry. Jl., vol. 58, no. 6, August 6, 1921, pp. 206–207, 2 figs. Single-phase current at 15,000 volts is applied directly to water in specially designed boiler.

TRANSPORTATION

Interdependence of Various Forms. Interdependence of the Various Forms of Transport, Philip Burtt. Jl. Inst. of Transport, vol. 2, no. 5, March 1921, pp. 233–247, 2 figs. Discusses ocean transport and railway traffic, light and heavy railways, inland waterways and other forms of transport.

TYPE-CASTING MACHINERY

Monotype. Building Type Casting Machinery. Eng. Production, vol. 3, nos. 46 and 47, Aug. 18 and 25, 1921, pp. 157–162 and 181–186, 27 figs. Methods in monotype factory of the Lanston Monotype Corp., Ltd.

V

VALVES

Gate, Electrically Operated. Electrical Operation of Gate Valves, Payne Dean. Fire & Water Eng., vol. 70, no. 8, Aug. 24, 1921, pp. 343–344, 4 figs. Value of quick electrical control through special devices. Description of control system.

Pump, Automatic. Investigation of Automatic Pump Valves and Their Effect on Performance of Pump (Untersuchung selbsttätiger Pumpenventile und deren Einwirkung auf den Pumpengang), Ludwig Krauss. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 233, 1921, 112 pp., 172 figs. Deals will all conditions occurring in practice in different types of valves, based on experiments on six different kinds, carried out in machine laboratory of Dresden Technical Acad. Bibliography.

VENTILATION

Duct Systems. The Meier Chart, A. C. Pallot. Domestic Eng., vol. 41, no. 32, August 1921, pp. 115–120, 3 figs. Describes method of designing ventilation duct systems.

Nozzle or Air-Duct. Comparative Tests with a Nozzle and Air-Duct Ventilators (Vergleichende Versuche mit einer Düse und Luttenventilatoren), O. Leidenroth. Gluckauf, vol. 57, no. 17, Apr. 23, 1921, pp. 391–393, 2 figs. Results of experiments with a jet blower and air-duct ventilator demonstrate superiority of former. Advantages of the described Höing nozzle.

VISCOSIMETERS

Gümbel. Determination of Absolute Viscosity with the Gümbel Viscosimeter (Zur Bestimmung der absoluten Zähigkeit mit dem Gümbelschen Zähigkeitsmesser), Ludwig Schiller. Zeit. für technische Physik, vol. 2, no. 2, 1921, pp. 50–52. Deals with apparatus developed by Gümbel and described in same journal (vol. 1, 1920, p. 72), and method of calculating absolute viscosity from velocity of flow through apparatus. Comparison with the Engler viscosimeter.

W

WAGES

Incentive vs. Production Basis. Incentive or Production Basis of Wage Payment—III, Henry H. Farquhar. Am. Mach., vol. 55, no. 9, Sept. 1, 1921, pp. 344–348, 3 figs. Assignment and recording of production; coöperation with workman; fitting system to conditions; coöperation of executives.

Premium System. The Premium Wage Payment, System, C. B. Lord. Management Eng., vol. 1, no. 2, Aug. 1921, pp. 108–110. Principles and advantages of Halsey premium system.

Rate Determination. An Analytic Method for Determing Wage Rates, Edward Peterson. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 146–148. Notes on determination of day-work and piecework rates.

WARFARE

Incendiary. Incendiaries in Modern Warfare, Part II, Arthur B. Ray. Jl. Indus. & Eng. Chem., vol. 13, no. 8, August 1921, pp. 714–722, 27 figs. Description of shells, bombs, flame projectors, etc.

WASTE ELIMINATION

Automatic Machinery, Use of. Eliminating Manufacturing Waste With Machinery, J. E. Hires. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 410–412. Recognition of importance of engineering research and extensive use of automatic machinery as means of eliminating wastes in labor, time and materials.

Industrial. The Elimination of Construction Wastes, George W. Burpee. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 394–396. Comprehensive dollars-and-cents analysis of preventable wastes in construction industries and thorough understanding of responsibility imposed upon contractor, owner, architect, engineer and workman.

Waste due to Poor Engineering and Management, Dexter S. Kimball. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 375–377. Sound engineering practice and competent management are said to be most effective methods of eliminating waste. Accurate cost records of what has been done should make possible prediction of improved results.

Metal Trades Industry. Waste in the Metal Trades Industry, Fred J. Miller. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 135–140, 4 figs. Abstract of field report on elimination of waste in industry based on studies in sixteen representative plants.

Research, Benefit of. The Role of Research in Waste Elimination, Harrison E. Howe. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 379–382. Encouragement of fundamental research in America said to be more urgently needed than stimulation of industrial research. Fallacy of curtailing research and disrupting organization in times of Industrial depression. Examples of waste eliminated by research.

WASTES

Industrial. Waste and Inefficiency in the Industries. Chem. & Metallurgical Eng., vol. 25, no. 9, Aug. 31, 1921, pp. 433–448. Series of short articles by industrial leaders featuring outstanding causes of waste in various industries. Frank confessions of inefficiency due to wide variety of causes.

WATCH MANUFACTURE

Machines for. Automatic Machines in a Watch Factory, Fred R. Daniels. Machy. (N.Y.), vol. 27, no. 12, Aug. 1921, pp. 1093–1097, and vol. 28, no. 1, Sept. 1921, pp. 25–29, 14 figs. Machines, devices and methods employed in plant of Waltham Watch Co., Waltham, Mass.

WATER POWER

Canada. Canada's Fuel and Water Power Problems. Engineer, vol. 132, no. 3418, July 1, 1921, pp. 4–6, 4 figs. (Abstract.) Statements respecting relation of water power to Canada's fuel problems, published by Dominion Water Power Branch of Can. Dept. of Interior. Examples of waste eliminated by research.

Water Powers of the Prairie Provinces, C. H. Attwood. Jl. Eng. Inst. Can., vol. 4, no. 8, Aug. 1921, pp. 437–440. Resources, administration and market.

Geology and. Geology and the Hydroelectric Utilization of Water Falls (La Géologie et l'Aménagement Hydroélectrique des Chutes d'Eau), W. Kilian. La Houille Blanche, vol. 20, no. 53–54, May-June 1921, pp. 81–90, 9 figs. Discusses cement work along the rivers. (Concluded.)

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Accurate Equipment. The Essentials of Weighing in Industry, Herbert T. Wade. Management Eng., vol. 1, no. 3, Sept. 1921, pp. 129–134, 8 figs. Points out dependence of industry upon weighing, and advantages of good weighing practice and equipment. An example of routine weighing.

WELDING

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[See also ELECTRIC WELDING; ELECTRIC WELDING, ARC; ELECTRIC WELDING, RESISTANCE.]

WELFARE WORK

Coöperative Stores. Food as a Factor in Industrial Morale, John T. Bartlett. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 83–88, 3 figs. It is claimed that the savings a coöperative store or farmers' market accomplish are equivalent to a wage increase.

Savings Plans. Thrift Encouragement by Employers—II and III, Leonhard Felix Fuld. Indus. Management, vol. 62, nos. 2 and 3, Aug. 1 and Sept. 1, 1921, pp. 93–94, and 139–140, Aug.: Discusses advantages of having employee authorize regular deductions from his pay, these deductions to be put into his savings account. Sept.: Bonus systems; savings and loan associations; the employer's position.

WIRE DRAWING

Dies for. Wire Drawing Dies With Connected Guides (Filières d'Étirage a Touches Rapportées), A. Catherine. L'Outillage, vol. 219, nos. 29 and 31, July 21 and Aug. 4, 1921, pp. 795–797, 12 figs., and 839–840, 8 figs. Describes improved methods of wire drawing and construction of guides.

Nail-Making Factory. Wire Drawing and Nail Manufacture. Eng. Production, vol. 3, no. 47, Aug. 25, 1921, pp. 175–177, 7 figs. Plan and methods of a Belgian Factory.

WIRE ROPE

Care of. Instruction in the Care, Uses, and Inspection of Flexible Steel Ropes, H. C. Boynton and W. Voigtlander. Jl. Engrs'. Club of Phila., vol. 38–7, no. 199, July 1921, pp. 274–279. Discusses production and treatment of steel, manufacture of wire rope lubrication and inspection.

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New Avenues of Employment. The New Place of Women in Industry—VI, Ida M. Tarbell. Indus. Management, vol. 62, no. 2, Aug. 1, 1921, pp. 106–108. Discusses new professions which have opened for women as outgrowth of expanding interest in personnel work.

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Drying. The Artificial Drying of Timber (Die künstliche Trocknung von Nutzhölzern), Otto Brandt. Der praktische Maschinen-Konstrukteur, vol. 54, no. 24, June 16, 1921, pp. 185–200, 23 figs. Notes on composition of wood and nature of wood drying; steaming; construction and equipment of dry kilns with forced hot-air circulation; plants for drying lumber loaded on cars; heat and air requirements for wood-drying plants; stacking of timber; artificial drying methods with electricity, by chemical means, and through cooling with aid of refrigerating plant.

WOOD PRESERVATION

Mine Timbers. Comparative Tests with Preservation Processes for Mine Timbers (Vergleichsversuche mit Imprägnierungsverfahren für Grubenholz), O. Dobbelstein. Glückauf, vol. 57, no. 26, June 25, 1921, pp. 601–607, 18 figs. Final report of special testing committee on investigation of wood impregnated in 1913 and 1914 and installed in two mines, which was examined annually for the five succeeding years.

WOODWORKING INDUSTRIES

Yield Values. "Yield Value" Variations in Woodworking, W. L. Churchill. Management Eng., vol. 1, no. 1, July 1921, pp. 17–21, 6 figs. How they affect profits due to sliding scale of lumber values.

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Contributors and Contributions

Boiler and Furnace Economy

D. S. Jacobus

Dr. David S. Jacobus, who writes on Boiler and Furnace Economy in this issue, at the present time acts as advisory engineer for The Babcock and Wilcox Company. Graduating from Stevens Institute in 1884 he was appointed assistant professor of experimental mechanics. The full professorship of experimental mechanics and engineering physics was conferred upon him in 1897 and he served in this capacity until 1906, when his relationship with The Babcock and Wilcox Company began. He received the honorary degree of Doctor of Engineering from Stevens Institute in 1906. Dr. Jacobus has written many scientific papers on engineering subjects and has been exceedingly active in engineering societies, especially in The American Society of Mechanical Engineers, which he served as president in 1915–16 and previously as manager and vice-president.

Heat Balance in Steam Power Plants

Four papers giving valuable data on steam power plant heat balance are published in this issue of Mechanical Engineering.

Ernest L. Hopping, who writes of the Delaware Station, is engineer of station mechanical design and construction for the Philadelphia Electric Company, having served with the company since 1911. His previous experience was gained mainly with various machine and engine constructors in Philadelphia where he worked on the design of locomotive parts, electric cranes, and stationary engines.

Charles W. E. Clarke, of the Dwight P. Robinson Company, presents data from Colfax Station. Mr. Clark received his early experience in Chicago. He designed several power and refrigerating plants for Armour and Company, and as chief draftsman for Sargent and Lundy was in charge of design, specification and construction work for installations aggregating 100,000 kw. in and near Chicago. From 1907 to 1910 he was in charge of mechanical engineering in the New York electrical zone for the New York Central Lines, and thereafter was associated with Stone and Webster in charge of a large number of power developments. Since 1919 Mr. Clarke has been associated with the Dwight P. Robinson Company.

John H. Lawrence, one of the co-authors of the Hell Gate Station paper, is a 1909 Cornell graduate and was in the service of the New York Edison Company in design and installation capacities until 1918. Since late in 1918 he has been in the employ of the Thomas E. Murray Co., at present holding the position of engineering manager.

Walter H. Keenan, Mr. Lawrence's collaborator, was graduated from Cornell in 1911 and was employed in laboratory research and design work by the New York Edison Company until 1919. He is a present assistant engineering manager for Thomas E. Murray Co.

Wastes in Handling Material

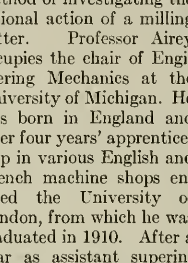
Harold V. Coes, who presents a timely paper on the principles involved in handling material economically, is manager for Ford, Bacon and Davis at Philadelphia. Mr. Coes, a graduate of Massachusetts Institute of Technology in 1906, has had broad experience in design and operation. He has been with Ford, Bacon and Davis since 1917.

On the Art of Milling

John Airey

Prof. John Airey and Carl J. Oxford present an exceedingly interesting method of investigating the rational action of a milling cutter. Professor Airey occupies the chair of Engineering Mechanics at the University of Michigan. He was born in England and after four years' apprenticeship in various English and French machine shops entered the University of London, from which he was graduated in 1910. After a year as assistant superintendent of a Swiss machine shop he came to America as instructor in engineering mechanics at Michigan, later acting as assistant professor and receiving the full professorship in 1919. During the war for nine months Professor Airey served as assistant inspector of munitions for the British Government and for two years was in charge of the engineering and mechanical department for the R. and V. Wagner Ordnance Company. He has made many contributions to the technical press.

Mr. Oxford was born in Norway and came to the United States in 1909. After two years in the engineering department at the University of Michigan, he served as tool draftsman with the Packard Motor Car Company, Dodge Brothers, and Nordyke and Marmon until 1916, when he became designing engineer for the Wilt Twist Drill Company. He entered the service of the National Twist Drill and Tool Company of Detroit in 1917 and is now chief engineer.



Carl J. Oxford

Wastes in the Machine Shop

James A. Smith, who contributes a paper on Salvaging Industrial Wastes, printed in this issue and to be presented at the Machine Shop Session of the A.S.M.E. Annual Meeting, is general superintendent of the Schenectady Works of the General Electric Company, with which concern he has been associated since January 1910. Previous to that he had eleven years' experience with the Pratt and Whitney Company and six years' service as superintendent of the Dutchess Tool Works at Fishkill-on-the Hudson.

MECHANICAL ENGINEERING

Volume 43 December, 1921 Number 12

Boiler and Furnace Economy

By D. S. JACOBUS,[1] NEW YORK, N. Y.

That it is possible to effect material savings in power plants is evident, according to the author, when it is considered that fifty or even a hundred per cent more fuel is burned in some cases than would be required by plants of the best economy. It does not follow, however, that it would pay to replace all plants of low efficiency by those having a higher efficiency. There are many factors which must be taken into consideration before deciding that a new investment is warranted, and each case must be considered individually in order to determine whether or not it will pay to replace an existing plant by one of more economical type, or to add apparatus to increase the efficiency.

The present paper accordingly deals with such questions as when it will pay to use economizers in a new plant; the most economical rating at which to operate a boiler; limitations imposed on efficiency by inability of furnace brickwork to withstand temperatures available with many classes of fuel; furnace volume and length of flame travel; where air heaters are of especial advantage; importance of employing properly trained men for boiler operation: information afforded by flue-gas analysis, etc., etc.

The author points out in closing that furnace and boiler design must be coordinated in order to secure the best results. It is impossible to separate the boiler efficiency from the efficiency of the stoker and furnace in such a way that the value obtained for the former will depend solely on the construction of the boiler and not be influenced through the construction of the stoker and furnace The stoker and furnace efficiency is influenced by the delayed or secondary combustion between the boiler tubes and this cannot be included in any analysis, neither can the loss due to excess air be correctly divided between the boiler and furnace.

THERE has been a steady improvement in the economy of power plants, on account of the increase in fuel costs and to keep pace with the advance in the art. Particular attention is now being given to savings in view of the economic struggle which appears to be before us. That material savings can be effected in power plants is plain when it is considered that 50 or even 100 per cent more fuel is burned in some cases than would be required by plants of the best economy. It does not follow, however, that it would pay to replace all plants of low efficiency by those having a higher efficiency. There are many factors which must be taken into account before deciding that a new investment is warranted and each case must be considered by itself in order to determine whether or not it will pay to replace an existing plant by one of more economical type, or to add apparatus to increase the efficiency. Adding an economizer will ordinarily add to the thermal efficiency; the same applies to an air heater, but in considering all features it may be found that the character of the load, the class of operation, and the fuel conditions are such that it will not pay to install an economizer or an air heater.

When It Will Pay to Use Economizers in a New Plant

In determining whether it will pay to use economizers in a new plant the problem should not be approached by comparing the efficiency of a boiler with that of the same boiler with an economizer added to it. The proper way is to compare the results to be expected from boilers best suited for the service without the addition of economizers, with the results to be expected from the best combination of boilers and economizers. It will sometimes be found for certain load conditions that a larger boiler properly designed and baffled will give better commercial returns, all features considered, than a smaller boiler with an economizer, or for that matter, than any boiler that can be selected with an economizer. In the case of an old plant, the question of whether or not it will pay to add economizers to the boiler is a simpler one to answer than for a new plant, as the added efficiency due to the economizers may be readily computed on the basis of the known flue-gas temperatures, gas weights, etc., but here again the load conditions must be taken into account, as well as the fact that there will be an increased cost of upkeep and added complication through the necessity of installing an induced-draft apparatus. For peak-load service where the peaks are of short duration, say an hour or so a day, it does not in most cases pay to install economizers on all of the boilers. A good arrangement may be secured for some classes of service by adding economizers to some of the boilers and operating them at a more nearly uniform load than the rest of the boilers, the boilers that have no economizers being held in reserve and cut in during the peak-load periods. Another case where it does not pay to apply economizers is where boilers are used for stand-by service. Where the operation is more or less continuous it pays in most cases to use economizers. The cost of fuel is a governing factor. The increase in fuel costs during the last few years has caused economizers to be used more generally than formerly and we are approaching more closely to European practice in the number of boilers fitted with economizers.

Increasing the Efficiency by Adding to Height of Boiler

In designing a boiler for use without an economizer additional efficiency may be secured by adding to the height of the boiler. Adding to the height of the boiler so as to increase it from, say, 14 tubes high to 20 tubes high, will result in a considerable increase in efficiency with but little increase in the draft loss. In many instances the higher boilers may be operated with natural draft at the desired capacity, thereby eliminating the added complication of the induced-draft apparatus that would be required for economizers. Of course, it would be impossible to operate a high boiler of the sort with natural draft at as high a percentage of rating as a lower boiler, as the flue-gas temperature at a given rating would be considerably lower than with the lower boiler, and this would reduce the amount of draft available from the stack.

Wrought-steel economizers are coming into use to a greater extent than formerly. We have learned how to prevent interior corrosion in a wrought-steel economizer by reducing the oxygen content of the feedwater with as low a temperature of feedwater as can be enployed in a cast-iron economizer. To avoid exterior corrosion through the condensation of moisture from the flue gases, the temperature of the feedwater to the economizer must be kept above a temperature of about 120 deg. fahr., and for most work 140 deg. fahr. is preferable, as this allows for some leeway in case the water is fed intermittently. There is more difficulty through exterior corrosion in intermittent service than where the service is more or less continuous, as soot which collects on the outside of the economizer is apt to become moist during the time that the economizers are down or are being started up, and the presence of moisture makes the soot from certain fuels highly corrosive. Coals having a high sulphur content give the most trouble through exterior corrosion, and with such coals the temperature at which the water is fed to the economizers should be somewhat higher than for coals having but little sulphur.

An Individual Economizer for Each Boiler

It is becoming more general practice to use an individual economizer for each boiler and not to install connections for by-pass-

[1] Advisory Engineer, The Babcock & Wilcox Co. Mem. Am.Soc.M.E.
For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. Copies of the paper may be obtained gratis on application. All papers are subject to revision.

depositing moisture and acid on the colder portions, and all of these features should be considered before deciding to use an air heater.

Importance of Employing Well-Trained Men for Operation of Boilers

Irrespective of how well a boiler plant may be designed, it will not give the best results unless it is properly operated. The man in charge of the boiler room is the "man behind the gun" when it comes to securing the best obtainable efficiency. The old idea that a man should graduate from the boiler room to the engine room is a mistake, as a good man in the boiler room can increase the efficiency through good operation far more than one in the engine room. Happily more attention is now being paid to this feature, with correspondingly good results.

All of those who have had much to do with increasing the efficiency of power plants know that often the simplest requirements of good practice are disregarded in the operation of boilers, the boilers often being dirty and run with leaky baffles and settings. Even where the boilers and settings are kept in good condition there may be a loss through improper firing. The fireman is often blamed as a factor of fuel waste. The difficulty is seldom with the fireman, but in having nothing to guide the fireman except what might be called his intuition. It is certainly a mistake not to provide proper instruments. This is well appreciated in the larger and best-run power plants, but there is often a lack of instruments that makes it impossible to operate the plant to the best advantage. There is no reason why operating results should not be as good as test results, and this can only be accomplished through installing high-grade indicating and recording apparatus for the guidance of the fireman and operators. The plants of today are of a more complex character than in the past and the success in operating these plants depends in a great measure on the use of the proper instruments and a proper training of the man.

Information Afforded by Flue-Gas Analyses

In the operation of a plant much is shown by the flue-gas analyses. The flue-gas analyses are not all that govern the efficiency, as much depends on whether or not there is delayed combustion between the tubes of the boiler. It is all wrong to assume that if two boilers are operated with the same average flue-gas analysis and percentage of carbon in the ash that the furnace efficiency is the same in each, as actually there may be a wide difference due to the fact that all of the combustible gases may be consumed in the furnace in one case and not in the other.

A small amount of CO is often present when a high percentage of CO_2 is carried. An analysis with coal firing which indicates 13 per cent of CO_2 and no CO is about equivalent from a heat-loss standpoint, where the flue gases leave boiler and economizer at 500 deg. fahr., to one which gives 15 per cent CO_2 and $^1/_4$ per cent of CO. Again, carrying a high percentage of CO_2 sometimes leads to secondary or delayed combustion between the boiler tubes, thereby involving an additional loss through increasing the temperature of the flue gases. It is important, therefore, in boiler-room practice to make accurate analyses to determine whether or not CO is present in the flue gases and also to avoid too great an amount of delayed combustion between the boiler tubes.

Automatic systems for combustion control are often used to advantage. The supply of fuel is regulated in some cases to meet the demand for steam as well as the amount of air supplied for combustion. Systems where the amount of fuel is automatically regulated are in more general use in oil burning than for coal. In most cases the air supply is regulated to correspond to the fuel burned and to give a proper amount of draft within the furnace, and the fuel supply is hand-adjusted. Such systems quickly regulate the air and draft, and in some cases the fuel as well, to meet changing load conditions, and are especially useful where there is a variable load.

High-class instruments and apparatus for guiding the firemen or controlling the combustion will not of themselves insure good results. Many such devices that would give highly satisfactory results in the hands of a capable man that believes in them would be a failure in the hands of one less capable or one prejudiced against them. Here again all depends on the man in charge, and as the art advances and more complicated apparatus is used in obtaining higher efficiencies, more competent men are required.

Necessity of Coordinating Boiler and Furnace Design to Secure Best Results

Furnace and boiler design must be coördinated in order to secure the best results. It is impossible to separate the boiler efficiency from the efficiency of the stoker and furnace in such a way that the value obtained for the efficiency of the boiler will depend solely on the construction of the boiler and not be influenced through the construction of the stoker and furnace. Many have worked on this problem and the ground has probably been gone over more thoroughly than any other feature in boiler-testing codes. The stoker and furnace efficiency is influenced by the delayed secondary combustion between the boiler tubes and this element can not be included in any analysis, neither can the loss due to excess air be correctly divided between the boiler and furnace. The element of delayed combustion may influence the overall boiler and furnace efficiency, say, 5 or 10 per cent with the same flue-gas analyses. In most proposed methods the stoker and furnace efficiency is based on the analyses of the flue gases and on the amount of unconsumed carbon in the ash, and it can be readily seen that such a basis cannot give reliable results. Should it be possible to accurately express the furnace and stoker efficiency, a purchaser should obtain the same overall economy from his boilers with any arrangement of stokers and furnaces having a given efficiency. There is no method, however, whereby this result could be insured and whereby the purchaser would be protected should he assume that the boiler and furnace efficiency would be an exact measure of the relative advantages of using one or another of the various stokers and furnaces in connection with his boilers.

Stainless steel is an alloy steel containing about 12 to 14 per cent of chromium. It may be hardened in air, oil, or water, and tempered to various degrees of hardness as required for the different purposes for which it is intended. Ordinary carbon tool steel is hardened from a temperature of 760 to 780 deg. cent. for the maximum hardness to be obtained; with stainless steel, however, the temperature for effective hardening is higher, and it is recommended that temperatures between 950 and 1000 deg. cent. be used. This is due to the fact that the phase changes take place at a much higher temperature than in ordinary carbon steels. The difference in hardening temperature can be illustrated by stating that ordinary tool steel may be hardened from a red heat, while stainless steel should be taken to an orange-yellow heat.

Stainless steel may be supplied either in, or to be put in, the hard condition as for cutlery; in the machinable condition as for pump rods, turbine blades, etc., and in the malleable state required for presswork, etc.

Hence it is desirable that engineers should definitely state the purpose for which they desire to employ the material. For the manufacture of cutlery it is supplied in the annealed condition, since the final processes of manufacture include the hardening of the blades. For use in the machined condition it is available in the specially heat-treated condition, complying with the mechanical properties required for specific engineering purposes, thus obviating any necessity for further treatment by the user. For presswork it is produced within such limits of composition and treatment as to insure a satisfactory malleable stainless steel as required for articles as are manufactured from sheet steel, etc.

The most common of corrosive influences—i.e., weathering agents—have little effect on stainless steel. Samples have been exposed to the weather, wet and dry, frost and snow, for many months, and at the end of the time have been perfectly bright and unaffected in any way. Samples have been placed in streams, and after twelve months have still maintained their pristine brightness. Nitric acid, oleic acid, stearic acid, benzol, and petrol are without effect; phosphoric acid in concentrated form has no effect, but 75 per cent solutions give a slight general attack. Citric acid and formic acid cause corrosion to some extent, but for the great majority of liquids tested the steel was unaffected.—*Mechanical World*, Oct. 28, 1921.

This paper gives particulars of an investigation undertaken at the University of Michigan for the purpose of finding a rational basis for the action of a milling cutter.

It is shown that metal is removed more efficiently with thick chips than with thin chips. It follows from this that, other conditions being equal, including speed and feed per minute, the cutter with the fewest teeth gives the greatest efficiency. However, it is evident that the efficiencies of two cutters with different numbers of teeth are equal provided the table feeds be adjusted so that the same feed per tooth is effected. This gives a definite working theory on the influence of spacing.

It is definitely established that for a given material, tooth shape and sharpness, thickness of chip is the sole criterion of the efficiency with which metal is removed in milling and that increase of spacing over that required for free cutting is a handicap. Present-day high-powered cutters have several times the chip space needed. Limitation of machine power has doubtlessly been the chief factor in giving a false bias to the influence of spacing.

Formulas for determining the number of teeth for a known diameter of cutter and for determining the depth are included in the paper, as well as a geometrical construction for obtaining the best shape of tooth.

THE practice of milling has, during the present century and the last decade of the nineteenth century, encroached decidedly on the field occupied by the shaper and planer. The action of milling possesses advantages over shaping; it also has its drawbacks. Much work must be done before we can state the relative merits or potentialities.

In the art of milling, the only published investigations have been handled by machine-tool builders. Attention has in consequence been focused more on the machine than on the cutter. Further, in the investigations already made, the objects sought have usually had the defect of being too immediate. This paper describes an

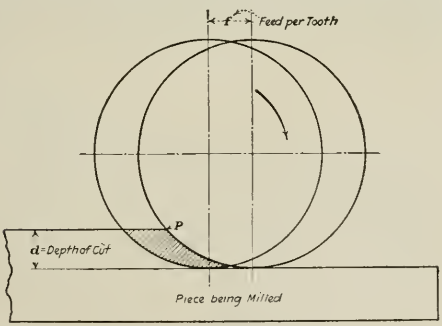


Fig. 1 Shape of Milling Chip

attempt to investigate the fundamental principles underlying the action of milling.

It is shown in the present investigation that metal is removed more efficiently with thick chips than with thin chips. It follows from this that, other conditions being equal, including speed and feed per minute, the cutter with the fewest teeth gives the greatest efficiency. However, it is evident that the efficiencies of two cutters with different numbers of teeth are equal provided the table feeds be adjusted so that the same feed per tooth is effected. This gives a definite working theory on the influence of spacing.

In addition to the present investigation, experiments published in substantiation of the advantage of wide spacing agree in confirming this theory. It is definitely established that for a given material, tooth shape and sharpness, thickness of chip is the sole criterion of the efficiency with which metal is removed in milling and that increase of spacing over that required for free cutting is a handicap. Present-day high-powered cutters have several times the chip space needed. Limitation of machine power has doubtlessly been the chief factor in giving a false bias to the influence of spacing.

The work described in this paper started in May, 1920, through a desire of the National Twist Drill and Tool Company of Detroit to find a rational basis for the action of a milling cutter, so far as this could be removed from the region of empiricism. This com-

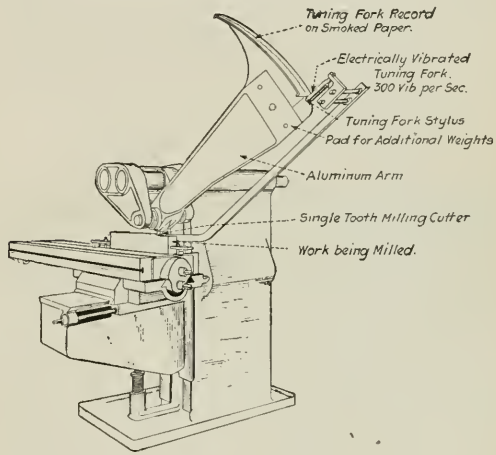


Fig. 2 Chip Investigator

pany furnished the financial support throughout. The experiments have been conducted in the Engineering Shops of the University of Michigan, and at the works of the National Twist Drill and Tool Company, the Lincoln Motor Company and the Hudson Motor Car Company. The greater part of the work was done at the University of Michigan, but the tests on machineability were run at the works of the National Twist Drill and Tool Company and those on endurance at the two automobile plants.

A Dynamical Study of Single-Tooth Action

The chip taken by a plain slab mill is very different from the chip taken by a lathe or shaper tool. A milling chip is shown exaggerated in the shaded portion of Fig. 1. The two circles show the outline of the cutter at the beginning and at the end of the interval taken for the cutter to revolve through the angle subtended by one tooth. The shaded portion will therefore represent the material removed by one tooth and will have an area $f \times d$.

The chip starts infinitely thin and its thickness gradually increases to a maximum just before the finish, from which point it quickly decreases. This decrease is practically instantaneous in an unexaggerated chip. The question arises, how does the force vary throughout the cutting of this chip?

The first problem is to find how the tangential force varies in relation to chip thickness. For measuring this force while the chip is being formed under reasonable commercial velocity conditions, a dynamical measuring method is the only solution, as a chip is completely cut in about one-tenth of a second.

Description of Chip Investigator. Fig. 2 is a diagrammatic representation of the apparatus here known as the Chip Investigator. A block of material is shown bolted to a milling-machine table

[1] Professor of Engineering Mechanics, University of Michigan. Mem. Am.Soc.M.E.

[2] Chief Engineer, National Twist Drill and Tool Co. Assoc-Mem. Am. Soc.M.E.

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and a single-tooth cutter in place, the latter being rigidly attached to the sector-shaped arm. This arm can partially rotate about an axis at its lower end, and in so doing it carries the cutter through an arc long enough to make a chip of the desired length.

If the arm be allowed to fall freely, the angular velocity will increase throughout the fall. If this be repeated after the table is adjusted so as to cause a cut to be taken, then the next fall of the arm will be retarded, because it must give up sufficient energy

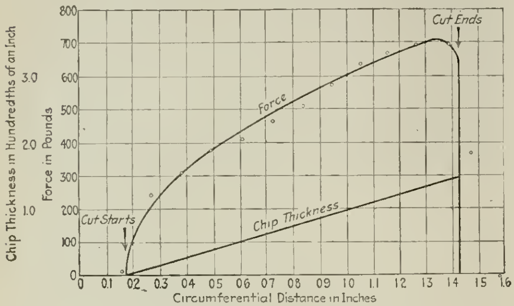

Fig. 3 Force-Space Curve of Chip Formation

to do the cutting. Weights can be placed on the Pad for Additional Weights (see Fig. 2) sufficient to secure a roughly uniform speed during cutting.

The investigation of the velocity at each instant is made by means of a tuning fork, which gives a record on smoked paper. The outer surface of the arm, remote from the axis of oscillation, is concentric: to this a glazed paper ribbon is attached and then smoked by a gas flame.

An angle iron bolted to the front face of the machine carries at its upper end a Koenig electrically driven tuning fork making 500 vibrations per second. As the arm falls, a wavy line is traced on the smoked paper by a stylus attached to one leg of the tuning fork. Each wave represents a definite interval of time, viz., two one-thousandths of a second. The smoked-paper record is immediately dipped in thin shellac varnish and hung up to dry.

An example of a chip study is given in Fig. 3, where it is very clearly shown that the force employed is not proportional to the chip thickness. In other words, material is removed more efficiently as the chip becomes thicker. This is confirmed later by experiments on varying feeds and furnishes the true explanation of the supposed advantages of coarse-tooth cutters.

Over twelve hundred chips were cut and the energy computed. These were taken at three different cutting speeds, viz., 17.5, 32 and 44 ft. per min., respectively. The average of the energy required at different speeds was remarkably equal. If the energy used at lowest speed be taken at 100, the results are:

Speed in ft. per min......	17.5	32	44
Energy..................	100	101.8	97.4

As there appears to be no law in this and the variation is slight, presumably due to experimental error, the conclusion was reached that speed does not influence energy required.

Influence of Rake and Feed on Cast Iron. The results of the analysis of sixteen sets of chip formations in cast iron are given in Figs. 4 and 5. Each set consists of three chips formed at the different speeds as stated in a previous paragraph.

The area under each curve gives a numerical representation of the average production of each tool over a certain region of chip weight. Taking the 0-deg. rake tool as 100, we have:

Production of 0-deg. rake tool = 100
Production of 10-deg. rake tool = 133
Production of 20-deg. rake tool = 138.4
Production of 30-deg. rake tool = 142.1

Influence of Rake and Feed on Bronze, Machine Steel and Carbon Tool Steel. The results of the analysis of sixteen sets of chip formations each in bronze, machine steel and carbon tool steel are given in the following table. As in the case of cast iron, the consistent superior economy of heavy feed is observed. This information is condensed as before and results in:

	Bronze	Machine Steel	Carbon Tool Steel
Production of 0-deg. rake tool	= 100	100	100
Production of 10-deg. rake tool	= 113.2	118.7	106
Production of 20-deg. rake tool	= 123	157.2	112.2
Production of 30-deg. rake tool	= 118	172	112

Effect of Lubrication. Various experiments were run with lubricants. The results must be taken qualitatively rather than quantitatively. This topic offers an important field of investigation for future experiments.

In milling there is a decided influence entirely apart from heat-conducting properties. If the surface exposed by the last chip was very slightly smeared with an oiled finger (the oil film was

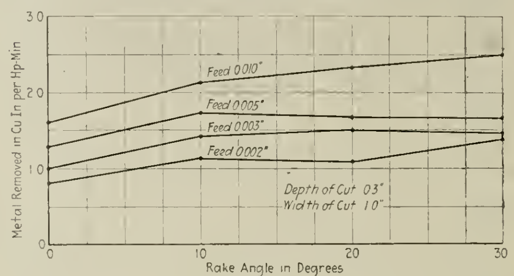

Fig. 4 Milling Tests on Cast Iron: Metal Removed as a Function of the Rake

scarcely discernible), the energy consumed in taking the next chip was from 10 to 25 per cent lower in nearly all cases.

On plotting batches of results, however, the surprising situation was found of oil proving advantageous with low rakes in bronze and detrimental with high rakes. The existence of some unknown varying factor was suspected and the results would have been

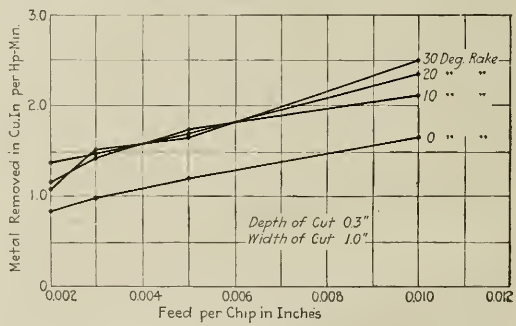

Fig. 5 Milling Tests on Cast Iron: Metal Removed as a Function of the Feed

rejected and forgotten but for the fact that the same effect showed up in experiments with machine steel made at a different time. The metal removed per horsepower-minute is shown plotted against rake for the two materials in Fig 6.

The authors hesitate to accept the foregoing unreservedly until further investigation sheds some light on its rationality. A study of the resultant force during the formation of a chip with reference to its changing magnitude and direction would give the needed explanation. This has not yet been undertaken.

Effect of Chatter. When chatter occurs, a violent fluctuation of energy results. The energy consumed was usually greater than with smooth cutting. The authors believe that, due to chatter alone, increase of energy invariably results and that where a decrease appeared it was caused by the cut being lighter than supposed to be. This can be brought about by the chatter causing

the work or cutter. A detailed study of chatter was not made, but probably will be at a later date.

Effect of Clearance. Clearance was found not to affect energy consumed. Chatter, wear of tool and liability of tool to snip are affected by clearance.

Effect of Spiral. Experiments were carried out on the effect of spirals. The results were not sufficiently uniform to justify a conclusion on the influence of spiral angle on energy, beyond the fact that cutters with spiral angles of over 25 deg. certainly require more energy.

Method of Determining Machineability. The word "machineability" is suggested to indicate the ease with which a given material can be machined. This, of course, presupposes standardized conditions of tool and size and shape of chip. If all conditions be

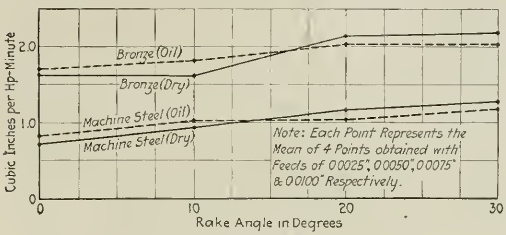

Fig. 6 Effect of Oil on Milling Machine Steel and Bronze

standardized except the quality of the material being cut, then the machineability can be expressed in foot-pounds of energy required to remove one cubic inch of the material under investigation.

It is well known that machineability is a continual bone of contention in machining departments and that no accepted satisfactory way has yet been devised for its measurement. It is generally admitted that even though chemical analysis, tensile strength, elongation, Brinell hardness number and scleroscope hardness number are known, yet the machineability is an unknown factor. In fact, the War Department gave to the American

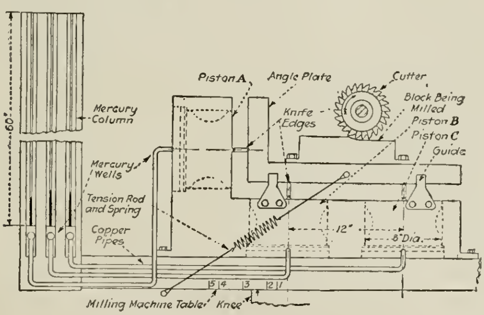

Fig. 7 Thrust and Torque Measurer

Research Council as their major topic the development of some definite means of determining machineability.

A machine has been developed along these lines and is described later in the paper. For identification purposes it is referred to as the "Machineability Tester." Experiments with this machine are presented at the end of the paper rather than here, because they were the last experiments to be performed.

To summarize: The authors had, at this stage of development, no definite idea leading to a rational structure which would connect up the results. They regard the work already described as useful in opening up territory, thereby enabling them to formulate more definite layouts for subsequent work and believe that broadly the following conclusions are justified:

1 As a chip thickens, metal is removed more easily per unit volume

2 ... per unit volume. Also this improvement is continuous but not uniform

3 The advantage of rake depends on the material and is more pronounced with ductile materials

4 The effect of lubrication proper (apart from cooling action) is decided, but the information available is inadequate to formulate it.

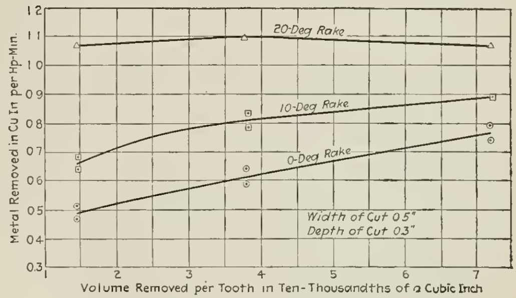

Fig. 8 Influence of Rake in Cutting Machine Steel

Force Analysis of Cutter in Action

It was thought desirable to measure both the vertical and horizontal components of the force exerted by the cutter. This necessitated developing an instrument that would measure both force and location, i.e., in all, three quantities: magnitude, direction and location. Or, which amounts to the same thing, the two components and the location may be measured.

Description of Equipment Employed. The apparatus developed for force and power analysis is shown diagrammatically in Fig. 7, and is designated the "Thrust and Torque Measurer."

The angle plate to which is bolted the material being cut is carried on three knife edges, through which the forces are transmitted to pistons *A*, *B* and *C*. The double-knife-edge principle used transmits only a horizontal force to piston *A* and only vertical forces to pistons *B* and *C*.

The fluid pressure under the pistons is transmitted through pipes and measured by means of mercury columns shown at the left of Fig. 7. As the table travels in feeding, the location of the downward thrust of the cutter in relation to cylinders *B* and *C* changes continuously. The table traveling from left to right results in the pressure decreasing on *C* and increasing on *B*. The readings of mercury columns must therefore be taken for known definite locations of table. Five marks were made in the table, and as these successively came into alignment with a zero mark on the saddle, the readings were taken.

Influence of Rake on Machine Steel. The results of fourteen experiments are shown graphically in Fig. 8. The noticeable consistency in the spacing of the pairs of values given as results of the zero rake cutter is due to the second three having been taken in a different part of the block from the first three. The results show the decided advantage of rake. The advantage of heavy chips is also clearly shown except in the case of the 20-deg. tool.

The authors do not draw any conclusion regarding this exceptional case as the experiments available are too few. In general, there is conclusive evidence that heavy chips are more economical of power than small chips, within the practical limits of present-day milling practice. The exact extent of this economy cannot be stated at the present state of the art. It is certain, however, that this condition is a function both of the material and of the rake. The influence of rake appears to depend largely on ductility.

The area under each curve gives a numerical representation of the average production of each tool over a certain region of chip weight. Taking the 0-deg. rake tool as 100, we have:

Production of 0-deg. rake tool = 100
Production of 10-deg. rake tool = 130
Production of 20-deg. rake tool = 176

Influence of Rake on S.A.E. 3240 Alloy Steel. The results of

twelve experiments are shown in Fig. 9. Again taking the area under the curve to represent the productivity, we obtain:

Production of 0-deg. rake tool = 100
Production of 10-deg. rake tool = 130.5
Production of 20-deg. rake tool = 137.5

In this case the advantage of rake is not so decided as with the more ductile machine steel, particularly above 10 deg. In addition, the same tendency is observed to reduce the advantage of thicker chips with a high rake.

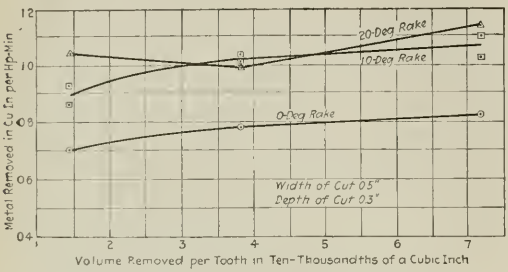

Fig. 9 Influence of Rake in Cutting Alloy Steel

Influence of Depth of Cut. Thirty-five experiments were run with various depths of cut, various feeds, and two different rakes. Analysis of these results gave rise to a belief that the block of material used was far from homogeneous. These experiments are not recorded in detail for this reason. It is advisable, however, to record certain impressions obtained and tentative conclusions.

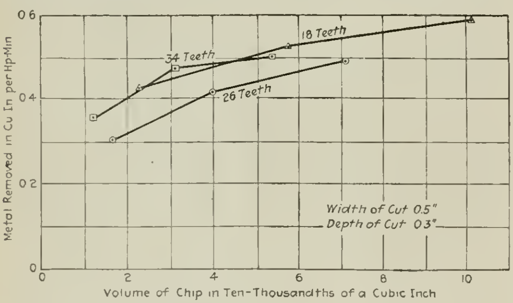

Fig. 10 Effect of Varying Spacing: Alloy Steel

If the material removed per hp-min. be plotted on a chip-volume base, then a shallow cut gives a curve higher than a deeper cut. This is not surprising. It has been shown that, as a chip thickens, the material is removed with less energy per unit volume. If two chips of equal volume but of different depths of cut be taken, then the chip of the shallow cut is shorter and thicker.

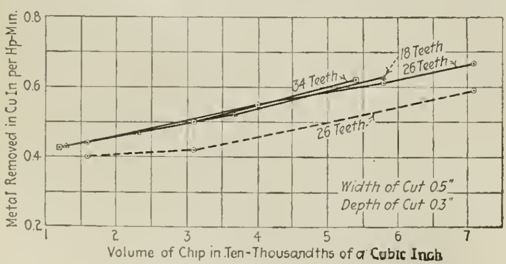

Fig. 11 Effect of Varying Spacing: Machine Steel

It appeared probable that, with a given cutter and uniform material, if the feed per tooth and depth of cut were varied, the number of cubic inches per hp-min. would prove to be a definite function of maximum chip thickness. Experimental verification of this is given later in the paper.

TABLE 1 EFFECT OF LUBRICATION

Milling Cutter: Clearance angle, 5 deg.; rake angle, 10 deg.; spiral angle, 0 deg.; diameter, 6 in.; number of teeth, 34; depth of cut 0.3 in.; width of cut, 0.5 in. Material: Alloy steel No. 10

Exp. No.	Feed in. per min.	Speed r.p.m.	Vol. per Tooth cu. in.	Torque, in-lb.	Cu. in. per hp-min.
1026 Oil	0.92	27.9	0.000145	306	1.018
1026 Dry	0.92	27.9	0.000145	364	0.855
1027 Oil	2.36	27.9	0.000375	760	1.070
1027 Dry	2.36	27.9	0.000375	875	0.930
1028 Oil	3.10	19.3	0.000710	1335	1.148
1028 Dry	3.10	19.3	0.000710	1430	1.071

Influence of Lubricant. The results of six experiments, which merely touched the fringe of the effect of lubrication, are given in Table 1. It is dangerous to generalize too broadly from a few results, but one can at least conclude that lubrication effects a reduction of energy and that this reduction appears more pronounced in light cuts. It should be again noticed that this is almost pure lubricating action and that the conduction of heat by the oil plays only an insignificant part.

Effect of Spiral. A 34-tooth non-spiral cutter 6 in. in diameter and having a 10-deg. rake was run in comparison with cutters similar in all respects excepting that they possessed a $12^1/_2$-deg. spiral angle. Two cutters with left- and right-hand spirals, respectively, were used in combination, thus eliminating end thrust. Two different combinations of speeds and feeds were used. The material cut was machine steel. The results were as follows:

R.p.m.	Feed, in. per min.	Cu. in. per hp-min. 0-deg. spiral	Cu. in. per hp-min. $12^1/_2$ deg. spiral	Lost output of spiral cutter
28.1	0.92	0.422	0.338	20 per cent
16.1	0.92	0.568	0.458	19.4 per cent

The authors are well aware that a general belief exists in the superior power efficiency of spiral cutters. Frequent statements to this effect can be found in the literature of the subject. In this investigation it has been impossible to substantiate these. It is difficult to understand the growth of the belief that spiral cutters are more efficient, because abstract analysis leads to the conclusion that spiral cutters must be inferior to straight cutters. By "inferior" the meaning intended is in reference to power efficiency only. The use of a spiral angle is heartily recommended, for it results in continuity of action, tends to avoid chatter, and keeps the driving power more smoothly constant. The smallest angle consistent with smoothness of action should be used.

Theory of Tooth Spacing. Opinions differ on the influence of tooth spacing or, in other words, the relative merits of coarse-tooth compared with fine-tooth cutters. Many cutter manufacturers standardize two types, the fine-tooth cutter and the "high-powered" cutter. Experiments have been published purporting to show the advantage of coarse-tooth cutters. Possibly many others have been made and have probably convinced the experimenter that the claims made were justified.

There is an interesting delusion in this subject and it is unfortunate that it has held sway for so long, for it has resulted in inefficient types of cutters being used. Most of the so-called high-powered cutters today on the market would be improved if more teeth were given.

It has been demonstrated earlier that the force required to remove metal does not increase in proportion to the chip thickness. It follows directly from this (and has been independently demonstrated by the Thrust and Torque Measurer) that as feed is increased the force will not increase in proportion.

Another way of stating the last paragraph is that the heavier the chip the more metal removed per hp-min. If one were to make a comparison of two cutters with different numbers of teeth but run at the same speed and feed per minute, then obviously the cutter with fewer teeth would remove the metal with less power *because the chips are thicker*, there being fewer teeth cutting per minute for the same amount of metal removed. It appears illogical, a priori, to suppose that the force action of a single tooth under any given set of conditions should be influenced by the location of neighboring teeth, *if free cutting is in operation.* This view is fully substantiated by experiment.

ness as with the coarse tooth cutter), *then exactly the same cubic inches per hp-min. would have been removed as were removed with the coarse-tooth cutter, and more actual cubic inches of material would have been removed per minute, provided the limit of machine power had not been reached.*

If comparative tests had always been analyzed from the point of view of chip volume (or maximum chip thickness, if the depth of cut varies), then the unmerited virtue of wide spacing would never have been recognized.

Three 6-in. diameter side mills were taken, 0.5 in. thick and with 10 deg. rake. They had respectively 34, 26 and 18 teeth. Various tests were run in alloy steel and in machine steel. The results of these experiments are plotted in Figs. 10 and 11.

Experiments with the same cutter are joined by a line. In both figures the 34-tooth line and the 18-tooth line came superposed within experimental error. The 26-tooth line came roughly parallel but lower in both cases. This appeared to establish the equality of cutter efficiency in the case of the 34- and 18-tooth cutters with different tooth spacings when given equal chip volume. The distinct inferiority of the results with the 26-tooth cutter to the results of both the others suggested some defect in the cutter. It was found that the side clearance was almost nil.[1] This was remedied and the tests were repeated in machine steel with the result that the 26-tooth line coincided on the left with the two others. On the right there is a slight separation due to experimental error, but no consistency can be traced. The experiments with the 26-tooth cutter were not repeated in alloy steel, as that particular block was not available.

In a paper[2] presented at the 1911 Spring Meeting of the Society by Mr. A. L. De Leeuw, claims were made regarding the superiority of wide spacing. This publication caused coarse-tooth cutters to increase in favor. If the experiments there recorded were to be compared on a chip-volume basis, the different cutters would

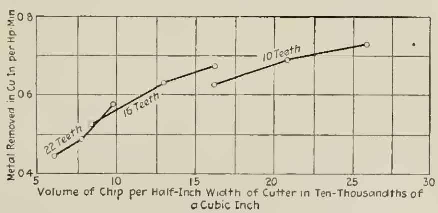

Fig. 12 Cincinnati Milling Machine Company's Experiments

doubtlessly lose their separate identity from an efficiency standpoint. As the speed of cutting is not recorded in these tests, it is not possible to find the chip volume, and so effect this comparison.

It is equally effective, however, to analyze data extracted from A Treatise on Milling and Milling Machines, issued by the Cincinnati Milling Machine Company. On page 147 of that work results are given of tests with cutters of 22, 16 and 10 teeth, respectively. These results are there submitted as establishing conclusively the superiority of the coarse-tooth cutter. The data in question are reproduced in Fig. 12, the chip volume being calculated for 0.5 in. width of cut, to make the results comparable with the others in this paper.

These results are seen to follow the same basic law as others already given. To summarize: Material and depth of cut remaining constant, the efficiency with which the metal is removed is determined solely by the chip volume and is independent of the number of teeth in the cutter.

If in using a fine-tooth cutter the feed be increased in order to give the same weight per chip as was given in a comparative test

[1] Most tests in the present section consisted in cutting grooves 0.5 in. wide and 0.3 in. deep with a side mill. It was repeatedly shown that power consumption was not affected whether the cut happened to be a groove or a land, except in this one case of side-clearance trouble.

[2] Milling Cutters and Their Efficiency, Trans. Am.Soc.M.E., vol. 33, p. 245.

b The limitation of power of machine might be reached

c The limit of structural strength of the cutter might be reached.

Condition (*a*) is very apparent, for the efficiency rapidly drops to zero as soon as chip room becomes too small. This is proof that the spacing is inadequate, a condition which doubtlessly frequently existed formerly. Condition (*b*) is probably the indirect cause[1] of existing opinions regarding wide spacing of teeth.

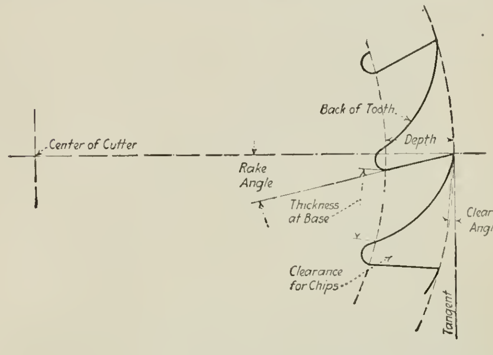

Fig. 13 Definition of Terms

If in given tests equal chips are taken, then the cutters will remove metal, the volumes of which per minute will be in the ratio of the numbers of teeth, and will of course call for correspondingly more power. Condition (*c*) would occur in the case of exceptionally thin cutters or of unusually deep cuts.

As many teeth as possible should be put into a cutter consistent with sufficient chip clearance. It is evident, of course, that sufficient excess chip space must be provided in a new cutter to allow for a reasonable amount of grinding. As soon as the necessary chip clearance is exceeded, possible economy is forfeited. A glance at existing high-powered cutters is sufficient to show that several times the necessary chip clearance is nearly always furnished.

The cuts taken in our experiments are throughout in an everyday production region. The Thrust and Torque Measurer was not capable of carrying spectacular cuts. However, that the same law holds in the region of heavier cuts, is proved by experiments plotted in Fig. 12, as they form a similar curve. Further, a study of these curves shows that chip congestion did not play any part with even the finest-toothed cutter, for this would have resulted in the last spot falling below the general trend of the combined curve.

Considering that the whole subject of milling action centers about the action of a single tooth, it appears desirable to think in terms of this. The authors take this opportunity of suggesting to milling-machine manufacturers that this point of view be encouraged in supplying instruction data with machines. As it is, the feed is invariably given in inches per minute.[2] This is useful in checking up the time required to do a given job after the feed is known. It is of no direct value, however, in checking up whether the feed is adequate for the work, because this is determined fundamentally by a definite feed per tooth.

Further, the feed per tooth is a function of the material and of

[1] See later paragraph entitled General Consideration of Removing Metal by Milling.

[2] The present practice is to give feed in inches per minute with machines having a constant-speed feedshaft. Feeds are given in inches per spindle revolution with machines having the feed train driven from spindle. Recent literature indicates that doubt exists regarding the relative merits of the two systems. The problem is purely and simply that of obtaining the greatest range with the simplest mechanism. The authors believe that the constant-speed feedshaft is unqualifiedly the better of the two systems. They further believe that this lends itself to a demonstration as rigorous as a proposition in Euclidean geometry does. For discussion of this, see letter in Mechanical Engineering, March, 1921, p. 207, by John Airey, on Milling-Machine Feed Systems.

the depth of cut. Data should be arranged so far as possible to focus attention on the maximum chip thickness. This is the basic criterion of effort from the cutter standpoint.

The authors believe that in a few years, by coöperation between milling-machine and milling-cutter manufacturers, data and practice will have evolved so that a set-up man will determine the appropriate chip thickness and then, by reference to tables, will set the speed and feed to give this. The feed per tooth for a given cutter determines the feed per revolution of spindle. If a chart were supplied giving the feed per revolution for all possible combinations of speeds and feeds, then this would be of direct use in working from a feed-per-tooth starting point and would constitute the first step in the suggested direction.

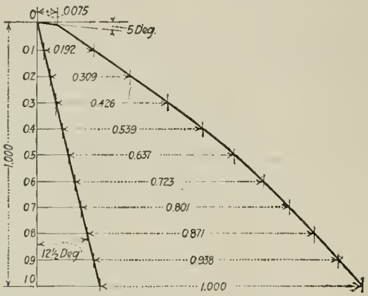

Fig. 14 Ideal Shape of Tooth

General Consideration of Removing Metal by Milling. It is an interesting and profitable line of thought to consider, in its broadest phases, the problem of removing metal by milling. The first factor to be considered is chip thickness. In order to remove the maximum amount of metal per hp-min. the chips should be as thick as possible.

The chip weight is limited by the endurance properties of the cutting tool, as is also the cutting speed, which is the second factor to be considered. Various experimenters in lathe-tool action have shown that, for a given tool, the chip weight and the cutting speed are interrelated. It should be remarked here that the degree of bluntness permissible in a milling cutter is very slight, when compared with the allowable bluntness of a continuous-cutting tool.

The greatest metal-removing capacity occurs when the product of chip volume and cutting speed is at a maximum. Let us assume that the most advantageous combination of speed and thickness is known for a given tool and material, so that these factors may be kept constant. It then follows that the closer the teeth are together, the more metal will be removed per minute, provided, of course, that the spacing of the teeth is not so far reduced that clogging of the chips takes place. Since power efficiency is determined by chip thickness only, it is evident that this is not altered by varying the tooth pitch.

If it is possible to keep the feed per tooth constant and decrease the tooth spacing without exceeding the power of the milling machine, the ideal conditions are achieved, i.e., the maximum volume of metal is removed per minute with the expenditure of the least possible power. Suppose, however, that the limit of the machine's power is reached before the minimum possible tooth spacing is obtained.

The problem now assumes a different aspect. We have already obtained the maximum power efficiency by virtue of using the thickest possible chip. If the tooth spacing is to be decreased, the power of the machine will be exceeded unless some of the other factors are changed. If the feed be reduced, the chip becomes thinner. This results in a decrease in the power efficiency coupled with a decrease in the amount of metal removed per minute.

Suppose that we leave the feed constant, decrease the tooth spacing, and at the same time reduce the spindle speed so that the feed per tooth remains the same. The power efficiency will then remain constant, as will the amount of metal removed per minute. Furthermore, the decrease in peripheral speed will result in a lengthening of the life of the cutter between grinds.

We have thus demonstrated a priori that fine spacing is superior to coarse spacing, regardless of whether the cutting speed or the power of the machine be the limiting factor. In the first case, the fine-toothed cutter will remove more metal per minute. In the second case, the fine-toothed cutter will wear longer between grindings, due to the decrease in cutting speed.

Shape of Tooth

The following six features of a tooth will be discussed:

a Clearance	*d* Depth
b Rake	*e* Thickness of base
c Shape of back	*f* Clearance for chips.

These features are defined in Fig. 13.

Clearance. Excessive clearance does not reduce the cutting force, does not appreciably affect the life of the tool in normal wear, but does tend to chattering action; also it weakens the cross-section near the cutting edge and increases liability to snip. Clearance should therefore be kept to a minimum. Three degrees was found to be ample but 5 deg. was usually used. In many tool cribs it might be desirable to standardize at 8 deg., due to the possibility of an error of a few degrees. In practice it is customary to speak of clearance in thousandths of an inch at the heel of a land. This is obviously a safer method, as the heel might bind for any given clearance angle if the land were sufficiently extended. However, for scientific analysis it is better to use degrees.

Rake. From a power-consumption standpoint rake is increasingly beneficial as it becomes greater. The advantage of rake, though, does not increase at so fast a rate after about 15 deg. is passed. Further, this is influenced by the kind of material being cut. On the other hand, the life of the cutter might be influenced disadvantageously by excessive rake.

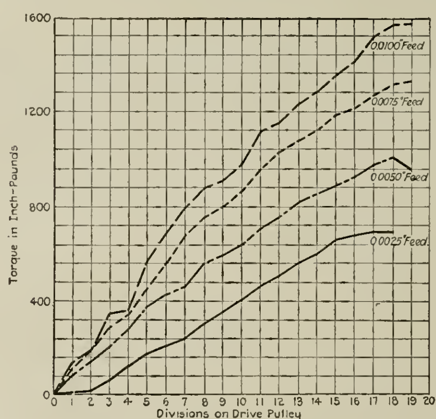

Fig. 15 Statical Experiments on Four Different Chip Thicknesses

It is believed that the greater the rake, the longer the life, from a simple abrasion standpoint. An increase in rake, however, necessitates a decrease in the heat conductivity of the tooth, as a consequence of which increased wear due to rising temperature is more likely to occur. A compromise can be obtained only by experiments on endurance and this is treated later.

While the decided power advantage afforded by rake is indisputable, it is not advisable to jump too far in the higher regions. Had the importance of developing cutter design in this direction been acted upon decades ago, as it should have been, then we should be on a much safer footing, as a considerable amount of data would have been available regarding action of greater rakes in all types of situations.

Under the circumstances, the authors believe and recommend that cutters be given 12½ deg. rake; further, that for any definite job it might be very desirable to go beyond this, even as high as 25 deg., but that 12½ deg. may safely be taken as a minimum, with the possible exception of rare and unusual job.

-chip room or deleteriously increasing tooth spacing. An ideal tooth shape is given in Fig. 14, with construction data.

Depth. The depth is controlled partly by the length of grinding life expected, but chiefly by the spacing, which in turn will be shown to depend on chip clearance. It is not possible by any method of calculation to predetermine the chip space necessary for given conditions of cut. The space actually needed is a function of the shape of the chip, depending on just how tightly it rolls, manifestly a condition not lending itself to computation.

This feature can be determined only by experiment, but one fact should be kept clearly in mind in considering this, viz., that the shape of the space between teeth is equally important with its net area. The shape should be such as to prevent the chips from "packing," for this quickly causes the power to increase abnormally. Narrow, wedging bottoms must be avoided. The prevention of packing is facilitated by a spiral cutting edge; it is less liable to occur in thin cutters than in thick ones.

Thickness at Base. For a given depth, the thickness at the base is controlled by the ability of the tooth to resist fracture. This is, in turn, dependent on the quality of steel. Thickness at the base is taken as equal to depth in the recommendation here given. This is fairly consistent with present practice and gives an ample factor of safety for cuts that are customary.

Clearance for Chips. Chip clearance should be sufficient to accommodate the heaviest cut that is desired to take, and no more. It has previously been shown that if clearance is more than necessary or if the cutter is used for chips smaller than the maximum possible, then metal-removing possibilities are being

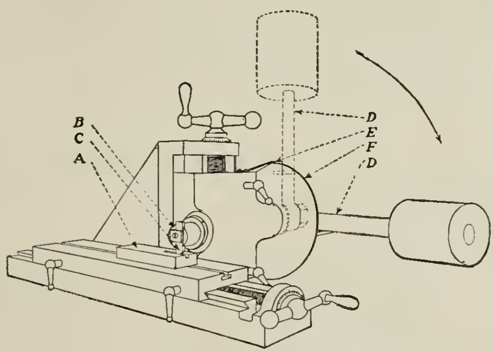

Fig. 16 Machineability Tester

sacrificed. Chip-clearance requirements govern the spacing, and this in turn fixes the number of teeth in a cutter for a given diameter.

Design Formulas. Formulas for determining the number of teeth for a known diameter of cutter and for determining the depth are given below, and a geometrical construction for obtaining shape of tooth has been given in Fig. 14. The arguments demonstrating the rationality of these are given in an appendix to the complete paper.

Let n = number of teeth

R = radius of cutter in inches

d = radial depth of straight face in inches

then

$$n = 19.5\,R^{1/2} - 5.8$$
$$d = 0.215\,R^{1/2}$$

A Statical Study of Single-Tooth Action

Objections will doubtlessly be raised to the use of statical experiments, due to the supposed discrepancy between cutting action at a dead-slow speed or in installments, and cutting action at a customary speed. The authors believe this discrepancy to be more imaginary than real and that considerable information can of which are at hand, was to find if instantaneous chip thickness is the sole criterion of force at a given instant. In the early part of this work the habit was formed of thinking in terms of chip volume. It was believed that this was the basic starting point for correlation of results; and so long as depth of cut was kept constant, there was no reason to question the legitimacy of this viewpoint.

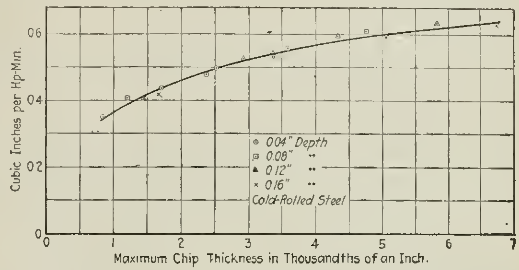

Fig. 17 Metal Removed as a Function of Maximum Chip Thickness

As stated in an earlier paragraph, the work done with various depths of cut was of doubtful value. Nevertheless, it was apparent that shallow cuts showed up more favorably on a chip-volume basis. This led to further speculation, ending with the conviction that not chip volume but maximum chip thickness was the feature of basic interest.

The truth of the above statement seems so obvious when the action of milling is carefully considered, that the fact would not be elaborated on, were it not that months of experimental work had been done before this idea developed. All chips, to within a small error of mathematical interest only, increase uniformly from zero thickness to a maximum. As any given instantaneous thickness of chip connotes a certain force action at that instant, and as the increase in thickness is uniform, it follows that the maximum chip thickness is a unique criterion of the material removed per horsepower-minute for a given cutter and material.

On this assumption a miscellaneous set of experiments with constant material and constant shape of cutter tooth would fall on one curve, if metal removed per hp-min. be plotted against maximum thickness. The variation in depth of cut and the varying tooth spacing would have no influence.

Comparison of Four Chips of Varying Feed. A cutter of 10-deg. rake was used, the depth of cut taken was 0.30 in. and the feed was taken successively as 0.0025 in., 0.005 in., 0.0075 in., and 0.010 in. The feed was obtained by carefully moving the table by hand and then locking the gib screw. The rotation of cutter necessary just to take one chip was divided into 20 equal parts and readings were taken.

The results are shown graphically in Fig. 15, the torque being plotted against divisions of the driving pulley. The same general shape is observed except in the case of the 0.0025-in. chip. Several attempts were made to obtain consistent results with this without much success. A little reflection on the probable distortion of results produced by the knee bracket being, say, 0.0002 in. too high or too low on a thin chip like this will account for this difficulty.

Endurance Tests Under Commercial Conditions

Although increasing the rake angle is unquestionably beneficial from a power standpoint, the same is by no means obviously true from the standpoint of endurance. In fact it is apparent that a continuous increase of rake must ultimately jeopardize endurance.

To investigate this, numerous experiments were necessary and arrangements were made to make them under commercial conditions.

As a result of these experiments it was found that from an endurance standpoint rake is certainly increasingly beneficial up to

(Continued on page 798)

Heat Balance in Steam Power Plants

Particulars of Systems Employed in Three Large Modern Stations to Adjust Rate of Steam Generation to Demand With the Least Possible Waste of Heat and Expenditure of Coal

THE general topic set for discussion at the 1921 Annual Meeting of the Society is the subject of "Waste," which is of vital importance in this country, where there is such a widespread disregard of the conservation of its natural resources. The Power Division has been asked to confine its session to some feature of this general topic.

Much has been written concerning the design of power-generating equipment, combustion methods, and general design of power stations. Comparatively little, however, has been said concerning the heat balances that have been secured, and that may be secured, in steam power plants.

By heat balance we are here to understand that correlation of events in the heat cycle of the plant as a whole which adjusts the rate of steam generation to the demand with the least possible waste of heat, and at the least possible expenditure of coal. The securing of this proper adjustment is the problem now under consideration.

Labor-saving methods and devices have been introduced to such an extent that the cost of fuel is now by far the greatest item of expense in generating power. Improvements in steam turbines, increased efficiencies of boilers, pumps and other equipment have materially assisted in reducing this item. But it still remains the duty of the power-plant designer to design the plant and to select and install its equipment in such a way that the heat generated therein may be utilized to its fullest extent and every source of waste avoided in so far as possible, in order that this share in the reduction of fuel cost may be performed. Some methods, while apparently very efficient, have inherent losses, which can be determined only by very careful study.

There are four principal sources of heat waste with which the power-plant designer has to deal:

1 Radiation
2 Stack losses
3 Losses in condensing water
4 Losses due to excess exhaust steam.

The means which he employs to reduce these losses determine the heat balance to be secured in the operation of the plant.

With the thought that much good could result from a general discussion of the subject of heat balance, engineers from various companies have been asked to present the ideas used in the design of some of the recent stations.

Intimately involved in the solution of the heat balance is the method employed for driving the station auxiliaries. In the early plants they were driven principally by means of steam engines of high water rates. Improvements in steam-engine design and the introduction of high-speed turbines gradually increased the economy of the steam-driven auxiliary system; later the electric motor, both alternating- and direct-current, found favor with the designers. Today there are advocates of many systems of auxiliary drive. Some engineers prefer to use only steam drive, others alternating current, some direct current, and many favor combinations of steam and motor drive.

The systems used in the stations dealt with in the following papers are the embodiment of the ideas of their respective designers as to the best methods of properly working out the heat balance for these stations.

The Power Division desires a thorough discussion of the subject and invites the members to express their views thereon without necessarily confining themselves to the systems described in the papers. They are presented for the purpose of starting a general discussion on this very broad subject, which is of paramount importance to the designers and operators of steam power plants. While the systems described in the following papers are those used in large stations, the ideas contained in them might well be applied to stations of moderate size.

Auxiliary System and Heat Balance at the Delaware Station of The Philadelphia Electric Company

By E. L. HOPPING,[1] PHILADELPHIA, PA.

FOR the past few years the high cost of fuel and other materials used for the generation of electrical energy, together with the high cost of labor for operation, has made it imperative that the maximum economy should be obtained in the use of materials and labor entering into the construction and operation of the public-utility company's steam-electric generating stations. The greatest economies are to be found in the efficient burning of the fuel for steam generation and in the proper utilization of the energy contained in the steam. There are various factors entering into the problem in connection with the auxiliary system and heat balance for any of the large generating stations that must be considered. Any decision regarding the auxiliary system and heat balance involves the consideration of certain outstanding conditions, which may be classified in the order of their importance as follows:

a Reliability of service
b The economy in heat units per kilowatt of net output
c Simplicity and flexibility of operation with which the heat balance may be maintained under widely varying conditions of load and temperature
d The flexibility of the system in view of possible future developments and changes in power-plant equipment
e The investment and maintenance cost of the equipment used in obtaining the desired economies, and its comparative value to other systems in terms of income from the investment.

In working out the auxiliary system and heat balance for the Delaware Station of the Philadelphia Electric Company, the factor of reliability of service was considered of prime importance, and of somewhat greater value than that of heat economy. A study of the system will indicate its flexibility and its value in meeting varied conditions or varied temperatures in boiler feedwater which might be obtained with the installation of apparatus such as air extractors.

It has always been considered by this company that the small comparative cost of duplicating the main generating unit auxiliaries is fully warranted in view of the resulting ability to keep a large unit on the line in case of failure of any of the different auxiliaries connected with the unit. This particular item is one which must be considered almost entirely in the light of reliability of service, since no direct returns on the investment can be shown by the installation of duplicate auxiliary equipment.

Having the question of duplication of auxiliaries decided, the next step was to settle upon the method of driving the various auxiliaries in the plant. Due to temperature changes in the circulating water, the vacuum on the main generating units varies from about 28 in. during the summer months to 29.25 in. during the winter months. Temperature charts of this water condition show average variations of from 40 to 80 deg. fahr. With this variation in vacuum there must be considerable flexibility in the method

[1] Mechanical Engineer, The Philadelphia Electric Company. Mem. Am.Soc.M.E.

A group of papers to be presented at the Annual Meeting, New York, December 5 to 9, 1921, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The papers are here printed in abstract form and copies of the complete papers may be had upon application. All papers are subject to revision.

of the feedwater to the required point, which in this case, up to the present time, has been 210 deg. fahr. Knowing the amount of heat required under varying vacuum and load conditions, it remained to select such auxiliaries to be steam-driven as would furnish the required heat through their exhaust. It was found possible to obtain this result by installing turbine drive on one of each of the duplicate auxiliary pumps connected with the main generating units, together with turbine drive on boiler-feed pumps and on one house pump. It was, however, found necessary at times of heavy load and high vacuum to supply a certain additional amount of heat, which was obtained by bleeding the main turbine at the eleventh stage.

All of the boiler-feed pumps are turbine-driven. This practice has been followed throughout the system of the Philadelphia Electric Company and has been made standard, based upon the fact that in case of a serious disturbance in the electric system of a particular plant, the boiler-feed pumps would not be affected. At such a time it is very necessary that these pumps be available for duty.

The forced- and induced-draft fans and the stokers are motor-driven and receive their current through a station light and power system. These auxiliaries and their protective equipment, described more fully later in the paper, would be shut down only in case of an interruption of the service to the two buses of this system.

On each of the main units one of the two circulating pumps is installed with a duplex (steam and motor) drive. By use of this type of drive two results are obtained:

a A flexible unit is available, which, by varying the load on the turbine drive, will supply the required heat variation for maintaining a practically constant feedwater temperature

b In case of trouble on either the steam supply or the electric service, the opposite drive will automatically pick up the load, and thus keep the condenser water in circulation. The other circulating pump, which is provided with a motor drive only, is used as a reserve, or in case it is desirable to operate two circulating pumps at a time when high circulating-water temperatures occur.

For the air and condensate pumps a duplex drive is not deemed necessary, as, in case of trouble with either of these auxiliaries, a brief shutdown would not be serious. If one of the pumps is in trouble, it only requires a very short time to put the other pump in service. During this time the vacuum, in case of an air-pump failure, should not be affected to any appreciable extent, and the condensate storage capacity in the condenser would take care of the time element in getting the other condensate pump on the line.

Throughout the plant apparatus such as coal hoists, conveyors, miscellaneous pumps, etc., is motor-operated. This equipment is all for intermittent service, and a brief shutdown of any piece of apparatus would not affect the plant system. In only two cases have we installed turbine drive on miscellaneous pumps. These are in the case of the fire pump and the house water-service pump. Turbine drives were installed on duplicate pumps in these instances in order to protect the plant should an interruption to the electrical service occur.

Electrical System

While considering the extensive use of electric drive for auxiliaries, it was clearly realized that it would be unwise to take advantage of the economies thus made possible, unless the reliability of this supply and the sturdiness of the equipment was comparable to steam drive. In order to insure this, four considerations were kept in mind in the design of the station light and power system:

a Great care must be used in the selection and layout of the equipment, so as to give a high degree of reliability

b In case of trouble on the system any defective piece of apparatus must be isolated immediately with the minimum effect on other apparatus

c Any apparatus whose operation might have been interfered with must be restored to service as quickly as possible, with the minimum of attention by the operating force

d Any disturbance on the main generating system must have a minimum effect on the station light and power system.

The electric load was found to be of such proportions that had and losses would have been very great. This consideration led to the adoption of 2300 volts for the supply of the larger motors. Though there was no definite experience available on which to base such a course in central-station practice, the economies thus effected, together with the improvements which had been made in 2300-volt equipment, resulted in the use of this potential for motors of 100 hp. and larger. Since ruggedness and reliability are essential for service on boiler and turbo-generator auxiliaries, it was recognized that great care must be exercised in selection of the 2300-volt equipment. With these thoughts in mind, features such as especially rugged contactors, both primary and secondary, for slip-ring motors, increased spacing of slip rings, 40-deg. cent. ratings, and oversize starting compensators were included in the specifications.

In the design and construction of the 2300-volt station auxiliary system the same care was exercised as in the case of the main 13,200-volt system. Bus bars and oil circuit breakers are housed in concrete compartments, and breakers of high rupturing capacity used. By the use of differential relays on all of the important motors, assurance is given that the latter will not be disconnected from the line for any reason other than failure within themselves or of the cable supplying them, thus insuring continued operation during system disturbances. The motors used with the boiler fans and circulating pumps are so arranged that, in the event of an interruption to service, they will automatically be restored to the condition of operation existing previous to the interruption.

It was recognized that boiler-room attendants, and even turbine engineers, would probably not be familiar with electrical equipment, and for this reason and for greater reliability of operation all apparatus is of the remote-control type. Hand-reset relays in locked compartments are employed, so that it will be impossible for any one but the plant electrician to restore service to a motor that has failed, and more than ordinary precautions are taken in enclosing all electrical equipment that is located in the boiler and turbine rooms.

While only two units are at present installed, the capacity of this plant has been planned for an ultimate installation of six 30,000-kw. generating units, and the electrical distribution as described below will take care of the complete installation.

The electrical supply to auxiliaries will be through four 5,000-kva. 13,200 to 2,300-volt transformer banks. Three of these are ample to carry the ultimate peak load. This energy is distributed to the various auxiliaries through twenty-eight 2300-volt feeders as follows:

9 feeders to circulating- and air-pump motors
8 feeders to boiler-fan motors' distributing bus
2 feeders to coal tower
2 feeders to motor-generator sets for d. c. supply
1 feeder for motor-driven exciter
2 feeders to miscellaneous motors' distributing bus
3 feeders to low-tension transformers
1 feeder to test set (for testing high-tension cable)

There will be three 1000-kva. transformer banks for stepping the voltage from 2300-volts three-phase down to 115–230-volts two-phase to supply small motors and lighting. There will also be two 300-kw. motor-generator sets to convert a. c. energy to 125–250-volts d. c. for driving motors of wide speed variation, such as those used for stoker drive. A storage battery serves as an emergency supply for this equipment.

Most Economical Heat Distribution

Two heat-distribution diagrams, Figs. 1 and 2, have been worked out, based on the present installation of two 30,000-kw. generating units. Fig. 1 illustrates the heat distribution for an hourly load at the most economical point of operation for the turbine, and with a vacuum of 29 in. Nearly all of the values shown are based on the results of actual tests conducted on the apparatus since its installation, and the coal rate has been based on a heating value of 13,500 B.t.u. per pound of coal as fired. At the time the heat balance for this plant was originally calculated, coal received contained an average heat value of 13,500 B.t.u., as used in this figure. This value has been used in calculations for all preliminary, or theoretical, heat balances.

The overall efficiency of the boiler, stoker and economizer of 80.4 per cent, given on Fig. 1, is based on an actual test made during the month of June, 1921, when an efficiency of 81.7 per cent at a boiler rating of 176 per cent was obtained. A correction has been made on this diagram for the lower air temperature that would prevail during the winter months, at which time a vacuum of 29 in. is obtainable.

Under "heater vent losses" has been included a loss of about 5 per cent of the exhaust steam used for feedwater heating. This loss would be difficult to measure with any accuracy, but it is believed from rough checks on heat absorbed in feedwater that the figure of 5 per cent should cover the losses at this point. The economizer and blowdown losses are correct within the limit of accuracy of the V-notch meter used to record these losses.

The item of line radiation losses, while apparently small, is noted separately, due to the fact that this is a heat loss only. When the original heat balance was figured for this plant, it was felt that it would never be necessary to bleed the turbine, due to the fact that a large increase in temperature of the condensate was expected as a result of passing the condensate through the waterbacks in the boiler bridge walls. It was found, however, in actual practice that, due to the very large combustion chamber and the more complete combustion secured therefrom, the temperature rise of the water was almost one-third less than that originally estimated.

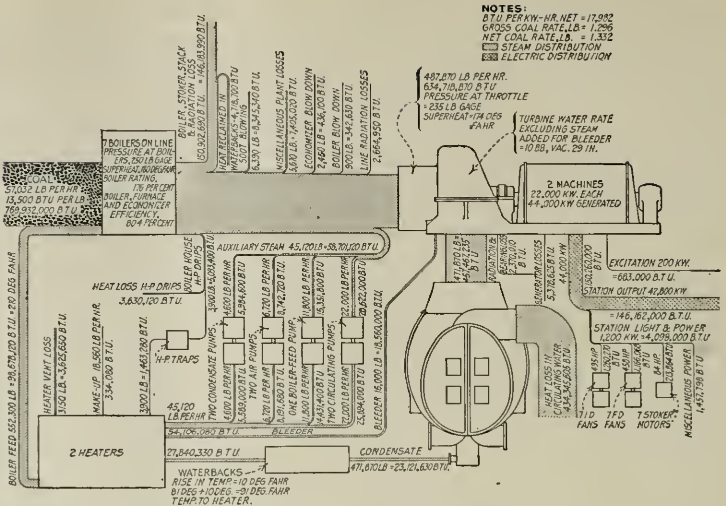

FIG. 1 HEAT BALANCE AT MOST ECONOMICAL LOAD
(60,000-kw. generating station with 44,000-kw. load and 29-in. vacuum.)

The heat distribution for the hourly condition (Fig. 1) does not of course, make any allowances for banking or emptying of boilers for repairs. These are about the only losses which would occur over continued operation, which is not included in this diagram.

TYPICAL WEEKLY HEAT DISTRIBUTION

Fig. 2 illustrates the actual heat distribution over a period of one week, during April, 1921. It will be noted on this diagram that the load factor of the plant, based on its maximum capacity, was only slightly over 50 per cent, which means, in this case, that the average boiler efficiency is lower, and the average turbine water rate higher, than will be obtained under more favorable load conditions. Several records of weekly coal rates which very nearly approach this result have been obtained with a lower load factor and the plant operating over considerable periods of the day with light loads on the turbine.

There are several items on this diagram which differ from the diagram in Fig. 1, as follows:

a A considerable difference will be noted between the heat value of the coal as used in this diagram and that used in Fig. 1. The coal was comparatively high in heat value during this week's operation, whereas the average over a longer period would be lower

b All of the turbine-driven condenser auxiliaries have been grouped, as the number of auxiliaries used in varying conditions necessarily varies with the load and temperature

c The station light and power load has also been given as one item, due to the fact that the number of auxiliaries in service at various times depends on the load and temperature

d There is no temperature increase shown in the condensate between the condenser and the heaters, as the water backs had not been connected to operate on condensate at that time. The heat which ordinarily would be picked up in the condensate water in this case was lost and is accounted for in the stoker and radiation losses

e The average boiler-feed temperature at this time (for the diagram in Fig. 2) was 204 deg. fahr. It was found in operation that this temperature is too low, and that not enough oxygen is liberated in the heaters to allow for operation of the boilers without considerable pitting in the integral economizer tubes

f The amount of superheat in the steam at this time was lower than shown on the diagram in Fig. 1, due largely to the fact that, with the combustion conditions obtained in the large furnaces, the superheat was below guarantees. Since that time the superheat has been increased by changes in baffling, with resulting increase in efficiency on the turbine water rate.

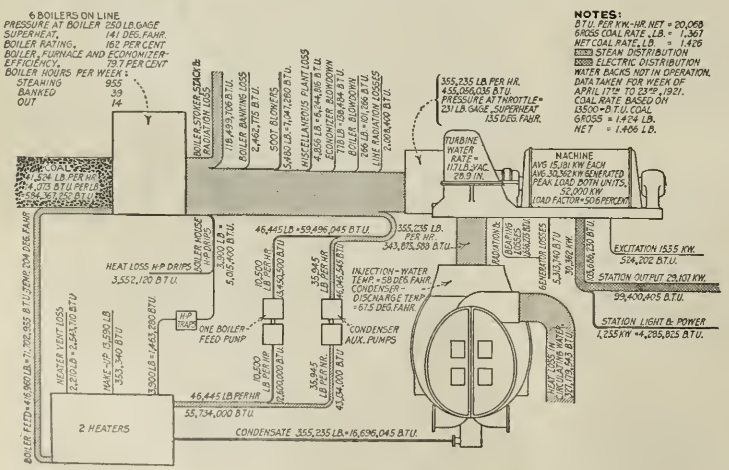

FIG. 2 HEAT BALANCE FOR ONE WEEK'S OPERATION
(60,000-kw. generating station having average load of 30,362 kw. and average vacuum of 28.9 in.)

Throughout the week illustrated in this

over the week end, when the station load is usually low enough to be carried on one turbine, one boiler was taken out for repairs and cleaning. The banking hours represent the hours during which certain boilers were banked to take care of low-load conditions between midnight and 6. 00 a.m. It was found more economical to bank boilers for this period than to operate the entire six boilers at a lower rating.

Summary

Summarizing the heat-balance situation at this station, it is believed that, while there may be a slight loss in heat economy as compared with some other method of obtaining heat balance, the very important item of reliability of service as obtained by this system, and the ease with which it may be operated, will fully offset the possible gains in heat economy secured by other systems.

At the present time steps are being taken toward the installation of an air extractor, which, by removal of the oxygen from the feed-corrosion due to this cause, but will increase the boiler efficiency and the overall plant efficiency by allowing us to operate with feed-water temperatures of about 140 deg. fahr.

In the operation of this auxiliary system the only points of variable control which must be taken care of by the operator are the steam supply through the duplex circulating pump and the bleeder steam. These are both, at the present time, manually operated by the regular pump-room engineers. All of the other steam-driven auxiliaries are operated to suit the larger changes in plant load and temperature conditions. These changes do not come very frequently, and are fairly regular in the time at which they occur, so that this phase of operation of the auxiliary system is of only minor importance.

The author wishes to extend his thanks to Mr. R. A. Hentz, assistant electrical engineer of the Philadelphia Electric Co., for his assistance in the preparation of the electrical features of this paper, and to the other associates in the engineering department who assisted him in assembling the data.

Heat-Balance System for Hell Gate Station

By J. H. Lawrence[1] and W. M. Keenan,[2] New York, N. Y.

The Hell Gate Station of The United Electric Light and Power Company, now being built in New York City, will have an ultimate capacity of 280,000 kw., consisting of eight 35,000-kw. turbo-generators. The initial generating installation will consist of two 25-cycle General Electric single-cylinder units and two 60-cycle Westinghouse double-cylinder units. The ultimate boiler installation will consist of 24 water-tube boilers, each having 18,900 sq. ft. of heating surface, with double stokers equipped with clinker grinders. At present one-half the total number of boilers are being installed.

The station will be operated as four independent groups, each consisting of one 60-cycle unit, one 25-cycle unit, one house alternator and six boilers, although provisions have been made for interconnecting the various groups electrically and mechanically.

In connection with the design of this station, the following systems for driving the auxiliaries were considered:

a All steam
b Steam and direct current
c Steam and alternating current
d Direct current
e Altерating current

After a careful study had been completed, it was decided to adopt the alternating current system.

All auxiliaries in this station are to be motor-driven, with the exception of one boiler-feed pump for each group, one fire pump and one of the two exciters for each house alternator. One-half the power for the auxiliaries of each group of two main units will be obtained from the main 60-cycle bus and one-half from the house alternator, so that in case of interruption of either source of power only one-half the auxiliaries will be shut down.

The house alternators will be 2500-kva. 60-cycle 3-phase 2300-volt direct-connected non-condensing machines, running at 3600 r.p.m. The power for the auxiliaries from the main station bus will be transformed from 13,200 to 2300 volts by means of two 7500-kw. power banks located in the boiler-house basement. All motors 25 hp. and over are to be operated at 2300 volts, excepting the motors for the coal towers, cranes and skip hoist, while motors under 25 hp. will be wound for 220 volts.

Any of the station auxiliaries excepting the motors on the coal towers, cranes and skip hoist may be operated from either the bus supplied by the main units or the house-alternator bus through the 2300-volt truck switches, which are located along the division wall between the turbine room and boiler-house basements. The house alternator and the bus supplied by the main units cannot be interconnected.

A diagram of the feedwater system of one group appears in Fig. 1. The condensate after leaving the condensers goes through closed heaters where it is heated to about 150 deg. fahr. and then enters the open heaters where it is raised to 210 deg. fahr. The condensate is then pumped by the boiler-feed pumps direct to the boilers.

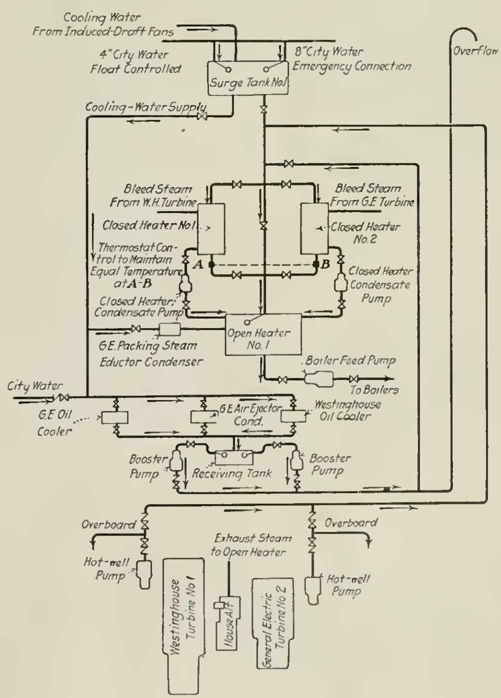

Fig. 1 Heater Connections For One Section

Thermostatically controlled valves equalize the load on the two closed heaters. The closed heaters are supplied with steam at about 6.5 lb. absolute pressure bled from the lower stages of the main turbines. The condensate from the closed heaters is pumped to the open heater. As indicated in Fig. 1, fresh water obtained from the surge tank is used for the oil coolers and air-ejector condensers

[1] Engineering Manager, Thomas E. Murray, Inc. Mem. Am.Soc.M.E.
[2] Assistant to Engineering Manager, Thomas E. Murray, Inc. Assoc-Mem. Am.Soc.M.E.

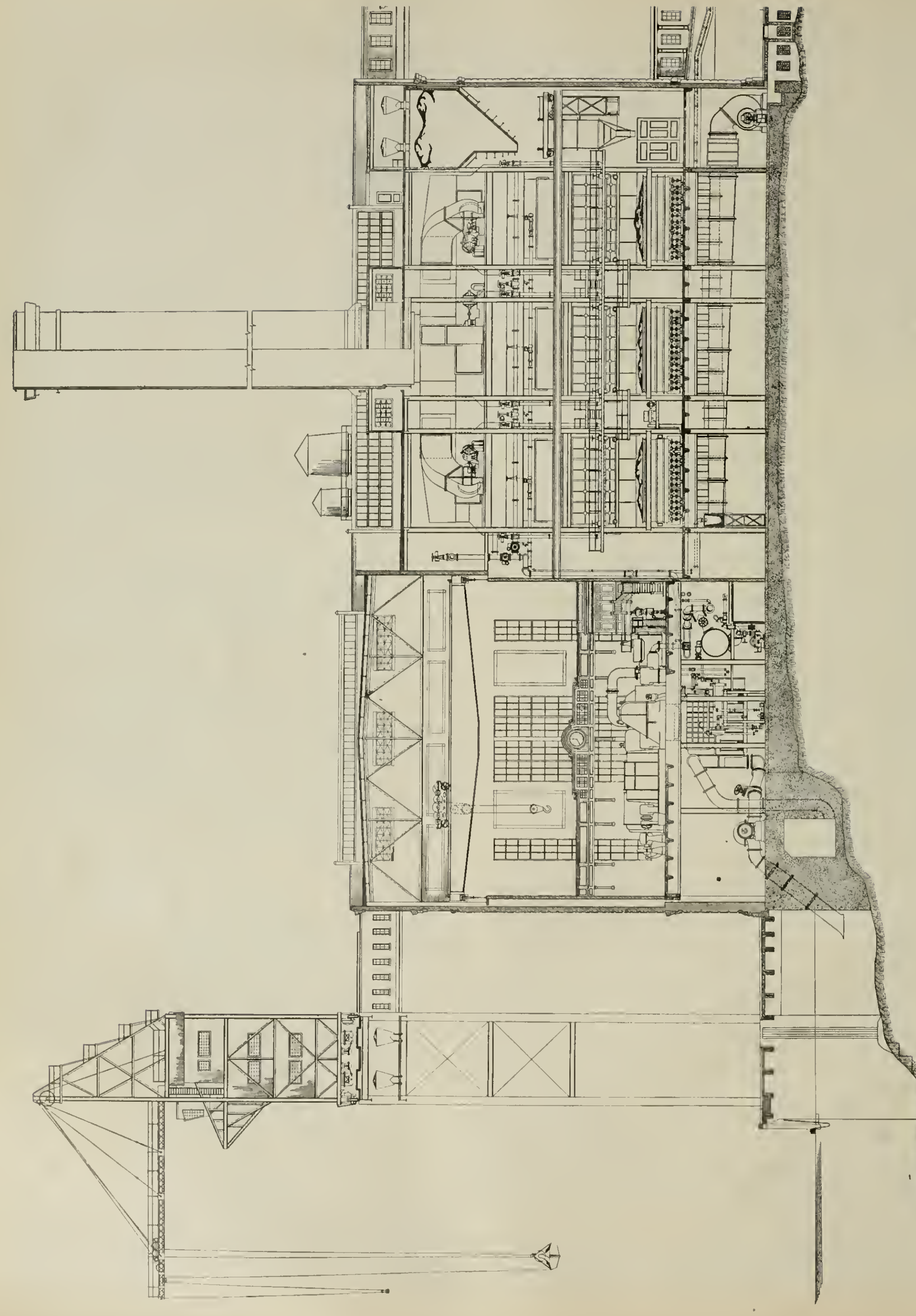

Fig. 2 Cross-Section of Portion of Hell Gate Station

the open heater. The exhaust from the high-pressure packing of the General Electric unit, approximately 4000 lb. of steam per hour, also flows directly into the open heater.

In order to insure a sufficient supply of steam to the open heaters at all loads on the house alternator, steam is bled from intermediate stages of the main turbines through pressure-control valves so adjusted as to automatically maintain 1 lb. back pressure in the open heaters.

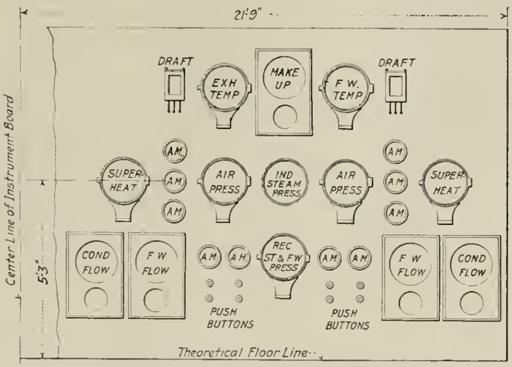

Fig. 3 Portion of Instrument Board for Mechanical Apparatus, Showing Layout for One of the Four Groups

The auxiliary control board, by which one man will supervise all the station auxiliaries, is located above the turbine-room floor. Practically the only manual regulation required for securing the proper heat balance will be the control of the forced-draft fans which will be operated by push-button switches on the control board. The induced-draft fans after being manually started are regulated by an automatic balanced-draft system.

The motors for driving the forced- and induced-draft fans will be of the brush-shifting variable-speed type. The boiler-feed will be driven by constant-speed squirrel-cage induction motors. The stokers will be driven by constant-speed squirrel-cage induction motors through variable-speed transmission machines. The clinker grinders will be driven by two-speed squirrel-cage induction motors.

Fig. 3 shows a typical layout of panel on the control board. The instruments for each of the four groups into which the station is divided are arranged as follows:

The draft gages in the top row are of the three-point type and indicate the furnace draft in each of the three boilers in each row of boilers.

The other instruments in the top row record: (*a*) the exhaust-steam temperature in the atmospheric exhaust line, in order to detect any loss due to excess exhaust steam; (*b*) the city water make-up to the group; and (*c*) the temperature of the feed-water to the boilers.

In the middle row are: (*a*) recorders for measuring the temperature of the steam at each of the main turbine throttles; (*b*) recorders showing the air pressure in the forced-draft duct leading to each row of boilers; (*c*) a steam-pressure gage for indicating the pressure in the main steam header; (*d*) ammeters for indicating the relative load on each of the induced-draft fans.

In the bottom row are recorders for measuring: (*a*) The condensate from each of the condensers; (*b*) the feedwater to each row of boilers; (*c*) by one instrument the main steam pressure and the feedwater pressure; (*d*) ammeters for indicating the relative load on the forced-draft fans.

It was the original intention to present herein the calculations made when computing the heat balance to be obtained, but after conferring with the various authors who were preparing papers on heat balance for the Meeting, it was felt that the chief interest would be centered upon operating figures, and as the Hell Gate Station is not in operation at the time this paper goes to press, operating figures are not available, and the heat balance calculated for it would therefore have only a theoretical value.

It was thought, however, that the presentation of the system to be employed to obtain the heat balance would be of interest at this time, and for this reason the present brief description was prepared. It is to be hoped that operating figures will be available for discussion at the Annual Meeting.

Heat Balance of Colfax Station

By C. W. E. Clarke,[1] New York, N. Y.

It has been the practice for a good many years to drive certain auxiliary station apparatus by steam and to use the exhaust from this apparatus for heating the feedwater. Within recent years various attempts have been made to proportion the amount of steam-driven auxiliary apparatus so as to have only enough exhaust steam to maintain the feedwater at a suitable temperature. This system has taken on many different forms, but the purpose of all of them is to avoid having any excess of exhaust steam that would have to be wasted. Systems having the foregoing object in view have received the general name of "Heat Balance System." It is not within the scope of this paper to discuss the relative merits of various types of heat-balance systems. The author will simply endeavor to explain briefly, but as clearly as possible, the system adopted for the Colfax Station of the Duquesne Light System, located at Cheswick, Pa., and give some of the results so far attained with it.

The Colfax Station is designed for an ultimate gross capacity of 360,000 kw. and for a maximum output of 300,000 kw. The generating equipment as now planned will consist of six 60,000-kw. turbo-alternators, of which one is now in service and a second in process of installation. The immediate boiler equipment will consist of seven B. & W. cross-drum boilers, each having 20,880 sq. ft. of heating surface; four others of the same type, each with 22,910 sq. ft. of heating surface, are to be installed in the near future. These boilers will be equipped with 17-retort extra long Westinghouse underfeed stokers. Each of the present units has four 25,000-sq. ft. Westinghouse surface condensers, two for each low-pressure element. All condenser auxiliaries are motor-driven. There are three 1500-g.p.m. turbine-driven centrifugal boiler-feed pumps. The forced-draft equipment consists of three 250,000-c.f.m. Greene fans, turbine-driven through reduction gears. All other station auxiliary apparatus is motor-driven. A 2000-kw. house turbine is provided to supply auxiliary power. This turbine comprises part of the heat-balance system as described below.

Fig. 1 shows the bus arrangement for supplying the electrical auxiliaries. There are two buses from which the auxiliaries may be supplied, one fed through a transformer bank from the main station bus, the other fed by the house turbine. These two buses are tied together through a motor-generator set, so arranged that energy can pass from the auxiliary bus to the house-turbine bus but not in the opposite direction. A direct tie is provided between these two buses for use in case of failure in the motor-generator connection. The switches in the direct tie and the motor-generator connection are interlocked so that only one can be closed at a time. Auxiliaries are so connected that they may be fed from either bus, the switches being provided with interlocks so that both cannot be closed at the same time. With the present auxiliary load the auxiliary bus fed from the main station bus is not necessary. The house turbine is ample to carry the entire load. When the second 60,000-kw. unit is installed, however, the auxiliary load will exceed

[1] Dwight P. Robinson & Co. Mem. Am.Soc.M.E.

the capacity of one house turbine, resulting in part of this load being placed directly on the auxiliary bus and being fed from the main bus. Only as much load will be thrown on the house turbine bus as is necessary for heat balance.

For starting purposes an 1100-volt bus is provided, which obviates the necessity for compensators and other starting devices. The starting and running switches are provided with sequence interlocks, which makes it impossible to close the switch on the 2300-volt bus until after the 1100-volt switch has been closed and opened.

Due to the slip in the motor-generator set, the frequency produced by the generator is about 57 cycles when the main bus frequency is 60 cycles. If the speed of the house turbine is varied so as to make its frequency slightly above or below that of the house-turbine bus, the amount of load carried by the house turbine will be correspondingly varied. The system of using a house turbine paralleled on the main bus is not new, but in existing installations of this kind considerable difficulty has been met with, due to differing characteristics of the small house turbine and the large units supplying the main bus. The motor-generator set mentioned above was introduced into the system to avoid this difficulty. This piece of apparatus acts somewhat like a flexible coupling, taking up the momentary variations in frequency on both sides. This arrangement permits of any desired variation in the quantity of exhaust steam available for heating the feed-water since the greater part of the steam for feed heating comes from the house turbine. Its control can be practically accomplished by manipulation of the house-turbine governor control on the main switchboard alone. Manipulation of the barometric injection valve is occasionally necessary. A graphic recorder in the control room indicates the boiler-feed temperature so that the switchboard operator can maintain the boiler-feed temperature at any desired point.

The general heat cycle is indicated on the diagram, Fig. 2. As will be seen from this diagram, the condensate passes from the hot well to the double-effect evaporator, where it acts as a circulating medium in the evaporator condenser, absorbing the heat of vaporization from the water evaporated. Thence it goes to a head tank located on the boiler-house roof. This tank merely acts as a small storage reservoir to take care of variations in water flow in this part of the system. Normally, the make-up to replace water losses throughout the system enters the flow at this point as well as returns from the main unit glands and other miscellaneous clean-water returns with the exception of the high- and low-pressure drips. The water from this tank flows to the barometric condenser whose steam supply originates as described below. A sufficient quantity of steam is admitted to this condenser, the quantity being controlled as described in the preceding paragraph, to raise the water temperature to that desired for boiler feed.

Fig. 3 shows the position of the head tank, the barometric condenser and the boiler-feed tank, as well as the relative position of all steam apparatus in the heat-balance system.

Boiler-feed pumps and forced-draft fans, which are steam-driven, exhaust into an auxiliary exhaust header from which the evaporator is supplied. It is seldom, if ever possible to make the quantity of low-pressure steam in this header exactly right for the evaporator demand. Consequently, there is a connection through a flow or back-pressure valve to the house-turbine exhaust pipe. This valve permits any steam in excess of that required by the evaporator to flow into the house-turbine exhaust pipe and thence to the barometric condenser. It is occasionally necessary to regulate the amount of water going to the barometric condenser, and this regulation is accomplished by means of a motor-operated valve controlled from the turbine-room floor. There is in conjunction with this valve a position indicator so that the operator on the turbine-room floor can tell just how far this valve is open.

The manipulation of this system is very simple and positive. For days at a time the temperature in the boiler-feed tank will not vary more than one or two degrees from 210 deg. fahr. This variation is, of course, due to fluctuations in the total station aux-

(Continued on page 825)

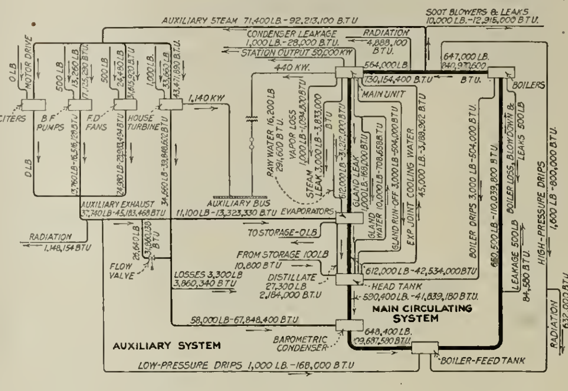

Fig. 2 Heat-Flow Diagram
(Average vacuum in main condenser, 28.73 in.)

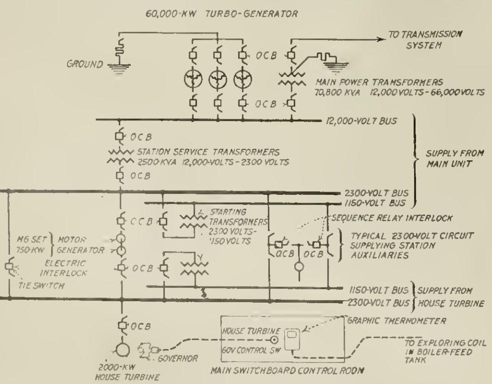

Fig. 1 Circuit Diagram of Auxiliaries

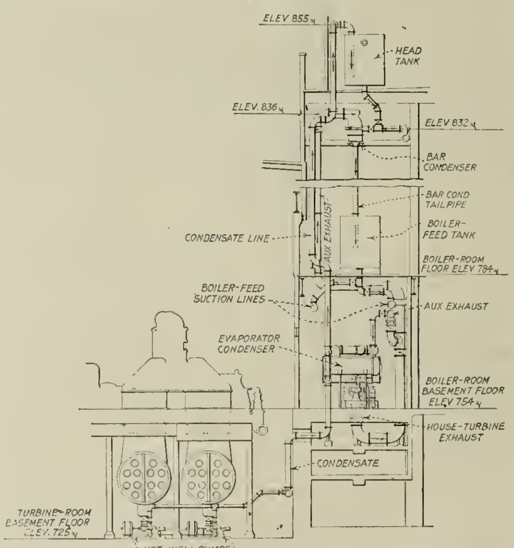

Fig. 3 General Arrangement of Feedwater System

T Industrial managers are studying operating conditions as never before in the history of business, and among the various phases of the subject which relate to the reduction of operating expense, the salvage of factory wastes comes in for a large measure of attention.

Let us first consider the question of salvaging metal wastes—for every factory in the country manufacturing a mechanical or semi-mechanical product produces metal scrap of one kind or another. It is essential that a system be set up whereby the various grades of metal chips and turnings will be kept separate in the shops during machine processes in order to save time and labor sorting and segregating in the scrap or salvage department. Non-ferrous metals should always be kept separate from steel and iron. When the parts machined consist of a non-ferrous metal with steel or iron, the chips should be run through magnetic separators.

In some of the bigger industries, chips and turnings are pressed into briquets of suitable cupola size, but this practice has not as yet become general throughout the country, and is carried on chiefly where the tonnage of chips and turnings is normally large. The process results not only in higher market value, but also in a material saving in transportation charges. Sheet-metal punching scrap, metal strips, trimmings, wire, etc., should always be put up in bundle form and in cupola size before being loaded for shipment, for the same reasons.

All the various classes of miscellaneous scrap metal, such as cuttings and trimmings from bar, rod, and heavy sheet stock, small castings, forgings, and solid pieces of every kind, should be accumulated in separate containers in the shop, for this class of scrap has a higher market rating than is obtained for chips and turnings.

Laboratory processes are often productive of valuable wastes either in the form of metals, such as tungsten, molybdenum, etc., or in the form of various chemical residues which may, through conversion or combination, become the basic elements of new preparations and compounds.

There is a wide variety of miscellaneous wastes which require our attention, and in this field a great amount of salvage work can be profitably done. Lumber, boxes, rope, rubber, fiber, cotton and woolen fabrics, cotton waste, paper, insulation materials, chemicals, etc., constitute some of the items which can be salvaged with profit in the modern industry. As an example, incoming boxes can be repaired and put in shape for future use either for storing materials, or as tote boxes in the shop. When too large to be suitable for these purposes, the lumber can be utilized for repairing and making tote boxes, temporary platforms, stagings, concrete forms, etc. The salvaging of lumber and making of boxes from this second-hand material in some of our large industries represents a saving of many thousands of dollars yearly in the purchase cost of new lumber. Even sawdust, usually considered of little value, can be used for the packing of porcelain and similar products, and the finer grades for the drying of metal parts in the dip shop. There is scarcely an item that we can name in the list of industrial wastes that has not some value either in its present state, or in the production of raw materials for the manufacturer's use. Even what is known as shop refuse may be burned in a destructor plant under boilers, and produce steam for heating and manufacturing.

A careful system of segregation is essential in the salvaging of metals, as well as of all other kinds of factory wastes, and this should be carried to the highest standard consistent with local conditions and without defeating the purpose of securing the highest market prices by undue expenditure for labor and equipment. It is well to have all scrap weighed and credited to departments for the twofold purpose of correct accounting and inculcating an interest for salvage work in all department heads.

But we must carry our salvage work into other branches of shop activity, such as maintenance of property, repairs to machinery and tools, handling of stocks, and upkeep of all the various classes of small tools, including lathe and planer tools, high-speed steels, etc.; and here is where the expenditures in big industries begin to mount up to vast sums, to hundreds of thousands and even to millions of dollars, during the course of a year. It is essential, therefore, that systems be set up whereby all these items of maintenance will receive the most careful scrutiny and the expenditures will be adequately limited and controlled. Systems must be set up governing the distribution and repairs of the various classes of small tools so that the consumption of these will be regulated within certain defined limits of economy and efficient service, in accordance with production requirements in the shop. It is good practice to make regular monthly inspections of machine tools and equipment, and make a record of the same, in order that repairs may be made promptly at a minimum of cost before the damage becomes more serious or breakdown ensues with increased repair expense and added delay to production. The record is valuable as showing the relative cost of maintenance and relative life of service of various makes of tools. It is often good economy to replace a tool showing high maintenance cost with a new tool of some other make, and thus save both expense and delays to production. In all cases of replacements and repairs, valuable parts should be salvaged and made use of on other jobs of repair work, wherever practicable.

In the supply of small tools to the shop much can be accomplished in the way of reducing expense by efficient methods of distribution and collection. A system of regular inspection of toolrooms, tool cupboards, benches, and areas around machine tools should be established in all departments. Tools not needed for immediate or current use should be cleared up promptly and returned to stock, and those needing repair put into shape for further requirements. This is particularly important in the case of high-speed-steel tools where the cost is relatively high by comparison, and a single idle tool may represent a good many dollars of tied-up capital. Nearly all the various small shop tools, such as wrenches, vises, hammers, drills, cutters, pliers, files, and numerous others can be repaired to good advantage and thus be made to give greatly lengthened service and reduce the number of purchases of new tools. By a properly organized system of distribution and collection the inventory of tool stocks carried may be greatly reduced, expenditures for new tools curtailed, and those in use in the shops kept more constantly in active service.

The subject of lubrication both of machine tools and of cutting tools affords opportunity for valuable reduction in the operating expense of the shop. With modern storage equipment and modern facilities for distribution to the shops, also proper feed pipes and oilers for regulating the supply to tools, a material saving in consumption of oils and cutting compounds can be made. Selection of oils is most important, and this should always be made with a view of reducing friction load on bearing surfaces and of keeping tools properly cooled and lubricated during the process of cutting, and not primarily in reference to cost. Valuable work has been done in recent years in the substitution of mineral oils and mineral lard oils for pure lard oil in a variety of processes where formerly pure lard oil was felt to be necessary. In fact, a heavy-body mineral oil of correct specifications will do the greater percentage of jobs commonly done with lard oil without any material increase in consumption, and with greatly reduced cost. A high-grade light-body mineral oil will also do many processes, such as turret-lathe work, milling high-carbon steels, etc. Soluble cutting compounds also have their place in machine-shop practice, and their use in a great variety of processes, such as drilling and milling, plain lathe work, cold cutting, etc., results in a greater economy than can be secured with oil. Attention needs to be given to the handling and distribution of oils in order to avoid waste. Machine tools should be equipped with proper tanks, drip pans, and aprons,

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[1] General Superintendent, General Electric Company. Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. Copies of the paper may be obtained gratis upon application. All papers are subject to revision.

in order that nothing may be lost. Reclaiming oil from production parts and from chips and turnings is a part of the salvage work of every up-to-date factory and one that need not be enlarged upon here.

We hear much talk these days on the subject of reducing inventory, and it is essential that the work be carried forward intelligently and earnestly in order to put industry on its feet. The present is the time to make thorough investigation of every department and storage space, and to gather up all surplus or idle materials and made effort to put them into service, or otherwise dispose of them to advantage. Analysis must be made of the methods of handling and distributing materials in order to establish improved systems, reduce labor, and avoid delay or damage. Special attention should be given to cutting raw materials to required dimension or multiples of required dimension in order to save waste; and to the salvaging of all left-over pieces and parts for further use in some portion of the factory, wherever practicable. For this purpose the central storehouse should act as a clearing house, and thus render aid in the general work of salvaging.

The human element enters into salvage work, as into all other industrial operations. If we can get department heads, and employees as well, interested in saving everything of inherent value, we will perform a valuable service in helping to reëstablish industry on a firm and stable basis. Not only industrial managers, but the public as well, are more and more becoming interested in this most vital of human problems. One of our big industries salvages annually, in normal times, more than eighty million pounds of factory wastes. The railroads also have caught the spirit of thrift and are establishing new practices which are showing greatly improved conditions as regards operating expense. The country at large in a recent year saved scrap, consisting of several items—metals, paper, rags, wool waste, cotton fabrics, etc.—aggregating more than one and a half billions of dollars.

In the years immediately before us, industry will be called upon to bear a large portion of the burden in the vast and arduous work of reconstruction. As engineers and managers we need, therefore, to be strongly imbued with the vital principles of economy and thrift, and with the importance of greatly increased effort along the lines of salvage work. The question of profit must not always be a deciding factor, but we must conduct our operations with a broader view of saving everything which may be of value to others in the production of raw materials or finished fabrics, whether we gain immediate, direct profit or not. The manufacture and supply of raw materials depends so often upon the supply of various kinds of scrap and waste that it is most essential we give consideration to the country's needs as a whole and do not limit our efforts at salvage work to our own desire for immediate profit. Indirectly we shall receive benefit through reduced cost of the raw stocks we purchase for our own manufacturing purposes because of the abundance of original materials which we have helped to create.

No appeal to the manufacturer to save the waste products of industry can be made too forcible or too strong, nor can we lay too much emphasis upon the necessity for every individual joining earnestly with us in this great work of universal benefit to the country at large. Every pound of junk saved at our homes and turned over to the junk dealer in the end reaches the great melting pot, and finally the marts of trade, in the form of raw materials to be of definite value to some one; and that one, incidentally, may be any one of us here engaged in the profitable manufacture of fabrics which serve a public need. The nations of Europe, through the very exigencies of the war, were forced to carry on the work of salvaging to its greatest limit in order to sustain the people at home and the armies in the field; and now, during the period of reconstruction, they appear to have doubled their effort and to have gone beyond this limit in the struggle to rebuild government and business and industry on a stable and enduring basis. We in America are gradually becoming more and more aroused to this big problem in our public and private life. We have been given to waste and extravagance in the past, but we are gradually awakening to the fact that it is not so important what we have or what we produce as what we are able to save and reclaim from all the various processes of production. What we need to learn as a nation and as individuals is the vital importance of practicing the simple precepts of economy and thrift and of guiding all our actions both in business and private life to that essential end. We need to learn to save everything of inherent value, and in doing this we ourselves shall derive a benefit in the general public good.

We ought to have a permanent reclamation service, fostered and maintained by our National Government as other public services are fostered and maintained. Through this office practical appeal could be made to the governors of states, through the governors of states to mayors of cities and presidents of villages, and through these latter to the heads of boards of trade and to public-spirited citizens, to coöperate in the great work of saving the nation's wastes. Through this channel also could be disseminated much useful knowledge and instruction relating to the work of reclamation, which would thus reach in a helpful way not only the populous industrial centers but the outlying districts as well, and by this means bring about a widespread, concerted action for the public good. No one may attempt to predict the full extent of the value or the aggregate return of such a movement to the Government and country at large.

Still another phase of salvage work which is distinct and apart from the field of salvaging metal scrap and other factory wastes, is the saving of time and of human effort, the harboring of mental and physical energy, and the devoting of all our effort to the highest purposes and the highest aims. Profitable manufacturing requires that we build up our organizations both in offices and in the factory with a view of concentrating directive effort, eliminating duplication of orders and instructions, establishing unity of purpose, system in method of procedure, and coöperative effort on the part of all employees, whether serving in official capacities or in the lower grades of mechanical and physical labor. It is essential that we organize departmental forces in such manner as will secure systematic control of all the functions of labor and consumption of materials, and the keeping of manufacturing expenses within the budget provided for conducting shop and office work. We must build our organizations with a view of attaining the highest standards possible, in order to reëstablish business on the high plane of influence which it must always occupy in the successful upbuilding and support of our Government and nation, and in the permanent establishment of the normal pursuits of industry and peace.

ON THE ART OF MILLING

(Continued from page 789)

10 deg. and probably is up to 15 deg. This statement is made definitely for steel up to 0.50 carbon, and it is believed that it will be found true for all metals.

Experiments With Machineability Tester

The Machineability Tester was designed, as stated earlier, for measuring quickly the machineability of different metals. This machine is shown in Fig. 16. If the weight be allowed to fall freely from the top position, it will rise almost to the same height. A pointer indicates the highest position to which the weight rises and this is taken as the zero reading. If, in a subsequent fall, a chip be formed then the weight will not rise as high. This change in height is a measure of the energy given up in forming the chip. The same principle is used in impact-testing machines.

One group of experiments run on this machine are recorded, as they were carried out to emphasize the analysis brought out previously that maximum chip thickness is the sole criterion of efficiency for a given tool and material. Four different depths of cut and four different feeds were taken, giving sixteen differently shaped chips in all.

The results of these sixteen experiments are given in Fig. 17, in which cubic inches per horsepower-minute are plotted against maximum chip thickness. It is seen that efficiency is a function of maximum chip thickness alone.

The importance of the above point of view cannot well be overemphasized. In arranging instructions for the operation of milling machines, in compiling feed and depth-of-cut data, or in comparing different jobs, the fact should be kept in mind that maximum chip thickness is the true criterion of cutter-tooth punishment.

Avoidable Waste in Car Operation —The Container Car

By WALTER C. SANDERS,[1] NEW YORK, N. Y.

This paper describes the "container" cars which have recently been placed in service on the New York Central Lines and others having improvements on the original type which are now under construction.

The advantages claimed for the container car are that less-than-carload lots of freight, mail and express may be shipped with a material saving of time to the shipper and the railroad company, in that the container car may be rapidly unloaded and reloaded. The car will also permit the railroad to secure the maximum mileage out of rolling stock.

Valuable commodities of all kinds can be transported from consignor to consignee inviolate from damage by fire, weather, breakage or theft, also eliminating to a great extent rehandling, trucking and checking.

THE container car was an outcome of the railroad congestion during the war and was first put into operation last year by Mr. A. H. Smith, president of the New York Central Lines, to reduce the transportation losses due to congestion which tied up industry. This congestion was caused by the railroads being unable to get rolling stock near the platforms or places where cars could be unloaded and reloaded and put back into circulation. In some cases manufacturing plants used box cars as a storage warehouse, gladly paying the demurrage charged by the railroads. It is hoped that mail, express and freight robberies, breakage, checking and rehandling, delays to shippers, and many other railroad evils may also be materially reduced by the container-car system.

Fig. 1 The Express-Type Container Car with the Containers Removed

At the sides are visible the guides which hold the containers firmly.

Loss of and damage to freight has grown in recent years into one of the heaviest leaks in the transportation industry and strenuous campaigns which included maintenance of extensive police and supervisory forces, together with educational campaigns among shippers and railroad employees to secure stronger packing, careful handling and suppression of theft, have failed to stop this economic waste.

The proportions of this transportation problem may be judged from the fact that in the year 1914 American railroads paid out $33,000,000 in claims for loss of and damage to freight, and for the year 1920 this mounted to a total of $125,000,000, the incidental injury to business affected being considerably greater. Under the ordinary system of handling less-than-carload lots or shipments the goods are checked and handled item by item from shipper to truck or dray, from truck to depot platform or warehouse, and from the platform to the car. They are subject to handling and checking at each stage of the journey, and when finally they reach their destination this handling and checking is all done over again. It is therefore necessary to maintain armies of employees to act as freight handlers, clerks, checkers and station overseers, as well as switchmen to shunt cars to fixed locations where loading and unloading are possible.

The container system provides that the portable container shall be loaded and locked at the shipper's own store door, conveyed by motor truck to the railroad yard, and lifted by crane aboard the container car, where steel bulkheads and sides form absolute protection against opening the container in transit. At the destination the locked container is unloaded by a crane and carried by motor truck directly to the warehouse or consignee's door, to be unloaded at his convenience. This simple system of handling goods will make it possible to greatly reduce the force of employees now necessary.

Fig. 2 The Express-Type Container with the Containers in Place

The steel sides of the car prevent the doors of the containers from being opened.

Another advantage of the container-car system expected to prove most valuable is the greatly increased use of container rolling stock in moving service, which is particularly important when traffic expands to its "peak" and the prime need is to shorten layovers of cars in yards and stations for loading and unloading, and to limit their idleness and obstruction through misuse for storage purposes. In busy times the need is to keep every wheel

Fig. 3 Post-Office Trucks Loaded with Containers at Chicago Post Office

[1] Equipment Engineering Department, New York Central Lines. Assoc-Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. Copies of the paper may be obtained gratis upon application. All papers are subject to revision.

turning as continuously as possible to secure maximum transportation. With ample supplies of the removable containers, which in their several classes are of uniform size and interchangeable, one carload of containers may be removed and sent with their

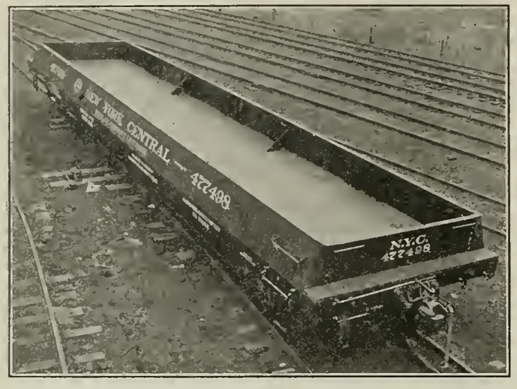


Fig. 4 The Freight-Type Container Car With the Containers Removed

Since this photograph was taken cross-plates have been added to keep doors of containers from being opened after one or more containers have been removed from the car.

loads to consignees, and another set immediately hoisted into place and the car be ready to proceed within a matter of minutes in most instances. The locked containers may remain on station platforms or at the stores of shippers for loading or unloading at convenience

Fig. 5 The Freight-Type Container Car With Containers in Place

It will be noted that the car differs materially in appearance from the express type. This photograph shows two large and two small containers. The large containers have been cut in two, making the standard equipment for this type of car 6 containers.

without tying up costly rolling stock at points where track capacity is limited and congestion quickly obstructs the flow of traffic unless the cars are kept moving. With this rapid handling of the containers on and off the car the mileage per year made by the ordinary piece of rolling stock may be doubled, and it is predicted that the tremendous expense of maintaining box cars and other rolling stock equal to all emergencies will be materially cut down.

The container car may make costly packing and crating unnecessary because goods packed in flimsy pasteboard boxes or even bound with heavy paper are protected against breakage, theft, and water or weather damage.

There are at present in service on the New York Central Lines, three container cars, one of the mail or express type, and two that are being used for valuable freight, such as silks and woolens. Three new mail cars of improved design which are now being constructed will be equipped with an improved type of all-steel container. A new freight-type container car is being designed, and refrigerator and tank container cars are contemplated.

General Description of the Container Car

The container car is nothing more than a long car with a steel side or fence, similar to a low-side gondola, loaded with large steel safes or containers, made as light as possible, in which commodities of all kinds travel from consignor to consignee, inviolate against thieves, fire, weather and breakage. The safes or containers are lifted on and off the car by cranes or hoisting devices, permitting

Fig. 6 Unloading a Container From the Freight Type of Container Car

the "parent" rolling stock to continue in immediate transportation circulation. In appearance the loaded car seems to be a solid load of safes or steel vaults set aboard a steel underframe with a low protecting steel fence.

Fig. 7 A Freight-Type Container Leaving the Railroad Yards on a Motor Truck

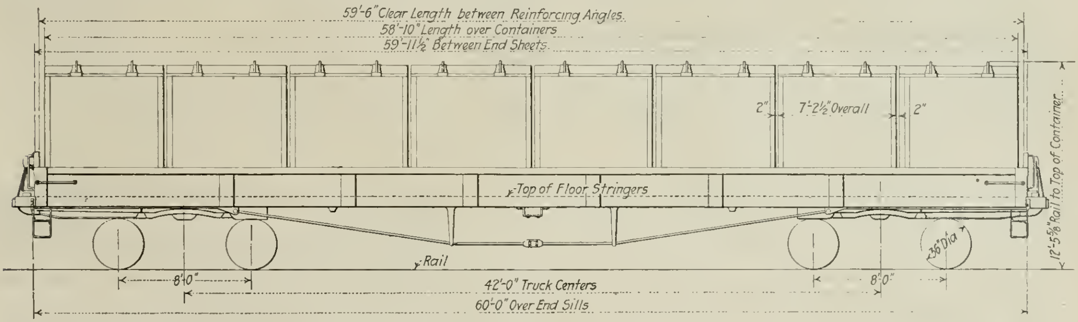
Express Container Cars

The present express car now in use is 61 ft. 3 in. in length, with trucks and fittings that make it interchangeable with standard passenger equipment for use in any passenger train. All modern safety appliances for a special type of car are installed, such as air brakes, hand-hold irons, sill steps, etc. This car carries nine containers, each 9 ft. wide by 6 ft. long, with an inside clear height of 7 ft. 4 in. and a door 3 ft. by 6 ft. The containers are as nearly

and are arranged with four eyelets or hooks, one at each top outside corner, for convenient lifting and handling. The doors are of standard refrigerator design and are arranged with a hasp and staple for the shipper's padlock, also with pin and slot for standard freight-car seal.

The steel sides of the car are spaced to suit the width of the containers, with a clearance of $^1/_2$ in. on each side; the containers cannot be made as wide as the car itself because of the various state highway laws which regulate the width of motor trucks. The New York State law, for instance, limits the width of an auto truck, including body, to 8 ft., the height from road to top of truck or lading to 12 ft. 6 in., and the truck and lading must not have a combined weight of over 25,000 lb. All container cars are fitted with bulkheads and steel sides 2 ft. high into which the containers fit.

In the interior of the body of the gondola part of the car are sectional guides, made of $^1/_4$-in. steel, resembling channel steel, with the laps projecting out from the open ends to enable them to be riveted to the sides of the car. There are guides at each place



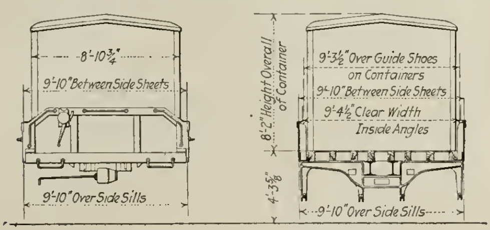


Fig. 8 General Arrangement of Improved Type of Mail Container Car Now Under Construction
This car carries 8 containers.

on the side of the car where the corner of a container will lie.

At each corner on the length side of each container there is a shoe, also of pressed steel, which will fit into the socket formed by the two guides. This arrangement guides the containers to the floor of the car and holds them in place while the car is in transit, without additional blocking or fastening. If it is found necessary to move the car over the road after one or more containers have been removed, it is unnecessary to put in any kind of blocking, because these guides and shoes are arranged to hold the containers and prevent them from shifting or falling over due to the oscillation of the car.

Freight Container Cars

The two freight-type container cars are 50 ft. long. This is exceptionally long for a car used in freight service, being 9 ft. longer than the longest of New York Central box cars. The general construction is similar to that of the express-type container car.

The freight type carries 6 containers, length 6 ft. 7 in., width 7 ft. $1^1/_2$ in. and clear height 7 ft. 7 $^3/_8$ in., all inside measurements.

Each container has a steel frame, base, and roof of open-hearth steel, sides or walls of fir wood, and a radial roof so that water will shed off. All joints are double-riveted. The door in the freight type of container is located in the width side and is of standard refrigerator design. As the door is in the end or width through the open clearance spaces between containers, so in case one or more containers are removed from the car, the doors of the remaining containers cannot be opened.

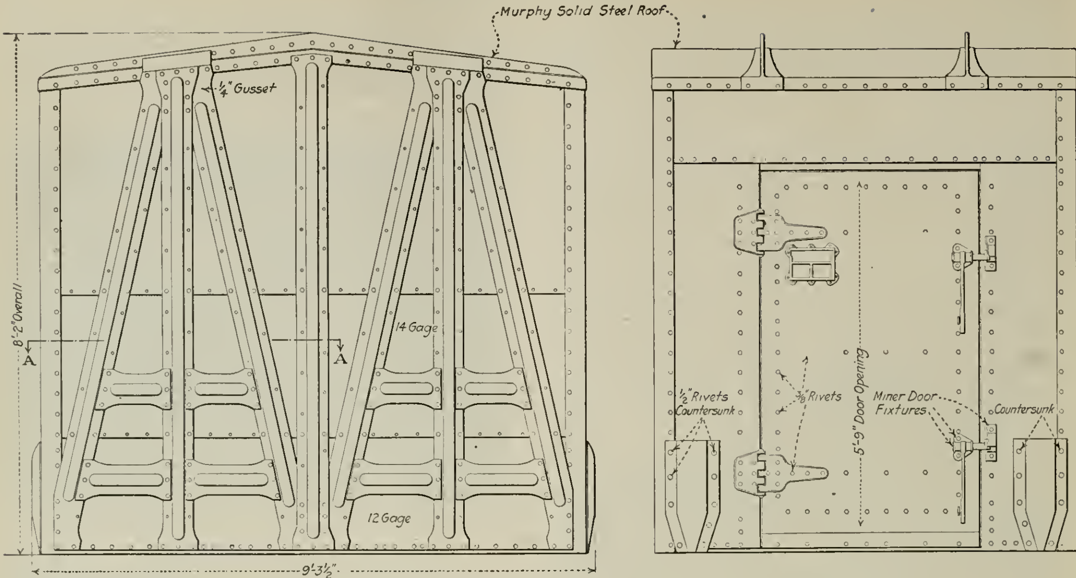
Containers and Container Cars Now Under Construction

The three new mail-type container cars now being built will carry 8 containers of a new, improved design, the outside measurements being, length 7 ft. $2^1/_2$ in., width 9 ft. $3^1/_2$ in., clear height 8 ft. 2 in., with a 5 ft. 9-in. by 3 ft. 6-in. door on the length side of the container. The cubic capacity will be 438 ft., light weight 3000 lb. and capacity 7000 lb.

Tests conducted in the last few months on the New York Central Lines have demonstrated that the express type of container car can be emptied of the nine containers by an ordinary crane in 21 min. and reloaded with other containers and the car put back in circulation in about the same time. This test was made with an ordinary moving track crane, since no special cranes or handling devices have as yet been constructed for use in handling the containers. With the special handling devices contemplated it will be possible to unload the containers with greater speed directly to waiting motor trucks, platforms, or on the ground.

During May, 1921, at the request of the Postmaster General, a mail test was run from New York City to Chicago, Ill., and return with the express type of container car. Upon arrival at Chicago the nine containers, containing 37,000 lb. of mail, were unloaded onto waiting Post Office motor trucks in 21 min., which is one-fifth of the time used in unloading an ordinary mail storage car. At Chicago connections were made with western mail trains that have never been made before. Upon the arrival of the car at New York on the return trip the containers were removed from the car in 18 min.

It is believed that the use of containers in mail service (1) will prevent the loss in transit of valuable registered mail, parcels post and other mail; (2) will mean a saving to the Government in handling mail, both in trucking and checking, as well as a material saving to the railroads in the use of equipment; (3) will make possible a quick transfer at important gateway points and the maintaining of close railway connections otherwise impossible; and (4) will afford an increased weight and capacity as compared with the average load now handled in mail storage or baggage cars, the average weight of mail now carried in mail storage cars being approximately 30,000 lb.; 37,000 lb. of mail were carried on the run to Chicago.



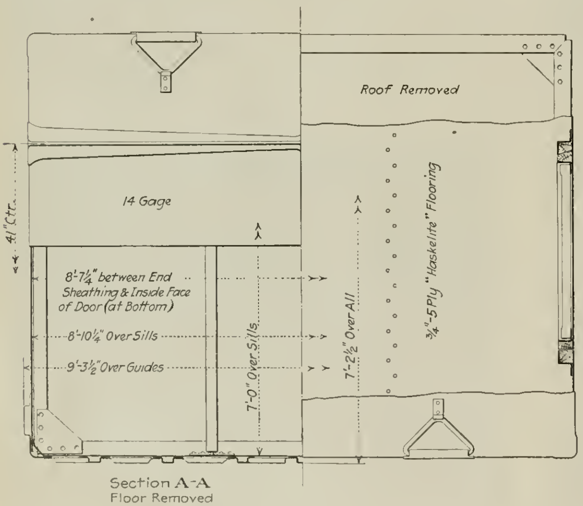


Fig. 9 General Arrangement of the New Improved Type of Mail Container

Note the eyelets for lifting and handling at the top.

Summary

A summary of the prime advantages of the container-car system is as follows:

(*a*) It will furnish a means of expediting delivery of less-than-carload lots of commodities by eliminating the time and expense of rehandling, checking and trucking

(*b*) It will eliminate costly crating and packing

(*c*) The immediate unloading and loading of containers at terminal points eliminates the item of demurrage, at the same time promptly releasing rolling stock, clearing the yards of cars and reducing congestion

(*d*) It will eliminate the piecemeal loading of cars at railway sidings in exposure to all kinds of weather

(*e*) It will tend to keep the car moving at all times, making possible double the mileage as made now by an ordinary piece of rolling stock

(*f*) Containers are fire- and weather-proof, and also burglar-proof in that they cannot be opened while on the car or while being transferred by handling device to and from the car.

The increased service capacity of each unit by the development of the container-car system is thought to hold far-reaching economic possibilities in railroad operation of the future, as well as in the coördinated use of the motor truck and the electric railway.

Advantage of Nitrogen in the Boiler Furnace

Recent developments seem to indicate that open-hearth steel furnaces will soon be using oxygen in place of air for combustion. This would undoubtedly shorten the melting period and give more economical operation.

In the boiler plant, although the same union of oxygen with the combustible in the fuel takes place, it would be very undesirable to introduce oxygen unmixed with the inert nitrogen. A pound of pure carbon in burning unites with 2.67 lb. of oxygen to give 3.67 lb. of gases and a total of 14,600 British thermal units is released. The heat contained in each pound of gas products would be approximately 4,000 B.t.u. If the specific heat of carbon dioxide is taken as 0.2, the temperature resulting from the combustion with no loss would be over 20,000 deg. fahr. This temperature is far above the melting point of either furnace walls or boiler plate. While this high temperature would increase the rate of heat absorption of the boiler, the temperature of the chimney gases would be high, since the small volume of highly heated gases would not be able to throw off as much heat as is possible with a larger volume of gases.

With air entering the furnace, instead of only 2.67 lb. of oxygen combining with the carbon we have 8.87 lb. of nitrogen carried along with the oxygen. The total weight of the gases then becomes 11.54 lb. and the theoretical flame temperature is reduced to around 5,000 deg. The weight of the nitrogen mixed with the oxygen reduces the heat generated per pound of gases, thereby reducing the furnace temperature. The larger volume of temperature gases transmits the heat more efficiently to the boiler. The presence of the inert nitrogen is actually an advantage.—*Power*, Oct. 25, 1921, p. 647.

Material Handling an Important Factor in the Elimination of Industrial Waste

By H. V. Coes,[1] Philadelphia, Pa.

It is only recently that industrial plants have been designed or laid out on a material-handling basis, and the present paper is timely in that it points out the opportunities in almost every branch of industry to reduce large wastes in material handling.

The problem of reducing the waste in material handling is not always an easy one and initial solutions are frequently complicated. However, thorough analysis will generally reveal a simple solution.

One authority postulates the principles: First, in handling material, perform only the handling operations that are absolutely essential; second, perform these operations in the way that secures the lowest cost.

Too much thought cannot be given to the selection of equipment that not only shows a saving, but fits into the general operating conditions of the plant, or suits physical conditions imposed by plant or location, and yet at the same time fits into plans for the future extension, development or rehabilitation of the plant.

The Committee on Elimination of Waste in Industry of the Federated American Engineering Societies states, "It is peculiarly the duty of engineers to use their influence individually and collectively to eliminate waste in industry."

The Materials Handling Division of our Society is concerned with the wastes of (1) capital, (2) material, (3) labor, and (4) production, resulting from lack of or inadequateness of material-handling equipment and methods in industry and their inefficient use and operation.

Modern civilization is the direct result of the application of the principles of subdivision of labor. This in turn has resulted in inventions largely labor-saving, and material-handling devices have played an important part in this development. Yet today, in spite of equipment and methods now available, material is handled constantly in identically the same manner as in the early stages of civilization.

Why is this? In the opinion of the author it is due to a number of influences, such as

1. Ignorance of methods and equipment available
2. Lack of standardization of materials, methods, containers to be handled to permit installation of and economical use of material-handling apparatus
3. Insufficient comparative economic data
4. Improper engineering
5. Poor salesmanship and selling policies
6. Lack of a central organization to educate the public and to act as a clearing house for economic and technica information.

There has recently been published an Encyclopedia of Material Handling, prepared by recognized authorities. This is a step in the right direction and it should prove of considerable assistance, particularly in eliminating ignorance of methods and equipment. The meetings and symposiums of the Materials Handling Division of our Society will, if conducted and prepared along broad lines, aid largely in the educational campaign.

Lack of standardization of containers is a peculiarly potent deterrent to proper economic solutions of material-handling problems, particularly at express and package-freight stations, terminals, transfer points and steamship docks. The. Materials Handling Division can perform a service of inestimable value to the country by forming strong committees to make an engineering study of this important problem. A proper solution would reduce waste due to loss and breakage, waste of transportation space, waste in production, and shipping costs.

It is a well-recognized fact in industrial-plant operation that the last 20 per cent of operating efficiency is the hardest to obtain, and yet shows the highest return. Thousands of plants in this country do not show an operating efficiency of more than 50 per cent, as compared with those plants that have an operating ratio as high as the present state of the art will permit. There are many reasons for this low operating ratio, but we are concerned only with the losses due to inadequate and inefficient material handling.

Industrial costs are composed of the following factors:

1. Material
2. Production labor
3. Factory burden or overhead
4. General administration expense
5. Sales expense.

As a usual thing, indirect or non-productive labor is charged out to factory burden. A very large portion of this labor is used in picking up, putting down and transporting material of all kinds. Hence one place to start in reducing factory burden is to reduce waste in labor and expense in this indirect-labor item by substituting adequate and properly adapted material-handling equipment and methods.

A Few Examples of Savings Effected

Some specific cases will help to visualize the situation better.

a In a large plant in Cleveland, Ohio, 55 men and 25 units are doing the work which today would require 550 men for handling alone, if they reverted to the old methods of five or six years ago.

b A tractor and 16 trailers reduced the yard gang from 18 to 4 men and eliminated a mile of industrial track, the salvage of which nearly paid for the initial installation.

c Mr. Max Sklovsky,[1] after an exhaustive study of material handling in his foundry, recently made the startling statement that he was handling 168 tons of material for every ton of finished castings produced, the figures for 100 tons of castings being as follows:

	Tons
Metals	2,606
Coke and lime	95
Core material	1,278
Molding sand	7,491
Equipment	5,150
Miscellaneous	200
Total	16,820

d Mr. W. G. Bridgeman[2] cites some interesting comparisons of handling costs at terminals. Two-wheeled trucks were used under the old method, electric tractors in the new method.

Terminal	Tons per man per hr., old method	Tons per man per hr., new method	Cost difference per ton
Wilmington, N. C.	0.873	3.49	$0.281
South Atlantic port	1.29	2.72	....
Cincinnati	0.722	0.918	0.14
St. Louis	1.2	1.8	....

Mr. Bridgeman further states that in his opinion 75 per cent of the freight houses in the country can increase production per man per hour anywhere from 25 to 100 per cent, and this will be accomplished mainly by the use of mechanical equipment for handling freight.

e Mr. J. A. Kreis,[3] states that their 20-ton locomotive crane "not only speeds up handling of material but pays for itself every $4\frac{1}{2}$ months."

f A battery of 4 Wellman-Seaver-Morgan unloaders can now unload a 10,000-ton ore vessel in $3\frac{1}{2}$ hrs. In the old days, using a clamshell bucket, the cost was around 25 cents per ton; today it is $2\frac{1}{2}$ to 4 cents per ton. This cost includes overhead, interest on plant investment, and maintenance.

[1] Manager, Ford, Bacon & Davis. Mem. Am.Soc.M.E.

For presentation at the Annual Meeting, New York, December 5 to 9, 1921, of The American Society of Mechanical Engineers. Advance copies of the paper may be obtained gratis upon application. All papers are subject to revision.

[1] Chief Engineer, Deere and Co., Moline, Ill.

[2] General Superintendent, Terminals Operating Co., New York, N. Y.

[3] Hupp Motor Car Co., Detroit, Mich.

g Table 1 is an example of the rehabilitation of a paper mill by material-handling methods. The mill was 60 years old or more, and had grown around itself in a manner that presented a number of problems difficult to solve. After a policy for rehabilitation and extension had been worked out, it was possible to predict future material-handling costs, based upon improvements that would obtain under the rehabilitation plan and application of the proper material-handling equipment to the problems in hand. The table illustrates the varied material to be handled, but one would need to know the physical handicaps at the mill to fully appreciate the necessity for and the difficulty of obtaining a right solution of the problem. The preliminary testing out and checking up of the equipment as installed indicates that the savings will be readily obtained and in some cases exceeded as operating proficiency increases.

It can thus be seen that there are opportunities in almost every branch of industry to reduce large wastes in material handling.

The Art is New and Requires an Unbiased Viewpoint

The public, industrial executives and business men generally are not in possession of sufficient data and economic facts to make them realize the astounding wastes going on all around. Engineers and manufacturers are largely to blame for this. The industrial executive usually knows how much per piece or per unit it costs to produce a given article, but rarely knows what it costs per unit to handle the materials entering into the manufacture of the article itself or the cost of handling the finished article. It is only recently that industrial plants have been designed or laid out on a material-handling basis. The writer knows of plants that do very well in normal times whose physical handicaps due to the absence of any consideration of material handling in the old days are such that it is a physical and financial impossibility to provide adequate material-handling methods and equipment for them. In many cases like these the savings in labor alone would pay a very substantial part of the fixed charges of a rehabilitated or a new plant.

For instance, a certain modern plant cost, including land, $1,500-000. It is operating today at about one-third capacity, yet the savings in labor alone pay the annual fixed charges of $145,000.

In many instances manufacturers of material-handling equipment have been remiss and short-sighted in selecting men of the wrong type to represent them, men in many instances without knowledge or comprehension of the underlying economic laws. Capital wastes, dissatisfaction, and frequently bitterness result from sale of unsuitable, inadequate or incomplete equipment.

If the manufacturer will get the engineer's point of view and the engineer the manufacturer's, and both will get the economic viewpoint, much good will result, fewer mistakes be made, and society and industry will benefit and prosper. By all means, then, let us work for right solutions of our material-handling problems. Let us be fair to each other, to ourselves, to the public, to labor, and make one dollar, not ten dollars, do the work of one. A proper attitude of mind in material-handling problems is important.

Initial Solution Not Always Best, But Perseverance Wins

The human mind apparently functions in a peculiar manner, particularly in connection with mechanical or technical problems. It seems necessary to start with the complex before the simple can be attained. This characteristic of the mind needs to be watched very closely in its relation to material-handling problems. The problems as usually presented in almost any industrial plant or terminal tend to confuse. The tendency of the mind to see the problem in all its complexities frequently leads to a complicated initial solution, but as a rule these initial solutions are rejected as the simple, less costly and more efficient solution finally evolves. We should analyze the problem, carefully determine the number of transfers and make ourselves find and retain the simple solution. Therefore, we should not be discouraged if the first solution does not yield the estimated savings that it is felt should be secured, but should persevere until a thorough analysis reveals the simple solution.

It should be the endeavor of our Materials Handling Division to place material-handling matters on a high plane; to seek the truth relentlessly and fearlessly; to secure a thorough exchange of views; to obtain a better understanding by the public, by labor, by engineers, by the manufacturer, of the real economic purpose of material handling.

Lowest Cost the Goal in Handling Materials

The initial test of any method, system or device, should be an economic one. The question of will it pay should not be begged. Capital has been wasted, pioneers discouraged, the public bewildered because of undertakings not conforming to this test.

Mr. Wm. F. Hunt[1] postulates these principles as follows:

1 In handling material, perform only the handling operations that are absolutely necessary

2 Perform these operations in the way that secures the lowest cost.

When a simple plan for handling materials has been developed, the financial returns of the installation will, in the absence of labor difficulties, largely determine the wisdom of the installation. It may pay to install apparatus and it may not, according to conditions such as:

a Constancy or intermittency of the work

b Character of the operation itself

c Results of analysis which follows.

TABLE 1 ESTIMATED ANNUAL COST OF PRESENT AND PROPOSED MATERIAL HANDLING
(Based on Average Quantities Consumed in Year 1919 and 6 Months 1920)

			Present Cost[1]			Proposed Cost[1]		Annual Saving		
Material	Unit	Average Annual Consumption	Unit	Total	Estimated New Investment	Unit	Total	Unit	Total	Equipment Selected
Alum	Ton	207	$10.60	$ 2,862	$ 5,500	$1.87	$ 505	$8.73	$ 2,357	Locomotive crane and power mule
Ash disposal	Ton	4,800	2.08	10,000	15,000	0.42	2,000	1.86	8,000	Pneumatic conveyor
Bleach	Ton	875	2.80	2,450	......	2.00	1,750	0.80	700	Locomotive crane and power mule
Clay (China)	Ton	1,800	4.48	8,064	11,100	1.60	2,880	2.88	5,184	Pneumatic conveyor
Lime	Ton	2,500	1.60	4,000	1,950	0.50	1,250	1.10	2,750	Pneumatic conveyor
Lumber: Box	M.B.M.	1,000	4.85	4,850	400	2.25	2,250	2.60	2,600	Loco. crane and gravity conveyor
Lumber: Strips	M.B.M.	100	6.00	600	......	3.50	350	2.50	250	Loco. crane and gravity conveyor
Pulp wood	Cord	10,000	4.10	41,000	60,000	1.67	16,700	2.43	24,300	Loco. crane and pneumatic conveyor
Rosin	Ton	250	6.55	1,637	6,000	1.00	250	5.55	1,387	Locomotive crane and power mule
Soda ash	Ton	545	2.40	1,310	500	0.50	273	1.90	1,037	Pneumatic conveyor
Sulphite pulp	Ton	5,500	4.10	23,000	14,000	1.95	10,500	2.15	12,500	Power mule
				$99,773	$114,450		$38,708		$61,065	

[1]The present costs include maintenance and repairs but no fixed charges, or other overhead items. The proposed costs include fixed charges of 20 per cent.

If labor can be saved or manufacturing conditions improved by the use of apparatus for handling material, we can readily determine how much labor will be required by the method proposed. By comparing this method with the present method, we can ascertain the probable labor saving effected.

The investment justifiable to effect the saving is the item in the investigation that is the most difficult to analyze, as it has so many variables. The figures obtained by the following method are an indication of facts and the ultimate decision must be dictated by good judgment and a general consideration of the whole situation.

How to Arrive at the Best Method

The variables are many in the work to be performed. The work may be of temporary character, infrequently done, the amount fluctuating widely, or it may be a regular daily operation, year in and year out; this item varies from 0 to 100 per cent. If the work is of a temporary nature, no saving can be made, whereas if it is of daily necessity for the future, the whole saving of reduced labor by the plan suggested is available. The true value exists somewhere between these two extremes, and it need not be difficult to

(*Continued on page 825*)

[1] Handling Materials in Factories, Wm. F. Hunt.

Code on Definitions and Values

Preliminary Draft of the Fourth in the Series of Nineteen Codes in Preparation by the A.S.M.E. Committee on Power Test Codes

IN 1918 the Power Test Committee of the A.S.M.E. was reorganized to revise and enlarge the Power Test Codes of the Society, published in 1915. The Committee is a large one, consisting of a Main Committee of 25 under the chairmanship of Fred R. Low, and 19 Individual Committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment. Below is reproduced the fourth of these codes to be completed, namely, Code on Definitions and Values.

The Individual Committee which developed this Code is headed by Mr. Reginald J. S. Pigott as chairman, and consists of the following men: Prof. Lionel S. Marks, Dr. Samuel W. Stratton, Albert C. Wood, Edgar Buckingham and Fred R. Low. This Committee will welcome suggestions for corrections or additions to this draft of its Code. These should be addressed to the Chairman, care of The American Society of Mechanical Engineers.

Code on Definitions and Values

The units to be employed in reporting the results of tests made in accordance with the various Power Test Codes are enumerated in Tables 1, 2 and 3. Explanatory and other notes follow in Pars. 60 to 112, to which references are given in the tables.

TABLE 1 FUNDAMENTAL UNITS AND CONSTANTS

Units	Abbreviations and Symbols	Definitions or Equivalent Values	Approximate Values Acceptable for Computation
1 One foot	ft.	12/39.37 of the length of the international prototype meter. (Par. 103)	
2 One pound mass	lb.	0.4535924 times the mass of the international prototype kilogram. (Par. 103)	
3 Standard gravity	g	32.174 ft./sec.^{2} (Par. 105)	
4 One pound force	lb.	A force represented by the weight of one pound mass at a place where gravity has the standard value. (Par. 105)	
5 One foot-pound	ft-lb.	The work done by 1 lb. force when its point of application moves one foot in the direction of the force.	
6 One British thermal unit	B.t.u.	1/180 of the heat required to raise 1 lb. mass of water from the ice point to the steam point. (Par. 109)	
7 Absolute temperature	T	deg. fahr. + 459.6 (Par. 108)	deg. fahr. + 460
8 Mechanical equivalent of heat	J	778 ft-lb. per B.t.u. (equiv.) (Par. 106)	778
Heat equivalent of work	A	0.001285 B.t.u. per ft-lb. (equiv.) (Par. 106)	0.001285
9 One horsepower	hp.	550 ft-lb. per sec. (def.)	550
		33,000 ft-lb. per min. (def.)	33,000
		1,980,000 ft-lb. per hr. (def.)	1,980,000
		2,545 B.t.u. per hr. (equiv.)	2,545
		745.702 watts (equiv.)	746
		0.7457 kw. (equiv.) (Par. 107)	0.746
10 One horsepower-hour	hp-hr.	2,545 B.t.u. (equiv.) (Par. 107)	2,545
11 One kilowatt	kw.	1,000 watts (def.)	1,000
		1.3410 hp. (equiv.)	1.341
		3,413 B.t.u. per hr. (equiv.)	3,413
		737.56 ft-lb. per sec. (equiv.). (Par. 107)	738
12 One kilowatt-hour	kw-hr.	1.3410 hp-hr. (equiv.)	1.341
		3,413 B.t.u. (equiv.) (Par. 107)	3,413
13 One U. S. gallon	gal.	231 cu. in. (def.)	231
14 One Standard atmosphere (International Standard)	atmos.	760 mm. mercury at ice point and standard gravity. (Pars. 108, 109 and 112) (def.)	760
		29.9212 in. mercury at ice point and standard gravity (equiv.)	29.92
		14.6963 lb. per sq. in. (equiv.). (Par. 112)	14.7
15 One ton refrigeration	ton refr.	288,000 B.t.u. (def.). (Par. 129)	288,000

It will be noted that the approximate values in the fourth column of Table 1 will not exactly cross-check with each other; if a check is necessary, for any reason, use the more nearly exact values in the third column.

Definitions and values which are of interest to special codes only, are to be found in the "Notes on Data" (Pars. 101–157).

TABLE 2 UNITS OF CAPACITY

Apparatus	Units
16 Steam Boilers and Superheaters	(*a*) Heat output in steam per hour. (Pars. 113, 130)
	(*b*) Actual evaporation, lb. of steam per hour, at stated steam pressure and quality or temperature, and stated feedwater temperature
	(*c*) Units of evaporation per hour = Item 19*a*/1000. (Par. 113)
17 Reciprocating Steam Engines	(*a*) Indicated horsepower at stated conditions of steam supply and exhaust
	(*b*) Brake horsepower at stated conditions of steam supply and exhaust
18 Steam-Engine Generators	Net kilowatts at generator terminals at stated conditions of steam supply and exhaust. (Par. 114)
19 Steam Turbines	Brake horsepower at stated conditions of steam supply and exhaust
20 Turbo-Generators	Net kilowatts at stated conditions of steam supply and exhaust. (Par. 114)
21 Pumping Machinery	(*a*) Gallons discharged in 24 hours at stated total suction and discharge pressures
	(*b*) Gallons per minute at stated total suction and discharge pressures
	(*c*) Water-horsepower output at stated total suction and discharge pressures. (Par. 119)
22 Compressors and Blowers, Centrifugal and Displacement	(*a*) Cubic feet of free air (or other, gas) per minute, at stated total intake pressure and temperature delivered at stated total discharge pressure
Low-Pressure Centrifugal only (less than 20 in. water total pressure rise)	(*b*) Cubic feet of free air (or other gas) per minute, at 68 deg. fahr. and one standard atmosphere or at 0.075 lb. per cu. ft. standard density
	(*c*) Air-horsepower output at stated inlet and delivery conditions. (Par. 120)
23 Locomotives	(*a*) Indicated horsepower
	(*b*) Drawbar horsepower. (Par. 154)
24 Gas Producers	(*a*) Pounds of fuel as fired per hour, of stated high calorific value (Par. 121)
	(*b*) Hot-gas output: cu. ft. of dry gas per hour, at stated temperature and pressure, and stated high calorific value

	(c) Cold-gas output: cu. ft. of dry gas per hour at 68 deg. fahr. and one standard atmosphere (d) Heat output per hour in hot gas (e) Heat output per hour in cold gas
25 Gas and Oil Engines	(a) Brake horsepower (b) Indicated horsepower. (Par. 115)
26 Hydraulic Turbines	Brake horsepower
27 Hydraulic Turbo-Generators	Net kilowatts at the generator terminals. (Par. 114)
28 Condensers	Heat transferred per hour, at stated vacuum, inlet and outlet circulating-water temperatures, and cubic feet of gases discharged by air pump per hour, measured at 68 deg. fahr. and one standard atmosphere. (Pars. 122–125)
29 Evaporators	(a) Heat transferred per hour at stated temperature of evaporation, and stated temperature and pressure of steam supply. (Pars. 122–126) (b) Pounds of raw liquor per hour (c) Pounds of concentrate per hour
30 Feedwater Heaters and Fuel-Oil Heaters	Heat transferred per hour at stated steam pressure and temperature and at stated inlet and outlet water or oil temperatures. (Pars. 122–128)
31 Oil Coolers	Heat transferred per hour, at stated inlet and outlet oil temperatures, and stated inlet and outlet cooling-water temperatures. (Pars. 122–128)
32 Economizers	Heat transferred per hour at stated pounds of flue gases per hour, inlet gas temperature and inlet and outlet water temperatures. (Pars. 122–128)
33 Cooling Towers and Cooling Ponds	Heat dissipated per hour at stated inlet and outlet water temperatures, stated air temperatures and humidity
34 Refrigerating Machines	(a) Heat absorbed per hour at stated head pressure and stated suction or cooler pressure. (Par. 122) (b) Tons refrigeration per 24 hrs. at stated head pressure, and stated suction or cooler pressure. (Par. 129)

TABLE 3 UNITS OF PERFORMANCE

	Apparatus	Quantities and Units	Conversion Relation
35	Boilers (including firing equipment and superheaters)	(a) Efficiency of boiler, superheater and furnace: ratio of heat units output to high calorific value of fuel as fired	
	Solid Fuels only	(b) Rate of combustion in lb. of fuel as fired per sq. ft. of grate surface per hour. (Par. 131)	
	All Fuels	(c) Rate of combustion in lb. of fuel as fired per cu. ft. of furnace volume. (Par. 132) (d) Heat transferred per sq. ft. of heating surface per hour. (Par. 122) (e) Heat developed per sq. ft. of grate surface per hour. (Par. 131)	
36	Reciprocating Engines	(a) Heat supplied per $\left\{\begin{matrix}\text{i.hp-hr.}\\ \text{b.hp-hr.}\end{matrix}\right\}$ (Pars. 140, 141)	
		(b) Thermal efficiency referred to $\left\{\begin{matrix}\text{i.hp.}\\ \text{b.hp.}\end{matrix}\right\}$ (Pars. 134–136)	$\frac{2545}{\text{(Item } a)}$
		(c) Rankine efficiency referred to $\left\{\begin{matrix}\text{i.hp.}\\ \text{b.hp.}\end{matrix}\right\}$ (Pars. 144–147) (d) Water rate, pounds of steam per $\left\{\begin{matrix}\text{i.hp-hr.}\\ \text{b.hp-hr.}\end{matrix}\right\}$ (Par. 152)	
37	Steam Turbines	(a) Heat supplied per b.hp-hr. (Pars. 140, 141)	
		(b) Thermal efficiency. (Pars. 134–136)	$\frac{2545}{\text{(Item } a)}$
		(c) Rankine efficiency. (Pars. 144–147) (d) Water rate, pounds of steam per b.hp-hr. (Par. 152)	
38	Steam-Engine Generators and Turbo-Generators	(a) Heat supplied per net kw-hr. (Pars. 114, 140, 141) (b) Thermal efficiency. (Pars. 134–136) (c) Rankine efficiency referred to net kw. (Pars. 144, 147) (d) Water rate, lb. of steam per net kw-hr. (Pars. 114–152)	
39	Steam-Driven Pumping Engines	(a) Heat supplied per water hp-hr. (Pars. 140, 141)	
		(b) Thermal efficiency (Pars. 134–136) referred to water hp.	$\frac{2545}{\text{(Item } a)}$
		(c) Water rate, lb. of steam per water hp-hr. (Par. 152)	
40	Steam-Driven Compressors, Blowers and Fans	(a) Heat supplied per air hp-hr. (Pars. 140, 141)	
		(b) Thermal efficiency. (Pars. 134–136)	$\frac{2545}{\text{(Item } a)}$
		(c) Water rate, lb. of steam per air hp-hr. (Par. 152) (d) Gross, (e) Net, (f) Indicated: horsepower per cu. ft. dry free air per min. (g) Water rate per i.hp-hr. (h) Volumetric efficiency (i) Compression efficiency (j) Mechanical efficiency (k) Overall efficiency	
41	Direct-Drive Steam Plants	(a) Fuel rate, lb. of fuel as fired per $\left\{\begin{matrix}\text{i.hp-hr.}\\ \text{b.hp-hr.}\end{matrix}\right\}$ (Par. 154) (b) Water rate, lb. of steam generated per $\left\{\begin{matrix}\text{i.hp-hr.}\\ \text{b.hp-hr.}\end{matrix}\right\}$ (Par. 152) (c) Heat in fuel, per $\left\{\begin{matrix}\text{i.hp-hr.}\\ \text{b.hp-hr.}\end{matrix}\right\}$ (Pars. 140, 141)	
		(d) Thermal efficiency referred to $\left\{\begin{matrix}\text{i.hp.}\\ \text{b.hp.}\end{matrix}\right\}$ (Pars. 134, 138)	$\frac{2545}{\text{(Item c)}}$
42	Steam-Electric Plants	(a) Fuel rate, lb. of fuel as fired per net kw-hr. (Pars. 114, 154) (b) Water rate, lb. of steam generated per net kw-hr. (Par. 148) (c) Heat in fuel per net kw-hr. (Pars. 114–116 and 140, 141)	
		(d) Thermal efficiency, overall, referred to net kw. (Pars. 132–138)	$\frac{3413}{\text{(Item c)}}$
43	Steam Pumping Plants	(a) Fuel rate, lb. of fuel as fired, per water hp-hr. (Pars. 119, 154) (b) Water rate, lb. of steam generated per water hp-hr. (Pars. 119, 148) (c) Heat in fuel per water hp-hr. (Pars. 119, 140, 141)	
		(d) Thermal efficiency, referred to water hp. (Pars. 119, 132–138)	$\frac{2545}{\text{(Item c)}}$
44	Steam Air-Machinery Plants	(a) Fuel rate, lb. of fuel per air hp-hr. (Pars. 120, 154) (b) Water rate, lb. of steam generated per air hp-hr. (Pars. 120, 152) (c) Heat in fuel, per air hp-hr. (Pars. 120, 141)	
		(d) Thermal efficiency, referred to air hp. (Pars. 120, 134, 138)	$\frac{2545}{\text{(Item c)}}$
45	Steam Locomotives	(a) Fuel rate, lb. of fuel as fired per i.hp-hr. (Par. 154) (b) Fuel rate, lb. of dry fuel as fired per drawbar hp-hr. (Pars. 154, 155) (c) Water rate, lb. of steam per i.hp-hr. (d) Water rate, lb. of steam per drawbar hp-hr. (Par. 152) (e) Fuel rate, lb. of fuel as fired	

		hp-hr. (Pars. 140, 141, 155)	
		(*g*) Thermal efficiency referred to drawbar hp-hr. (Pars. 134, 136, 155)	2545 / (Item *f*)
46	Gas Producers	(*a*) Hot-gas efficiency; ratio of high calorific value plus sensible heat above room temp. in hot gas, to the high calorific value of fuel as fired. (Par. 121)	
		(*b*) Cold-gas efficiency; ratio of high calorific value of gas to high calorific value of fuel as fired. (Par. 121)	
47	Internal-Combustion Engines	(*a*) Fuel rate, lb. of fuel as burned per {net i.bp-hr. / net b.hp-hr.} (Par. 154)	
		(*b*) Fuel rate, cu. ft. of dry gas of stated high cal. value at 68 deg. fahr. and one standard atmosphere, per {i.hp-hr. / b.hp-hr.}	
		(*c*) Heat supplied per {i.hp-hr. / b.hp-hr.} (Pars. 140, 141)	2545 / (Item *c*)
		(*d*) Thermal efficiency referred to {i.hp-hr. / b.hp-hr.}	2545 / (Item *c*)
		(*e*) Otto or Brayton efficiency referred to {i.hp-hr. / b.hp-hr.} (Pars. 144, 149–151)	
48	Gas- or Oil-Electric Units	(*a*) Fuel rate, lb. of fuel as burned per net kw. (Pars. 154, 114, 116)	
		(*b*) Fuel rate, cu. ft. of dry gas of stated high cal. value at 68 deg. fahr. and one standard atmosphere per net kw-hr.	
		(*c*) Heat supplied per net kw-hr. (Pars. 140, 141)	3413 / (Item *c*)
		(*d*) Thermal efficiency. (Pars. 134–137)	
		(*e*) Otto or Brayton efficiency referred to net kw. (Pars. 144, 149–151)	
49	Gas-Producer Plants	(*a*) Fuel rate, lb. of fuel as fired per net {i.hp-hr. / b.hp-hr.} (Pars. 115, 154)	
		(*b*) Heat in fuel per net {i.hp-hr. / b.hp-hr.} Pars. 140, 141)	
		(*c*) Thermal efficiency referred to {i.hp-hr. / b.hp-hr.} (Pars. 134–137)	2545 / (Item *c*)
50	Hydraulic Turbines	Efficiency of turbine; ratio of brake horsepower to water horsepower. (Par. 119)	
51	Hydraulic Turbo-Generators	Efficiency of unit; ratio of net electrical hp. to water hp. (Pars. 114–119)	
52	Surface Condensers	(*a*) Heat transferred per sq. ft. of cooling surface under stated conditions of vacuum, inlet and outlet circulating-water temperatures and cu. ft. of gases discharged per hour, at 68 deg. fahr. and one atmosphere. (Pars. 123, 124)	
		(*b*) Heat-transmission coefficient. (Par. 157)	
53	Evaporators	(*a*) Heat transferred per hour, with stated conditions of steam supply, temperature and pressure. (Pars. 126, 127)	
		(*b*) lb. of steam per lb. of distillate	
		(*c*) lb. of steam per lb. of concentrate	
54	Closed Feedwater Heaters and Fuel-Oil Heaters	(*a*) Heat transferred per sq. ft. of heating surface per hour at stated conditions of steam supply, and stated inlet and	
		cient	
55	Oil Coolers	(*a*) Heat transferred per sq. ft. of cooling surface per hour, at stated inlet and outlet oil temperatures, and stated inlet and outlet cooling-water temperatures. (Par. 128)	
		(*b*) Heat-transmission coefficient. (Par. 157)	
56	Economizers	(*a*) Heat transferred per sq. ft. of heating surface per hour at stated lb. of flue gases per hour, inlet flue-gas temperature and inlet and outlet water temperatures. (Par. 128)	
		(*b*) Heat-transmission coefficient. (Par. 157)	
57	Cooling Towers	(*a*) Efficiency. (Par. 158)	
58	Steam-Driven Refrigerating Machines	(*a*) Heat supplied in steam per ton of refrigeration, at stated conditions. (Pars. 129, 154)	
		(*b*) Coefficient of performance; ratio of heat abstracted to indicated work, expressed in B.t.u.	
		(*c*) Water rate, lb. of steam per ton of refrigeration, at stated conditions. (Pars. 129, 148)	

NOTES ON DATA

101 In order to render terminology consistent, the following symbols in frequent use are adopted:

H = heat content of the steam (Par. 111)
h = heat content of the liquid (Par. 111)
L = latent heat, or heat of vaporization
C_p = specific heat at constant pressure
C_v = specific heat at constant volume
V = specific volume of the vapor
V' = specific volume of the liquid
$u = V - V'$
E_o = Internal energy
P = pressure, lb. per sq. in. abs.
N = entropy of steam
n = entropy of liquid
$I = E - h$
J = mechanical equivalent of heat
A = heat equivalent of work = $1/J$
T = temperature, deg. fahr. abs.
W = work
w = weight
Q = quantity of heat in general; not to be used for denoting the property of a particular substance in a particular state.

102 Congress has never fully exercised its constitutional power of fixing the standards of weights and measures throughout the United States. The Bureau of Standards is now the legal custodian of the standards; and in the absence of specific action to the contrary by Congress, its practice in determining the values of lengths and masses is authoritative.

103 The ultimate standard of length is the international prototype meter, of which the Bureau has the two official copies assigned by lot to the United States. Determinations of length are referred to the ultimate standard through these copies by using the relation 1 meter = 39.37 in. Similarly, the ultimate standard of mass is the international prototype kilogram, of which two official copies are in the custody of the Bureau of Standards; and determinations of mass are referred to the kilogram by using the relation 1 lb. = 0.4535924 kg. There is no legally established United States primary standard yard bar or pound mass, and the adoption of the numerical relations mentioned above is, in effect, a definition of the foot and the pound.

104 For further information, see The History of the Standard Weights and Measures of the United States, by L. A. Fischer, *Bulletin* of the Bureau of Standards, Vol. 1, p. 365 (1905).

105 *International Standard Gravity*, adopted in 1901 by the Com-

mittee of the International Bureau of Weights and Measures, has the value.

$$g = 980.665 \text{ cm./sec.}^2 = 32.1740 \text{ ft./sec.}^2$$

which is the actual value of this acceleration at sea level and about 45 deg. latitude. At other latitudes, and at sea level, the ratio of local to standard gravity is as shown in the following table:

Latitude, (deg.)	g (local) / g (standard)	Latitude, (deg.)	g (local) / g (standard)
0	0.9973	50	1.0004
10	0.9975	60	1.0013
20	0.9979	70	1.0020
30	0.9986	80	1.0024
40	0.9995	90	1.0026

For higher altitudes, subtract 1 part in 10,000 for each 1000 ft. above sea level. At an elevation of 10,000 feet at the equator, local gravity is about 1 part in 79 less than standard gravity. For latitudes between 20 deg. and 70 deg. and altitudes below 5000 ft., the maximum difference between local and standard gravity is about 1 part in 400, an amount which is ordinarily negligible for engineering purposes.

106 For the mechanical equivalent of heat, the value

$$J = 778 \text{ ft-lb. per B.t.u.}$$

is adopted: it is equivalent to 1 mean calory = 4.186 true joules.

Other values which have been used in some of the recent steam tables are: Mollier (1906), 778.28; Marks and Davis (1916), 777.52; Goodenough (1914), 777.64; Callendar[1] (1915), 777.8. The greatest difference of any of these values from 778.00 is about 1 in 1620, an amount which is devoid of physical significance because the uncertainty of the value is at least 1 part in 500 and perhaps 1 in 200. The 15 deg. calory is known to about 1 part in 2000, and the mean calory is known to be nearly the same precisim as the 15-deg. calory. But the difference between the two is not so accurately known, even its sign being uncertain. In view of this fact it is quite evident that in the value J = 778 ft-lb. per mean B.t.u., even the 8 is not certain, and that the use of additional figures beyond the decimal point is a purely illusory refinement.

107 With J = 778 ft-lb. per B.t.u. we have

$$1 \text{ horsepower-hour} = \frac{1{,}980{,}000}{778} = 2544.987 + \text{B.t.u.}$$

$$1 \text{ kilowatt-hour} = \frac{1{,}980{,}000}{778 \times 0.745702} = 3412.874 + \text{B.t.u.}$$

Since the value 778 is uncertain by more than one unit, the use of decimal places in the foregoing values is a pure waste of time and they are abbreviated to 2545 and 3413.

108 *Absolute Temperature* in fahrenheit degrees is denoted by $T°$, and temperature on the ordinary Fahrenheit scale by $t°$, the relation between the two being

$$T° = t° + 459.6$$

and the absolute temperature of the ice point being $T_o = 491.6$. The values are uncertain by about one unit in the last place given. For all ordinary engineering purposes, such as reductions of gas volumes, the values 460 and 492 are more than sufficiently accurate.

109 *Ice Point and Steam Point.* The ice point is 32 deg. fahr. and the steam point 212 deg. fahr., both at one standard atmosphere.

110 *Internal Energy of a Substance.* When a pound of substance is brought from one state to another, for example, when a pound of water at 100 deg. fahr. and 50 lb. per sq. in. pressure is changed into steam at 100 lb. per sq. in. pressure and 70 deg. superheat, the amount of heat required for the change is not definite but depends altogether on the "path" of the change, i.e., on the series of intermediate states. But the sum of the heat put into, and the heat equivalent of the work done on the pound of substance during the change of state is definite and depends only on the initial and final states and not on, the path of the change. This sum is the value, expressed in heat units, of the energy that must be added to the pound of substance to produce the change, or it is the increase of the *internal energy*, in B.t.u. per lb., during the change. Since we are always concerned with *changes* of internal energy and not with absolute values, the internal energy may arbitrarily be set equal to zero at any convenient standard or normal state, such as 32 deg. fahr. and one atmosphere pressure. When such a convention has been adopted, the value of the internal energy in any other state is thereby fixed; and if the necessary data are available, it may be tabulated. Internal energy is denoted by the symbol E and expressed in mean B.t.u. per lb. of substance.

111 *Heat Content.* Let V be the volume in cubic feet, and E the internal energy in B.t.u. of one pound of a fluid at the pressure p in lb. per sq. in. Then the important quantity

$$H = E + \frac{144pV}{J} = E + 144\ ApV \text{ B.t.u. per lb.}$$

has been called the "total heat," "heat of formation" or "heat content" of the fluid, no one of the names being very satisfactory. The first is the most usual; but the necessity of using the adjective "total" in its ordinary sense sometimes makes it difficult to avoid ambiguity when the word is also being used with a special technical meaning in the compound noun "total heat." The name "heat content" will therefore be used for the quantity denoted above by H. When the substance is all in the liquid state, the symbol h will be used instead of H, and h thus denotes what is commonly called the "heat of the liquid."

112 The *standard density of mercury* at 32 deg. fahr. is 13.5955 grams per cu. cm. (Kaye & Laby, 1918.) The mean cubical expansion between 32 deg. fahr. and 212 deg. fahr. is 0.0001014 per deg., and from 32 deg. to 110 deg. fahr. it is 0.0001010.

113 *Units of Evaporation.* If it is desired to reduce B.t.u. output per hour to *units of evaporation*, divide by 1000. The use of the boiler horsepower (33,479 B.t.u. per hr.) is discontinued. The above changes are made for the following reasons: The boiler horsepower as originally standardized by the A.S.M.E. in 1889 was based on a conventional engine water rate of 30 lb. of steam per hp-hr. at 70 lb. gage pressure and feedwater at 100 deg. fahr. This corresponds to 34.5 lb. evaporated from and at 212 deg. fahr. At the present time, water rates vary from 8 lb. per b.hp. hr. in large condensing turbines to 50 or 60 lb. for small non-condensing units, and the boiler horsepower has no connection whatever with the water rate of the engine. It has never been used on the Continent or in England, and in the United States, marine boilers are rated in horsepower according to the hp. and water rate of the engines they serve. The unit has therefore become archaic, and it is better to state capacity in B.t.u., or in multiples of B.t.u. Under the boiler-horsepower definition, the unit of evaporation is the latent heat of vaporization at 212 deg., the value for which has varied with the steam tables from 965 to over 970 B.t.u. per lb. The statement of capacity or performance in B.t.u. is basic, and as the computations must in any case be made in B.t.u. at some point in the calculations, it is convenient to omit other arbitrary units as unnecessary. The objection that has been raised that capacity in B.t.u. gives large numbers is hardly worth consideration; it is only necessary to head the columns "units of evaporation" (1000 B.t.u.) which is but three per cent different from "equivalent evaporation" as now used, or "million B.t.u.," in which case the figures are smaller than when stated in boiler hp. The rating of boilers for size only, in square feet of heating surface, should be adopted; the area method has been in use for years in Europe, and in view of the fact that the ultimate steaming capacity per square foot is dependent solely on amount of fuel fired, it is a suitable unit, as not involving capacity.

114 *Net Output.* For any kind of separately excited engine or generator, the net output is expressed by the following formula:

Net kw. = gross kw. (main unit)—kw. excitation at collector rings

Net output where direct connected exciters are employed, is expressed by the following formula:

Net kw. = gross kw. (main unit) plus gross kw. exciter—kw. excitation at collector rings.

The gross kw. of both main unit and exciter is to be measured at the generator terminals. Further correction must be made if separately driven ventilating fans are employed, by substituting kw. to fan motor, or as determined by prior agreement, if the fan is not motor-driven.

115 *Net I.Hp.* for internal combustion engines, is the i.hp. of

[1] Callendar's fundamental value is 1 pound-degree centigrade = 1400.00 London foot-pounds, the British foot and pound mass being sensibly identical with the U. S. values, while the value of gravity at London is g = 981.19 cm./sec.^{2}.

eliminating all corrections. I.hp. is, strictly speaking, not a true output, inasmuch as it does not represent the power available for use at the engine shaft.

116 For complete power stations, gross output is the sum of the gross outputs of individual units. The difference between gross and net outputs is the kw. used for lighting, auxiliaries and house service and has the same character (necessary loss) for the complete plant as friction or excitation for an individual unit. It will be seen the term "net" is used to indicate that output which is available for use, outside the main unit, or plant, as the case may be.

117 *Rate of Combustion* is defined in two ways; the first is confined to solid fuels. For this case it is the pounds of fuel as fired per square foot of grate surface per hour.

118 Rate of combustion for the second case is used for all fuels, and comprises the pounds of fuel as fired per cubic foot of furnace volume per hour. For gas only, it may be stated as the cubic feet of gas as fired per cubic foot of furnace volume per hour.

119 Water horsepower is to be computed from the equation—

$$\text{Water hp.} = \frac{(\text{lb. of liquid per min.}) \times (\text{total head in ft.})}{33{,}000}$$

Both suction and discharge heads are to be total heads, as given by the impact tube, except in cases where the velocity head is less than 0.2 per cent of the total head. In the latter case static pressure, as usually taken by pressure gages, may be used.

If the total head is given as a difference of pressure, the value to be used in the foregoing equation is to be found from the formula

$$\text{Head in feet} = 4.476 \times \frac{\text{Pressure difference in lb. per sq. in.}}{\text{Actual density of water in lb. per cu. ft.}}$$

where $4.476 = 144/32.174$.

Water horsepower for pumps is the energy supplied to the water or other liquid by the pump in unit time. In the case of hydraulic turbines it is the available energy in the water to be employed by the turbine in unit time.

120 *Air Horsepower* (air hp.) is defined as the horsepower that would be required to compress the actual air output of the compressor or blower, if there were no friction and no clearance, if the inlet and outlet pressures were constant, and if the compression were adiabatic.

The suction and discharge pressures must be the total pressures as obtained with the impact tube, so as to include velocity head, except in those cases where the difference of velocity head at inlet and discharge is less than 0.2 per cent of the total head, in which case the usual static pressures given by pressure gages may be used.

121 *Calorific Value* as used in the tables, for solid and liquid fuels, is in all cases the high heat value per pound on complete combustion. The calorific value for gas is the high heat value per cubic foot. The low heat value is not to be used. The standardization on high heat values is adopted in order that all heat apparatus shall be charged with heat supplied, on the same basis. If the high heat values are used for some heat engines, and the low values for others, the efficiencies and other performance figures will not be comparable.

122 *B.t.u. Transferred per Hour.* In heat-transfer apparatus heat is transferred, or flows, from a region of higher to a region of lower temperature, without change of total quantity. The heat is nearly always given up or received by a fluid, and the rate of transfer is determined by measuring the rate at which the fluid gains or loses heat. Usually, as in surface condensers, evaporators, etc., both sides of the apparatus contain fluid, and measurements may be made on either of the fluids. If the apparatus is well insulated or is at nearly the same temperature as its surroundings so that the external heat transfer is negligible, the rate will be the same in which ever way it is found, but different methods may be most suitable in different cases.

123 *Surface Condensers.* Let M = total pounds of cooling water per hour and let t_1 and t_2 = its mean inlet and outlet temperatures. Then the rate of heat transfer is—

$$Q = Mc(t_2 - t_1) \text{ B.t.u. per hr.}$$

this being the rate at which the water receives heat.

per hour; let H_2 = heat content, in B.t.u. per lb., of the steam as it enters the condenser; and let h_2 = heat content in B.t.u. per lb. of the water in the hot well. Then the rate of heat transfer from the steam is—

$$Q = W(H_2 - h_2) \text{ B.t.u. per hr.}$$

The "heat of the liquid" h_2 may be found from the steam table if the back pressure is known, but the value of H_2 has to be determined indirectly because the dryness factor of the steam cannot well be observed, and H_2 can therefore not be found directly from the steam table.

125 The value of WH_2 is to be found from the equation

$$WH_2 = WH_1 - A - R$$

where H_1 = heat content of initial steam from the steam table
A = extraction in B.t.u. per hr.
R = heat lost by the engine to the surroundings in B.t.u. per hr. (commonly but incorrectly called "radiation loss").

(*a*) For reciprocating engines—

$$WH_2 = WH_1 - \text{i.hp.} \times 2545 - R$$
$$= WH_1 - \frac{\text{b.hp.} \times 2545 - R}{\text{mech. effy.}}$$

(*b*) For steam turbines—

$$WH_2 = WH_1 - \text{b.hp.} \times 2545$$

(*c*) For turbo-generators—

$$WH_2 = WH_1 - \frac{\text{kw.} \times 3413}{\text{generator effy.}}$$

For turbines the heat loss R and the bearing and gland friction are negligible: all other losses appear as reheat in the steam.

126 *Evaporators.* Let M = pounds evaporated per hour; h = heat content of the entering liquid in B.t.u. per lb. and H = heat content of the issuing vapor. Then the rate of heat transfer is—

$$Q = Mc(H - h) \text{ B.t.u. per hr.}$$

127 If the quality of the entering steam is known, so that its heat content may be found from the steam table, we also have—

$$Q = W(H_2 - h_2) \text{ B.t.u. per hr.}$$

where W = total pounds of steam condensed per hour
H_2 = heat content of entering steam
h_2 = heat content of condensed water.

When there is heat loss to the surroundings the second formula will give the higher result, and the first is to be preferred.

128 *Feedwater Heaters, Fuel-Oil Heaters, Coolers and Economizers.* The rate of heat transfer is—

$$Q = Mc(t_2 - t_1) \text{ B.t.u. per hr.}$$

where M = total pounds of water or oil passed through per hour,
c = the specific heat of the substance (for water $c = 1$)
$(t_2 - t_1)$ = the rise or fall of temperature.

129 *One Standard Ton of Refrigeration* is defined as the absorption of 288,000 B.t.u. irrespective of time.

The unit of capacity, one ton per day, will then be $\frac{288{,}000}{24 \times 60} = 200$ B.t.u. per min.

130 *Total B.t.u. per Hour Output in Steam from Boiler:*

$$Q = W(H_1 - h_2) \text{ B.t.u. per hr.}$$

where W = total pounds of water evaporated per hour
H_1 = heat content of the steam generated in B.t.u. per lb.
h_2 = heat content of feedwater in B.t.u. per lb.

H_1 and h_2 to be found from the steam table.

131 *Grate Surface* is defined as the total horizontal projected area of grates or stoker, including dump plates, ash crushers, etc. it is also stated as the total projected area of all surface supporting coal, within the front wall of the furnace. This definition will cover cases in which the bridge wall is undercut for ejection of refuse.

132 *Total Furnace Volume* is defined for horizontal return tubular boilers and water tube boilers as the cubical contents of the furnace between the grate and the first place of entry into or between tubes. It therefore includes the volume behind the bridge wall as in ordinary horizontal return tubular boiler settings, unless manifestly ineffective, (i.e., no gas flow taking place through it), as in the case of waste-heat boilers with auxiliary coal furnaces,

where one part of the furnace is out of action when the other is being used. For Scotch or other internally fired boilers it is the cubical contents of the furnace, flues and combustion chamber, up to the plane of first entry into the tubes.

133 *Heating Surface* for boilers and superheaters comprises the total area of all the surface in actual contact with the hot gases. This definition implies that tubes of water-tube boilers will be figured on outside diameter, and of fire-tube boilers, on inside diameter. The amount of boiler surface should be stated separately from superheater surface. The heat transfer is always to be figured on total heating surface.

Heating or cooling surface, for condensers, evaporators, feedwater heaters, oil heaters and oil coolers, will be figured on total surface in contact with both fluids, and based on outside diameter of tubes. Heating surface for economizers will be figured the same as for boilers and superheaters.

134 *Thermal Efficiency* based on any unit of output is defined as the heat equivalent of the work done divided by the heat supplied.

135 *The Heat of the Liquid*, for steam engines and turbines, is to be taken at the temperature corresponding to the back pressure.

136 *Thermal Efficiency* is expressed as follows:

For steam engines:

$$\text{Indicated thermal efficiency, } E_i = \frac{2545}{W_i(H_1 - h_2)}$$

For steam engines and turbines:

$$\text{Brake thermal efficiency, } E_b = \frac{2545}{W_b(H_1 - h_2)}$$

For engine-generators and turbo-generators:

$$\text{Combined thermal efficiency, } E_k = \frac{3413}{W_k(H_1 - h_2)}$$

where W_i = steam consumption referred to indicated horsepower
W_b = steam consumption referred to brake horsepower
W_k = steam consumption referred to net kilowatts
H_1 = heat content, B.t.u. per lb. at the throttle
h_2 = heat of the liquid, B.t.u. per lb., corresponding to pressure in exhaust.

137 *The Thermal Efficiencies* of the internal-combustion engine are expressed as follows:

$$\text{Indicated thermal efficiency, } E_i = \frac{2545}{Q_i}$$

$$\text{Brake thermal efficiency. } E_b = \frac{2545}{Q_b}$$

$$\text{Combined thermal efficiency, } E_k = \frac{3413}{Q_k}$$

where Q_i = B.t.u. per i.hp.
Q_b = B.t.u. per b.hp.
Q_k = B.t.u. per net kw.

138 The thermal efficiency for complete plants will be expressed in the same way, using i.hp., b.hp., net kw., water hp., air hp., etc., as the reference. For example, the *overall thermal efficiency* of a coal-fired electric plant is—

$$\frac{3413}{\text{Calorific value of coal} \times \text{lb. coal per net kw-hr.}}$$

139 It is to be noted that in present usage the terms "thermal efficiency" and "cycle" are not limited to the thermodynamic sense only. They are therefore not to be interpreted in the strictly special manner usual in thermodynamics, as used in the Code: their use in the general sense is established by custom and is perfectly understandable.

140 *Heat Supplied*, referred to any unit of output, is defined as the heat input per unit of output.

141 *Heat Supplied*, for steam engines and turbines, is expressed as the total heat content of the steam supplied less the heat of the liquid at exhaust pressure. For complete steam plants, for gas producers, internal-combustion engines and internal-combustion plants, it is expressed as the high calorific value of the fuel per lb. as fired, times the pounds fired.

142 *The Initial Steam Pressure* for any steam engine or turbine is defined as the average pressure obtained in the supply pipe directly preceding the throttle valve of the engine or turbine. The same definition will apply to any other apparatus using steam and using a stop valve to start or stop it.

143 *The Back Pressure or Exhaust Pressure* for steam engines or turbines is defined as the pressure obtained at or as near as possible to the exhaust flange, and it shall also be considered to be the pressure obtaining in the condenser, where the condenser is directly connected to the turbine or engine-exhaust flange (applied only to steam prime movers).

144 *Engine Efficiency* is the general term used for the ratio between heat input per unit of output for the ideal cycle, and heat input per unit of output for the actual engine. It may also be expressed as $\frac{E_i}{E_r}$, $\frac{E_b}{E_r}$ or $\frac{E_k}{E_r}$; and in other ways; all of which are simply transpositions of the same quantities. The ideal cycles are different for the different classes of prime movers. For steam engines and steam turbines, the ideal is the Rankine cycle, and the above ratio will be called the "Rankine efficiency." For explosion internal-combustion motors the Otto cycle is the ideal, and the ratio will be called the "Otto efficiency." For constant-pressure internal-combustion motors the Brayton cycle is the ideal, and the ratio will be called the "Brayton efficiency." Other cycles may be employed as ideals for comparison, as prime movers are developed, but are not required at present. The Carnot cycle, although it affords the highest thermal efficiency, is not employed in any commercial prime mover at present, and therefore is of no practical value in these codes.

145 *The Rankine Steam Cycle* consists of (*a*) admission at constant pressure and temperature, (*b*) isentropic expansion to the back pressure, (*c*) exhaust at constant pressure and temperature, (*d*) return to the boiler of the equivalent amount of feedwater, taken at the temperature and pressure of the exhaust steam; there is to be no heat leakage and no friction, so that all stages of the cycle are ideally perfect.

146 *Thermal Efficiency of the Rankine Cycle:*

$$E_r = \frac{H_1 - H_2}{H_1 - h_2}$$

where H_1 = heat content of steam, at initial condition
H_2 = heat content of steam after isentropic expansion
h_2 = heat of the liquid at exhaust pressure.

The foregoing formula is not exact because it neglects the work of the feed pump, but this is in fact negligible, so that the formula may be used without correction.

147 *Heat Input of the Rankine Cycle* is expressed as

$$\frac{(H_1 - h_2)\ 2545}{H_1 - H_2} = \frac{2545}{E_i} \text{ for i.hp.}$$

$$\frac{(H_1 - h_2)\ 2545}{H_1 - H_2} = \frac{2545}{E_b} \text{ for b.hp.}$$

$$\frac{(H_1 - h_2)\ 3413}{H_1 - H_2} = \frac{3413}{E_k} \text{ for net kw.}$$

148 *The Otto Cycle* consists of (*a*) adiabatic compression, (*b*) heating at constant volume (explosion), (*c*) adiabatic expansion to the original volume, and (*d*) cooling at constant volume (exhaust).

149 *The Brayton Cycle*, (of which the Diesel cycle is a modification), is defined as (*a*) adiabatic compression, (*b*) heating at constant pressure, (*c*) adiabatic expansion to the back pressure, and (*d*) exhaust at constant pressure.

150 *Thermal Efficiency of the Otto and Brayton Cycles* is expressed as

$$E_o = 1 - \left(\frac{P_a}{P_b}\right)^{\frac{\gamma - 1}{\gamma}} = 1 - \left(\frac{V_b}{V_a}\right)^{\gamma - 1}$$

where E_o = thermal efficiency of the Otto or Brayton cycle.
P_a and V_a = absolute pressure and volume at beginning of compression.
P_b and V_b = Absolute pressure and volume at end of compression.
γ = ratio of specific heats $\frac{C_p}{C_v}$ equals 1.41 when air, is used in compressive gas cycles.

(*Continued on page 821*)

AERONAUTICS

The Z R-2 Disaster. The Report of the Court of Inquiry into this disaster, issued in London in October, adds little information to what was previously available.

The cause of the accident in the opinion of the court was that the structure failed in the rear of the after-end cars and the hull broke in two while the ship was being subjected to rudder and elevator tests at a speed of about 45 to 50 knots.

It appears that almost extreme helm, with quick reversal, was being used at the time and the swing of the stern resulting from this maneuvering set up greater stresses in the hull framing than could be resisted.

The Aeronautical Research Committee and the Admiralty are conducting additional and independent investigations, the findings of which have not yet been published.

The editorial in *Engineering* from which the above information has been taken makes the comment to the effect that the airship was not, as might have been expected, the embodiment of the skill and experience of British airship designers as a whole. The disaster might possibly have been prevented by a very careful investigation of the design after one of the preliminary trials in which the weakness of some of the girders amidships became evident, as proved by the fact that these particular girders were reinforced before the final trial. (*Engineering*, vol. 112, no. 2911, Oct. 14, 1921, pp. 545, *g*)

The D.H. 29 Monoplane. Description of the new DeHaviland monoplane and of interest because it is the first commercial aeroplane designed and built in England with wings of the cantilever type. (In addition to the monoplane described here another one was built for the Air Ministry, the details of which are confidential.)

The wing is of thick section, high-lift type, with a high L_c maximum, giving the same landing speed for a much higher wing loading. The wing area of the monoplane designed to carry twelve people is the same as that of the D.H. 4, which was quite a small aeroplane and well known in this country.

The fuselage shows a total absence of wire bracing. The cabin portion of the fuselage is triangulated by deeply splined H-section diagonal struts, and it is of interest to note that three of these transmit the weight of the wing to the points on the lower longerons where the struts of the undercarriage are attached.

In section the fuselage is usual, inasmuch as the floor is considerably wider than the deck. The main reason for this appears to be the desire to get a wide base for the attachment of the undercarriage struts.

In the design of the passenger cabin a consistent effort was made to secure comfort and safety for the passengers. In connection with the latter, emergency doors were provided in the roof. Also plywood construction of the fuselage was adopted in conjunction with water-tight door joints, in order to enable the machine to remain afloat for a considerable period, should a forced descent in the sea ever have to be made.

The engine is powered with a 450-hp. Napier-Lion engine mounted high in the nose. The radiator is placed below and behind the engine. As to the gasoline tanks, two of them are placed in the leading edge of the wing, one on each side. It is intended to employ a low-pressure gasoline system.

The monoplane is of particular interest as indicating a determined attempt to test out to the limit the possibilities of cantilever wing construction. In this construction experience with the D.H. 29 is enlightening in showing that some of the assembly difficulties with a cantilever wing are not as formidable as they were believed to be. Thus, it has been generally believed that with thick section high-lift wings it was necessary to have a rigid covering, such as plywood and sheet metal, as such wings have been thought to be very sensitive to quite minute changes in curvature, such as may be caused by a slight sagging of the covering. Altogether the D.H. 29 is covered with fabric in the ordinary way and there does not appear to have been any trouble due to this cause.

The details of control, especially the lateral control at or near the stalling angle, are given in the original article. (*Flight*, vol. 13, no. 39/666, Sept. 29, 1921, pp. 641–647, illustrated, *dA*)

AIR MACHINERY (See Refrigerating Engineering)

CORROSION

Corrosion of Cast Iron

The Self-Corrosion of Cast Iron and Other Metals in Alkaline Soils, W. Nelson Smith and Dr. J. W. Shipley. Data of research carried out in Winnipeg, Canada, and covering the electrochemical phenomena underlying corrosion of metals in certain soils, soil analysis, effect of moisture content and salts in solution, and products of corrosion. The first of the authors is consulting electrical engineer of the Winnipeg Electric Railway Co., and the second is assistant professor of chemistry at the University of Manitoba.

The investigation was primarily undertaken in order to derive proof that the external corrosion of city water mains in areas where any stray electric current present would necessarily be flowing into the pipe and not out of it, must be due to the action of the soil and not to the passage of stray current, which can only dissolve iron where it leaves the pipe.

The experimental work was carried out both in the field and laboratory with pieces cut from cast-iron pipe and bars of cast iron immersed in various salts. The following conclusions were drawn:

1 The corrosion of cast iron by the salt solutions found in natural soil is readily accomplished under natural conditions without access of stray current. This corrosion is of the so-called graphitic pitting type, by which is meant the commonly observed condition of the material remaining in place, which is invariably of a soft, spongy texture with part of the iron dissolved out, the remainder resembling graphite in consistency.

2 Magnesium salts are the most corrosive of the soil salts, and magnesium sulphate, which was found wherever a cast-iron pipe had been destroyed, is apparently the most effective of the salts experimented with.

3 Local action induced by naturally occurring concentration cells may easily be a factor in the pitting of cast iron exposed to salts of varying concentration.

4 Slight pitting corrosion was found in pieces of cast iron exposed to the action of small samples of wet soil and intermittently heated, even in the short period of 40 days, and with only a limited supply of water as compared with conditions in natural ground, no impressed electromotive force being present.

The products of corrosion on cast-iron pipes were next investigated and it was found that they consisted mainly of metallic iron, ferrous oxide, ferric oxide, and silicious graphitic residue, in addition to which, however, were found also ferrous phosphate and iron sulphide, showing the great complexity of corrosion processes.

The moisture content is apparently an important element in the rapidity of corrosion on pipe. It was generally found that soils of Winnipeg and vicinity when in contact with iron can of themselves set up an appreciable electromotive force like that of a battery, amply sufficient to decompose the iron. Moreover, indications become available to the effect that lead and copper are also affected by self-corrosion.

Thus, a small new lead plate was buried in contact with a clay soil and some black surface soil in a sealed glass container, with plenty of moisture present, and when removed at the end of $4^1/_2$ months was found to be pitted with little cavities about as big as pin heads, which were filled with white pellets of crystallized lead sulphate. No heat was applied during the experiment. A copper ground plate buried below the basement floor of the Manitoba Government Telephone Exchange in St. Boniface, corroded in 18 months or less after installation.

As regards preventive treatment, it is stated that usual treatments with tar, dips and paints have generally proved futile, but the authors believe that the life of cast-iron pipe in a wet, salty soil could be lengthened considerably by backfilling the pipe trench with quartz sand or washed gravel rather than depending on a thin layer of paint.

E. L. C. Forster, chemist on the Dominion Health Board staff, has advised that a very small percentage of aluminum with cast iron has prevented microscopic shrinkage cracks in the surface of castings that otherwise formed when the casting cooled, and that this property was utilized in making munitions during the war. The absence of minute surface cracks might render the silicious coating of cast-iron pipe more impervious to salt solutions. Any method of casting pipe which could produce a flawless exterior coating of silicate, that would resemble enamel would certainly retard the solution of the iron. (Paper presented at the 10th General Professional Meeting of the Engineering Institute of Canada, Saskatoon, Aug. 11, 1921. *The Journal of The Engineering Institute of Canada*, vol. 4, no. 10, October, 1921, pp. 527–535, *ep*)

ENGINEERING MATERIALS (See also Corrosion)

Lafarge Quick-Hardening Cement, Edwin C. Eckel. Data on a cement developed during the war, of which the most remarkable property is that it hardens with great rapidity so as to make a good, heavy gun platform within 24 hr.

This new cement is a lime-aluminate and differs from normal portland cement in the almost total absence of silica; it is prepared by actual fusion and not by mere clinkering and is almost white in color.

It is made in a small blast furnace which is charged with coke, limestone and bauxite. When the furnace is in steady operation it turns out from 10 to 15 metric tons a day of fused slag, which, cooled and ground, is the new cement. It contains, roughly, 50 per cent lime, 40 per cent alumina and 10 per cent other additions, such as silica.

Its cost is said not to vary materially from that of the normal portland cement. It has a normal setting time but hardens, as mentioned above, with far greater rapidity. It is believed that it would be of practical advantage for use in marine work which has to be completed between two tides. It is said to possess great resistance to the decomposing effects of sea water and similar solutions, as indicated by the experience of an important railway in France. (*Engineering News-Record*, vol. 87, no. 14, Oct. 6, 1921, pp. 566–567, *d*)

Genelite, an Improved Bearing Alloy, E. G. Gilson. Data on a new synthetic bronze-graphite bearing material developed by the Research Laboratory of the General Electric Company. It is claimed that it does not seize nor score when bearing surfaces are permitted to run dry through negligence or accident.

The material has uniformly distributed throughout its mass approximately 40 per cent by volume of very finely divided graphite. It is made by thoroughly mixing the finely powdered oxides of the metals composing the bronze with sufficient graphite to completely reduce them and leave in excess of this amount the graphite content desired in the finished material. This reduction process must be carried on at temperatures below the welding point, and therefore the material cannot be cast, but is shaped by molding under high pressure while still in powdered form. As the powder does not flow readily under pressure, it is necessary to use a complicated mold and confine this operation to only the simplest shapes. The material cannot be machined easily by ordinary methods as it rapidly dulls the cutting tool. It grinds easily, however.

Genelite has not the physical characteristics of ordinary bronze. Its tensile strength and elongation are low and the ultimate strength and yield point are practically identical at 8000 lb. per sq. in. Under compression, however, it will withstand 50,000 lb. per sq. in. The structure of the material is of a porous nature and it will absorb from 2 to 3 per cent by weight of oil.

The self-lubricating property of genelite is taken advantage of in many applications, such as in tilting motors where the standard oil-ring practice cannot be used because the oil will run out of the bearings when tilted.

Owing to its spongy structure genelite should be given a greater allowance for pressed fits than is customary with other materials and it need not be held to such close limits. (*General Electric Review*, vol. 24, no. 11, Nov. 1921, pp. 940–951, 3 figs., *d*)

FUELS AND FIRING (See also Transportation)

Cheap Oxygen Manufacture

The Influence of Cheap Oxygen on Economy of Fuel and of Time, E. A. W. Jefferies. The author describes a process of oxygen separation which, in general, consists of liquefying the air by compression and expansion. The nitrogen is next distilled off, but the distillation is carried on under the same pressure to which the air is originally compressed. By this method the nitrogen leaves the steam under the original pressure and can then be heated to increase its volume and power capacity and used in a piston engine to drive the compressor.

For this purpose only a comparatively little heat is required, so that the entire process requires only fuel, but not external power, to operate.

The new method has been demonstrated on a large scale by the Government in the separation of helium from the natural gases of Texas.

A claim is made that oxygen can be produced in large quantities by this process at a price of the order of 8 cents per thousand cubic feet.

The remainder of the paper is devoted to the use of oxygen in gas producers, open-hearth furnaces, blast furnaces, and industrial applications, and made possible its low price. (*Association of Iron and Steel Electrical Engineers*, vol. 3, no. 10, October 1921, pp. 471–477, *dg*)

Powdered-Coal Firing in Industrial Plants. Report of Commission appointed by the Minister of Public Works to investigate the best methods of utilization of fuels, reprinted from an official publication of the French Government. The purpose of the report was to investigate in view of the extensive application of powdered-coal firing in America to what extent the same would be suitable under French conditions. Only the conclusions are given here.

The report cites the following points in favor of powdered-coal firing—

1 The very high utilization of the value of the fuel whether the latter belongs to the class of rich or poor fuel;

2 The possibility of burning successfully low-grade fuels, some of which could not otherwise be burned at all today; easy handling of the fire, its instantaneous starting and extinction, and, under certain conditions, a great flexibility in regulation.

As against the employment of powdered fuel are cited the liability to accidents, troubles due to ash and clinker formation and high first cost of installation.

As regards these objectionable features, it is pointed out, however, that accident liability may be largely reduced by greater knowledge of past experiences with this fuel and by proper and careful precautions. The trouble due to ash and clinker formation appears to have been already largely eliminated by the use and good handling of suitable apparatus, and as regards the high first cost of installation it is stated that in certain cases this may be more than compensated for by economies of operation due either to lessened consumption or the use of cheaper grades of fuel.

On the whole the report recommends the subject of powdered-fuel burning to the earnest attention of French industries. (*Memoires de la Société des Ingénieurs Civils de France*, vol. 74, series 8, nos. 4, 5 and 6, April to June 1921, pp. 123–172, *g*)

Pelton-Wheel Bucket Efficiencies

Comparative Tests on Pelton-Wheel Buckets of Different Inclinations. An investigation for the purpose of determining directly the inclination of the buckets that gives the best efficiency, carried out at the Hydraulic Laboratory of the Engineering Division, Kyushu University.

The wheel is 520 mm. (20 in.) in diameter and designed to develop 6 b.hp. under a head of 30 m. (98.4 ft.) at 400 r.p.m. The wheel carries 22 ellipsoidal buckets.

Experiments were made with four different inclinations of buckets and the results are presented in the form of tables and curves. It was found that when the central ridges stand at right angles to the jet axis at the mean position between the beginning and end of full jet, the best efficiencies are obtained for all gates except one-quarter gate. At seven-eighths gate, which corresponds nearly to the normal load of the wheel, case 2 has an efficiency of 83.2

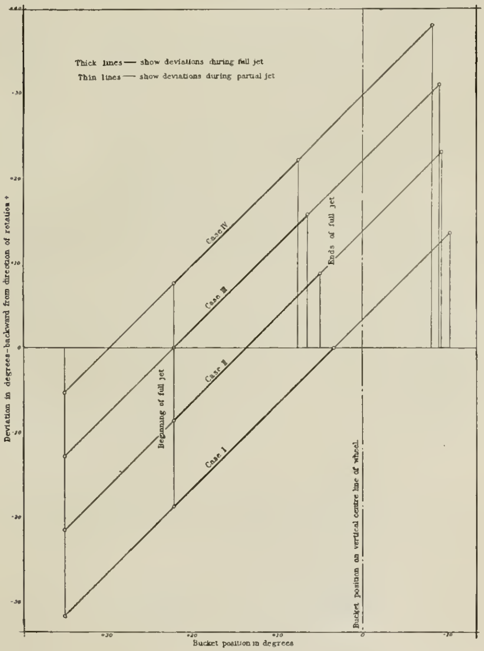


Fig. 1 Deviation of Bucket Planes from Normal to Jet Axis

per cent, exactly 10 per cent greater than in case 4 when the relative entrance velocity of the jet is at right angles to the ridge at the same mean position of the bucket. In the order of efficiencies, case 1 is next to case 2, then comes case 3 and lastly case 4. These variations of maximum efficiencies in the four cases may be explained briefly as follows: When it is remembered that the buckets under consideration are so shaped that the normal cross-sections of the double ellipsoidal deflecting surface of the bucket are all at right angles to the plane containing the central ridge and the exit edges (hereafter called the bucket plane), it is evident that the impulsive action of the jet will be most efficient if the buckets can move parallel to themselves standing always at right angles to the jet, in which case the absolute deflection of the mid particles of the jet will always take place on the axial plane through the jet parallel to the wheel axis. Actually, the bucket's inclination against the jet axis continually changes and the buckets so disposed as to make them move in a way nearest to the ideal motion above mentioned, at least during the most important part of the range of jet action will have the highest efficiency. From these considerations it ciency of the four experimented upon. The deviation of the bucket plane from the normal to the jet axis in the four cases are shown in Fig. 1, in which it will be observed that the deviation is least in case 2. The maximum deviation in this case is ± 8 deg.5 min., while it is + 22 deg. 14 min. in case 4. When the deviation is excessive as in the latter case, that is to say, when the bucket plane is much inclined toward the impinging jet, the deflected stream is forced downward considerably from the axial plane of the jet parallel to the wheel axis, which phenomenon was clearly observable during the tests through glass holes on the cover of the wheel; as a consequence of this, the torque exerted by the impinging jet is much reduced.

If the central ridge be not parallel to the plane containing the exit edges as in some buckets, it seems advisable so to fix the buckets that the jet shall be at right angles to the major axial plane, if it may be so called, of the double ellipsoid at the mean position of bucket between the beginning and end of the full jet. (*Memoirs of the College of Engineering, Kyushu Imperial University*, Fukuoka, vol. 2, no. 3, pp. 143–174, 16 figs., *e*)

INTERNAL-COMBUSTION ENGINEERING

New Nelseco Diesel Engine. Details of a 600-b.hp. marine Diesel engine. In introducing the subject the author makes a significant statement to the effect that from his personal knowledge of the factories in this country and Europe there is no single European country whose compound Diesel and surface-ignition engine facilities can equal those of the eight leading factories of this country.

The New London Ship and Engine Company, the builders of the Nelseco engine, have in the past devoted their facilities principally to the construction of submarine-type engines for the United States and foreign navies, but expect now to give more attention to the commercial craft field.

The new engine weighs 53 tons overall, or 191 lb. per b.hp., and is chiefly designed for use in direct drive on small commercial vessels, such as ferries, tugs, etc. For large freighters, passenger vessels and tankers it may be used in conjunction with electric transmission, several engines being employed when necessary.

As regards the technical features, it may be mentioned that the six working cylinders for the engine are in line with the single three-stage air compressor at the forward end. In this air compressor the piston is driven from the crankshaft by means of a connecting rod and crosshead. Because of this the compressor cylinders are made entirely separate from the crankcase, which provides an accessible machine and avoids all trouble due to lubricating oil in the cylinders.

Independently driven circulating-water and lubricating-oil pumps are provided, but direct-connected pumps may be fitted at the forward end if desired.

For the lubricating of the engine, the system can best be described by calling it a gravity forced feed. With this system the lubricating oil flows from the gravity tank which is at a sufficient height above the engine crankshaft to give the proper pressure to the main bearings, then through holes in the crankshaft to the crankpins, and up the inside of the connecting rods to the wristpins. The crankcase is enclosed and all surplus oil drains to a suitably formed trough in the bottom of the bedplate, whence it is pumped back through suitable strainers to the gravity tank. All of the important bearings are thus under forced lubrication and a free flow of oil is circulating through them at all times. The camshaft parts are oiled by splash from oil carried in the bottom of the trough of the camshaft casings. All cylinders and exhaust-valve stems are taken care of by mechanical oilers, and the minor valve-gear bearings are fitted with oil cups for hand oiling. (*The Motorship*, vol. 6, no. 10, Oct. 1921, pp. 798–801, illustrated, *d*)

The Open-Fronted Surface-Ignition Engine, F. G. Butt-Gow. General discussion of design of semi-Diesel engines, with particular attention to the differences between the closed type and the open for marine service.

The author compares the two types in detail from the point of view of manufacture and operation and shows that on the whole the crankcase is rather easier to build in the open type than in the

closed type. The cylinders of the two types are not very different, though possibly in the closed engines they may be slightly longer. The piston on the open engine may be made shorter as it does not have to perform the duties of a slide in the cylinder walls which serve as guides. The general conclusion to which the author arrives is that the cost of manufacture of the open engine should not be very much more than that of the closed engine, and in the larger sizes, that is, 60 to 100 b.hp. per cylinder, it ought to be less, owing to the use of smaller castings and subdivision of parts. This is especially so in view of the difference of lubrication.

On the closed engine the same system of forced lubrication is generally used. The crankpin brasses are usually supplied with oil by means of banjo rings or centrifugal lubrication. In the open-fronted engine the lubrication is practically the same as on a marine steam engine; either an ordinary open-drip system may be fitted or a drip with side feeds.

As regards operation, it is claimed that the closed engine shows more wear in the cylinder and bearings, the former being ascribed by the author to the use of a trunk piston. In the open engine the main bearings, top and bottom ends and guides, are in full view all the time, while in the closed engine the main bearings only are in sight. There is really no way to judge reliably of the extent to which the crankpin brasses are supplied with oil.

The following data as to lubricating-oil consumption are cited by the author:

Bolnes 130 b.hp., 0.005 pint per b.hp. per hr.

Closed type 160 b.hp., 0.010 pint per b.hp. per hr.

The question of adjustments is next discussed and the author shows that gudgeon-pin and crankpin adjustments are very much simpler and easier on the open-type than on the closed-type engine.

Various types of open crankcase engines are described and illustrated—namely, the Reliable, the Bolnes, the Grei, Lambert and Adie, Stallard double-acting hot-bulb engine and the Summér. Of these, the Lambert and Adie is of interest as it was first designed to work on the Brons (known in America as the Hvid) system of ignition, but can be adapted to surface ignition. (*Transactions of the Institute of Marine Engineers*, vol. 33, September, 1921, original paper pp. 239–269, 21 figs., and discussion pp. 270–278, *cA*)

Supercharging Engines and Their Uses

Supercharging Engines, G. H. T. Alston. General discussion of the subject, of which the part abstracted here deals with the application of supercharging engines for various purposes.

In particular, in considering the application of supercharging to road motor vehicles, the author calls attention to the fact that much would depend upon the method employed. If the supercharging were to be in action all the time, the effect would be equivalent to fitting a larger engine, or, conversely, an engine of smaller cubic capacity could be used and the same power maintained.

Supercharging can be applied also so that the capacity of the engine be such that the power developed at nearly full throttle but without supercharging would be that required during the greater part of the time, supercharging being only resorted to when greater than average power was required. Such an engine would be more economical as regards fuel consumption than one running normally under reduced throttle conditions.

There is therefore every reason to believe that supercharging, so applied, would lead to a large reduction in fuel costs per ton-mile on give-and-take routes. In order, however, to reap the maximum advantage from supercharging, it would be necessary to utilize to the fullest extent the accelerative powers possessed by such an engine. In such an application of supercharging it should be possible, without demanding any additional attention from the driver, to so control the engine (possibly by means of a permanent restriction in the induction pipe leading to the supercharging device) that only at slow speeds, on any gear, full supercharge is available at full throttle opening. As the speed increases, the restriction begins to take effect so that the supply of mixture is reduced.

By some such means it would be impossible to obtain full supercharge at any except reduced speeds, thereby avoiding seriously overloading the engine. A supercharge valve, under control of a governor, could operate in the same way, but it might, perhaps, be rather more easily put out of order. In Fig. 2 is illustrated an estimated power curve showing the effect of operating under these conditions compared with a power curve from a normal type of engine of slightly larger capacity but developing the same maximum brake horsepower.

It will be seen from these curves that the same maximum brake

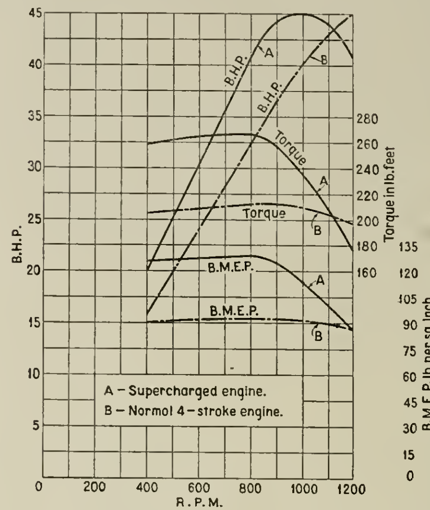


Fig. 2 Power Curves of Normal and Supercharged Engines

horsepower is available from each type of engine, but it is obtained from the supercharging engine at a much reduced speed, and that from this speed upward revolutions per minute are gained at the expense of the brake mean effective pressure, and that the brake horsepower therefore remains practically constant over a fairly wide speed range.

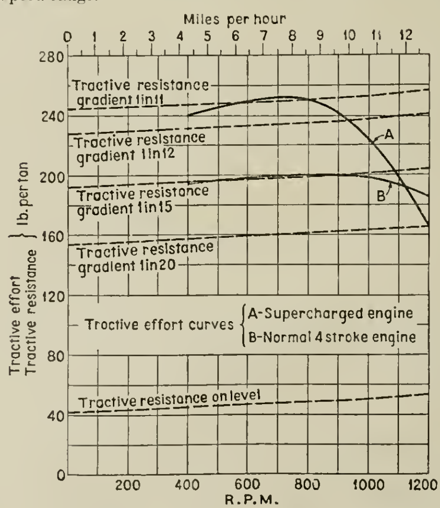


Fig. 3 Tractive-Effort Curves of Normal and Supercharged Engines

The aim has been, not to develop a maximum horsepower at maximum supercharge and revolutions per minute, but at a lower speed, so that the maximum brake horsepower is maintained over a considerable speed range by, as indicated above, exchanging brake mean effective pressure for revolutions per minute. In Fig. 3 are shown the tractive-effort curves for two different heavy-type

is fitted with a supercharging engine capable of giving a power curve as (a) Fig. 2, while in the other is installed a normal four-cycle engine whose power curve is as (b). Road-resistance curves are both level and certain gradients are also shown, from which it is apparent that an engine with a power curve such as (a) would have a greater capacity for top-gear work.

These curves also show that the supercharging engine could still propel its load at a speed of $8^1/_2$ m.p.h. on a gradient of 1 in 11, and at 10 m.p.h. on a gradient of 1 in 12, whereas with the normal four-cycle engine of the same maximum horsepower the speed would be reduced to 10 m.p.h. on a gradient of 1 in 15, and would then probably require a change of gear. Since hills of 1 in 12 and steeper are the exception on the main roads, it is safe to assume that the supercharging engine would be able to maintain its normal speed of 12 m.p.h. on top gear except when compelled to slow down for considerations other than gradients.

In a commercial vehicle of the passenger bus type, which is constantly stopping and restarting, speed of acceleration is of great importance, tending to considerably increase the mean speed of the vehicle without any increase of the maximum speed. Increased acceleration, if common to all vehicles, would speed up the traffic rate of the streets generally, and thus increase their carrying capacity.

The fact alone that gear changing was the exception and not the rule, as at present, would, in itself, tend to an improved service due to less fatigue to the driver, and would, in fact, largely reproduce with internal-combustion engines the almost ideal conditions obtained in this connection with steam.

If the foregoing be true with reference to road transport it is certainly also true with regard to transport on rail, such as yard shunting locomotives, etc. Such engines are, of course, almost continually employed starting up heavy loads from rest, so that the benefits derived from a large starting torque should be felt in a peculiar degree.

On the whole, the writer shows that for certain work the supercharging engine may possess three advantages: namely, lower fuel consumption under working conditions; greater torque at starting and at reduced speed; and greater horsepower for its cubic capacity, of which the last is hardly worth while with the exception of the semi-Diesel type of engine. (*The Automobile Engineer*, vol. 11, no. 155, Oct. 1921, pp. 337–341, 2 figs., *gtA*)

MACHINE DESIGN AND PARTS

Riveted Joints. Butt joints usually carry two rows of rivets, but a joint devised in England (Fig. 4), in particular for joining

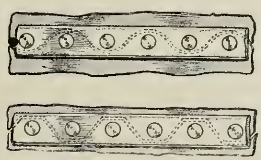


Fig. 4 Butt Joint with a Single Row of Rivets

panels of motor bodies, is of the butt type but so arranged that only a single row of rivets is required for it.

This result is obtained by scalloping the abutting edges of the plates so that the projection thus formed upon the one plate can be located in the corresponding notches formed on the other plate.

The rivets are therefore in a straight line and adjacent rivets lie alternately in each plate, being located in their respective projecting parts. Various forms of scalloping may be adopted, two kinds being shown in the illustration. (*Motor Transport*, vol. 33, no. 865, Sept. 26, 1921, p. 345, 1 fig., *d*)

MARINE ENGINEERING (See also Measuring Instruments)

Abandonment of Turbine Electric Drive by a Swedish Company. It is stated that the Ljungstrom Steam Turbine Co., electric transmission, has recently abandoned the electric drive and installed mechanical friction clutches with friction disks for reversing and power transmission. (*Motorship*, vol. 6, no. 10, Oct. 1921, p. 819, *g*)

MEASURING INSTRUMENTS

Thrust Meters in Marine Work. General discussion of the subject of thrust meters and the results which may be obtained thereby, based on tests on the British destroyer *Mackay* and the U. S. destroyer *Pruitt*.

In both cases the operation of the meters enabled a measurement of thrust over a range of speed to be obtained, which, by its ease of application and reliability of results, offers a method of solution of many problems connected with both resistance and propulsion which for lack of such apparatus have hitherto defied precise analysis.

The two performances essentially corroborate one another to a very marked extent. Among other things, thrust meters show precisely what the propeller is doing (whether cavitation is present or not), and by deduction from the effective horsepower of the model permit assessing the uncertain influences of air or appendage resistance.

When cavitation is present accurate calculation of the thrust horsepower delivered by the screws becomes very difficult. The use of the thrust meter largely discounts this uncertainty of results. As an instance may be cited the fact that the measured thrust per square inch of projected area of screws ran up to 15.7 lb. in the case of the *Pruitt* and to just 15.0 lb. in the *Mackay*, but though the *Mackay's* propellers were obviously breaking down, the *Pruitt's* were still continuing work with high efficiency. Calculated from the effective horsepower of the model with appendages the respective pressures were 14.8 lb. and 12.5 lb., which is but a small instance of the light shed on some unsolved propeller problems by this measurement.

Thrust measurements will not solve the problem of the propeller efficiency of the ship, but they remove a most important element of doubt regarding its performance. The determination of the wake factor in the ship as distinct from the amount found by experiment in the tank, is essential before the real slip, and hence the efficiency, can be accurately estimated. This can be best done when the true thrust is known.

But it is mainly in the facilities which it affords for the comparison of experimental data with observations in practice that the value of the thrust meter will be found. It possesses the paramount advantage of giving the actual resistance of the whole ship under any condition or combination of conditions of loading, trim, weather, state of sea, depth of water, or condition of bottom; quite apart from the comparative data to be gained regarding the differences between trial and service performance, such matters as astern performance or maneuvering data (one engine ahead and the other astern) can be elucidated, while the use of actual screws to corroborate model results for purposes of design can now be placed on a very definite footing. In these items there is scope for a deal of research and profitable development of knowledge. (*The Engineer*, vol. 132, no. 3432, Oct. 7, 1921, pp. 375–376, (editorial), *g*)

MOTOR-CAR ENGINEERING

Unconventional Italian Tractor

The Agrophile Tractor. Description of a new type of Italian tractor (the Pavesi) of unconventional design.

It consists of two separate carriages whose wheels are controlled and united or separated as required. Each carriage consists of a frame ending on one side in an arched rod shaped like a convex arc and fitted on the under part with a rack. The engine (horizontal, opposed, two-cylinder), steering gear and gear box are in the forecarriage, while the differential is in the second carriage.

To assemble the two carriages they are joined by the arched parts, which thus have a similar function to that of the buffers on tramway trailers, and they are fixed by means of a jointed cardan tie rod on the two axles. This tie rod carries, at its center,

a loose pulley which engages with the two racks placed below the curved members. Another shaft with a double cardan goes from the gear box of the main carriage and controls the differential of the second carriage. The four wheels are all driving as well as steering wheels, or, more accurately speaking, two axles steer. In fact, if the driver moves the steering wheel, the axle E of the main carriage AV (Fig. 5) turns obliquely, e.g., to the left of E_1, which moves the curved members to the right. The rack c carries the loose pinion p of the tie rod T, but this, on turning, forces the rack c' and the curved member of the second carriage AR to move to the right, and, consequently, forces the axle E' of that carriage to move to the right and take up the position E'_1. The two axles are then in such a position that a very short radius is required for turning the tractor. In fact, the external turning radius is 3.25 m.

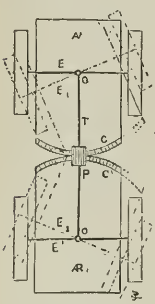


Fig. 5 Agrophile Pavesi Tractor

When it is observed that the articulations o and o' of the tie rod T on the two axles are cardans, it will be seen that the two carriages can take up any position in a transverse direction compared with each other. Thus the tractor can travel on the most uneven ground, as its two driving axles allow it to overcome obstacles more easily in spite of an average power and relatively light weight (2350 kg.). The usual compensation for complicated transmissions requires total adherence, and the complication is partly avoided in this case by the use of driving and steering axles instead of driving and steering wheels.

For light work, the driving carriage can be used alone by attaching it to a cart as a forecarriage; but with both carriages the high tractive effort obtained is sufficient to tow several vehicles (*The Practical Engineer*, vol. 64, no. 1806, October 6, 1921, p. 218, 1 fig., *d*)

POWER-PLANT ENGINEERING (See also Special Processes)

High Steam-Pressure Economies

Economy of Steam Engines, Frederick Samuelson. Discussion of high steam pressure and other means of increasing economy of steam engines.

In all heat engines the theoretical efficiency depends upon the limiting temperatures between which the plant works. In steam engines the lower limit of temperature is determined by the condenser, and to obtain a higher efficiency it is necessary to raise the upper limit of temperature, either by superheating the steam, or raising its pressure, or both.

The ideal efficiencies obtainable, that is, the values of the ratio: (heat available in steam)/(total heat in steam), corresponding to various pressures and temperatures in the simple steam turbine, are shown in Fig. 6. As the highest safe working temperature when ordinary materials of construction are used is about 800 deg. fahr., higher efficiencies can only be obtained by increasing the pressure.

The steam consumptions of a larger turbo-generator set under various conditions are shown in a table. The figures do not include auxiliaries, and assume a boiler efficiency of 100 per cent. With 350 lb. pressure, 300 deg. fahr. superheat, 29 in. vacuum, and cold feed, the consumption is 9.60 lb., and the efficiency 26.38 per cent. With feedwater raised to 300 deg. fahr. by steam extracted from the turbine, other conditions remaining as before, the steam consumption increases to 10.72 lb.; but the overall efficiency is raised to 28.44, or an improvement of over 7.5 per cent.

When evaporators are necessary, they should be heated by steam abstracted from the turbine, and the water evaporated should be condensed in the feedwater. With feedwater at 300 deg. fahr. stack losses should be kept down by inserting an air heater after the usual economizer.

A 1500-kw. plant constructed by the author's firm (British Thomson-Houston Co.) and supplied with steam at 350 lb. superheated to a total temperature of 700 deg. fahr., has been in use since 1914. It has proved very successful, and the expected saving in coal of 15 to 18 per cent has been more than realized. Larger sets of from 5000 to 15,000 kw., to work under similar steam conditions, are now being supplied. (*Proceedings of the Institution of Mechanical Engineers*, no. 6, Oct. 1921, pp. 601–604 and discussion pp. 604–606, 2 figs., in original article, *gp*)

Steam-Condenser Design and Construction

The Modern Steam Condenser, E. R. Briggs. A general discussion of condensers with particular regard to the practice of a certain British manufacturing company. Only certain parts are abstracted here.

The author is not in favor of the so-called "boat-shaped" condenser, claiming that it is unsatisfactory in that it requires internal stays which interfere with the flow of the steam, and is moreover expensive to construct.

As regards the method of withdrawing the air from the condenser without permitting air pockets, the article describes and illustrates an arrangement where the air branch is taken from the side of the condenser and communicates with the space inside the plate that extends the whole length of the body. As regards the permissible amount of air in a condenser, it is stated that from 3 to 6 lb. of air per 10,000 lb. of steam is allowed, the higher figure for 3000-kw. sets and the smaller figure for 20,000-kw. sets. The method of basing the air allowance on the quantity of the steam is very unsatisfactory, because only a very small amount of the air to be dealt with comes over with the steam itself, the bulk

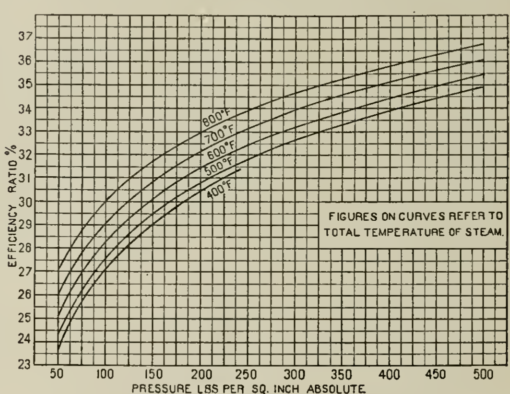


Fig. 6 Efficiencies in Steam Turbines at Various Steam Pressures

of it entering through the turbine glands and the joints in the exhaust piece and condenser. An excess of air can usually be detected by noting the difference between the temperature of the condensate in the bottom of the condenser and the actual vacuum, the original article giving the complete calculations necessary.

In Great Britain the transportation factor enters into the design of a condenser to a very serious extent, because of the limitations of the British loading gage. Generally speaking, condensers up to 8 ft. internal diameter can be fitted with tips at the maker's works and so delivered to site. Above 9 ft. diameter it is seldom possible to deliver the shell in one piece. Up to 11.5 ft. the shell can be made in rings, but above 11.5 ft. the body and water boxes must be divided into segments, which means, as a matter of fact that the segmental type must be used for practically all units in excess of 20,000 kw.

A typical British condenser design is described and illustrated in the original article. The tubes are of Admiralty mixture, $^3/_4$-in. O.D. by 18 gage. In some of the condensers, instead of following the usual practice in the arrangement of the inlet and outlet water boxes, the arrangement shown in Fig. 7 was employed. This arrangement permits of easy stream-line flow of the water from the pipe line (40 in. diameter) into the tubes and from the tubes to the return pipe. The frictional resistance required to get the water into and out of the condenser is reduced, which means

(*English Electric Journal*, vol. 1, no. 6, April 1921, pp. 244–253, 9 figs., *d*)

RAILROAD ENGINEERING (See also Transportation)

Feedwater Heating on the London and Northwestern Railway. Details of the latest application of the Weir feedwater heating system and pump to a George V.-class express locomotive. This arrangement is different in some respects from that previously used. Thus, the pump is placed alongside the front of the smokebox on the left-hand side of the engine, and a top feed device is used mounted on the boiler barrel between the steam dome and the safety valves. The feed device consists of a spray delivery valve through which the hot water passes into the boiler.

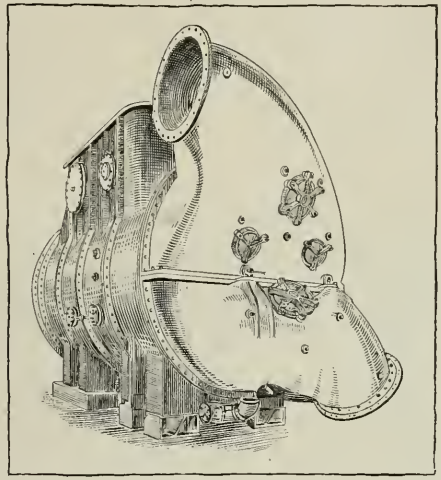


Fig. 7 End View of a British-Built Condenser, Showing Inlet and Outlet Water Boxes

The pump is of the vertical double-acting type essentially similar to the Weir marine boiler feed pump. Its principal feature is the method of distributing steam to the cylinder whereby the pump will work well at all speeds from as slow as one stroke in 5 min. up to about 30 double strokes.

G. and J. Weir, Ltd., the makers of this device, are the strongest advocates of direct-contact feed heating for marine work, but adhere to the surface type in their locomotive work.

This is due to the belief that the direct-contact heater is inherently weak, owing to the complication of the feeding agents, and would have to be too large to fit on a locomotive or its necessary feeding agents too small for their work. Because of this a heater is used of the surface type, consisting of a cast-iron shell with end doors and a tube element made up of straight, solid, drawn copper tubes expanded into headers, one of which forms the end cover of the shell while the other is free to move within the shell due to the expansion or contraction of the tubes.

In the heater installed on the locomotive described here, the water traverses the element 12 times by means of two tubes each flow, the headers being divided into compartments. The provision of these divisions within one casting eliminates the objectionable necessity of having joints under high pressure. (*The Railway Gazette*, vol. 35, no. 16, Oct. 14, 1921, pp. 572–574, 2 figs., *d*)

REFRIGERATING ENGINEERING

High-Speed Ammonia Compressor

High-Speed Ammonia Compressor. Description of a compressor of British manufacture having a normal running speed of 350 r.p.m. and cylinders with an internal diameter of 9 in. and piston stroke of 9 in.

day and an ice-making capacity of 60 tons a day of 24 hours. It is of interest to note that the definition of capacity adopted by the British manufacturers is the standard definition of the American Society of Refrigerating Engineers (December, 1920) which, it is said, will probably be adopted universally in England in the near future.

The advantages from the employment of the high-speed compressors are reduction in weight, space occupied, and first cost. In this case the actual floor space required by the steam-driven plant is 85 sq. ft., whereas that for a horizontal slow-speed compressor of similar capacity driven from the tail rod of a steam engine would be about 385 sq. ft. The weight of the compressor and the bed plate alone is $7^1/_2$ tons, or about one-third of the weight of a slow-speed horizontal machine of equal capacity.

The compressor is of the four-cylinder vertical single-acting type with a totally enclosed crankcase and forced lubrication.

The crankcase is of the dry type, the used oil passing through an opening into a large tube situated between the crankcase and bedplate. From this tube it is drawn through a strainer by means of a gear-type rotary pump and delivered through jets to the main bearings and stuffing boxes. Other jets in the delivery pipe supply oil to the big ends, gudgeon pins and cylinder walls.

The cylinders and pistons are all of the same construction, a fact which together with the sectional construction of the crankcase considerably reduces the time and cost of manufacture. Also machines of different capacity can be made up by merely employing a larger or smaller number of cylinders.

The upper portion of the cylinder is bored to a larger diameter than the working portion, and in it fits a movable head which is held in position by three strong helical springs in compression. The lower ends of these springs fit into recesses in the head, and their upper ends are pressed downward by a cast-iron dished cover secured to the cylinder casting by means of studs. It will be readily understood that this arrangement constitutes a safety device, which serves to relieve excess of pressure arising from any accidental cause, and also to prevent any serious damage from occurring in the event of a solid foreign body getting into the cylinder. The head itself, which is shown to a larger scale in Fig. 8 is composed of two steel forgings, of which the lower one forms the seat for the delivery valves. The lower part, it will be seen, is formed with a screwed shank, and a nut on this clamps the two parts together. Two annular valves, made of a specially hard and tough steel alloy, are provided, and these valves, which are formed with lips on their working faces, cover the delivery ports in the lower portion of the cylinder head. The valves are prevented from moving laterally by three resilient stops, one of which is shown in section on the left of Fig. 8, and their vertical lift is controlled by light steel springs surrounding the stops, as will be clear from the illustration. The necessary lift for normal working conditions is of the order of $^1/_{16}$ in., and vertical movement in excess of this amount is limited to the resilient stops. The compressed gas passes through the annular delivery passage to a pipe connection and it should, perhaps, be explained that the smaller annular groove above the delivery passage is provided merely to reduce the thickness of the metal at this part; it has no connection with the working of the compressor.

The inlet arrangement is one of the most interesting features of the design. Four annular inlet valves, of similar design and material to the delivery valves above described, are fitted, and their lift is restricted by spring-controlled bolts, as will be clear from Fig. 8. The heads of these bolts are formed with flanges which project over two valves, as shown, but parts of the flange are cut away, so that by pulling up the bolts against the action of the springs and turning them about their axes, the valves can be removed for examination without withdrawing the piston; snugs on the heads of the bolts prevent them from turning in their normal working positions. The opening and closing of the inlet valves is produced mainly as a result of inertia effects, as will be clear from the consideration of the motion of the piston. When the latter commences its down stroke, assuming for simplicity that the motion is simple harmonic, the downward acceleration will be a maximum, so that the valves will leave their seats and allow the gas to pass into the space above the piston. The ac-

celeration, of course, diminishes as the piston descends, becoming zero in the middle of the stroke and afterwards changing sign, so that the valves then tend to return to their seats. The difference in pressure is, however, sufficient to prevent them from doing so until the retardation reaches its maximum value at the end of the down stroke. On the up stroke the conditions are of course reversed, inertia effects at first assisting in keeping the valves closed and afterwards tending to open them, but before this latter stage has been reached, the gas pressure above the piston has risen sufficiently to counteract the effects of inertia.

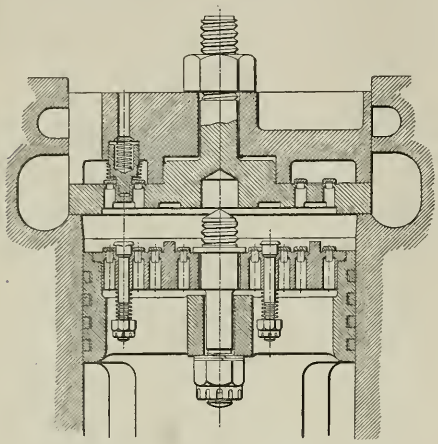


Fig. 8 Head of High-Speed Ammonia Compressor

From the foregoing descriptive matter it will be seen that the inlet and delivery arrangements of the machine are designed in accordance with the well-known uniflow principle, and it is perhaps hardly necessary to point out that the arrangement has similar thermodynamic advantages in the case of an ammonia compressor to those experienced in the working of a uniflow steam engine. The fact that the inlet and delivery passages are widely separated, greatly reduces the interchange of heat between the fluid and the metal, thereby diminishing the superheating of the incoming gas. The larger passages and valve openings, rendered possible by the annular valves, also have the effect of reducing wiredrawing, and these two features together materially increase the volumetric efficiency of the machine and the weight of gas pumped, in comparison with the older double-acting compressors having mushroom valves. The large valve openings, as already mentioned, are obtained with a very small lift, and this fact, in conjunction with the light weight of the valves, eliminates hammering and reduces wear to almost negligible proportions; the largest inlet valve in the compressor illustrated, we may add, weighs only $2^1/_2$ oz. Another feature which should be mentioned in this connection, is that the inlet ports in the piston head are drilled obliquely with the axis, so that the gas flowing through them has a velocity component tangential to the valves. A slight rotary motion is thus imparted to the latter, which tends to dislodge any particles of grit present on the seating, and also to render the small amount of wear taking place quite uniform. (*Engineering*, vol. 112, no. 2910, Oct. 7, 1921, pp. 507–508 and 510, 9 figs., *dA*)

SPECIAL MACHINERY

Thrust-Boring Machines. Description of a new method and machinery for constructing underground public lines without disturbing the surface layer. This machine was used extensively during the war where pipes and cables had to be laid under roadway crossings and it was not possible to stop the traffic and dig a trench in the ordinary way. A similar purpose machine has also recently been used by the British Postoffice Department for thrusting nine $3^1/_2$-in. steel pipes under the Channel Sea River at Stratford, London.

In this instance the Manganol-Irving thrust-boring machine was used, consisting of a hydraulic ram and various accessories. The ram consists of a steel cylinder and piston and the cylinder, which is approximately 5 ft. long, is fitted in a substantial iron crane and provided with means for rotation.

The apparatus works only on ground of a clay nature and the hardest blue London clay can be thrust-bored; it is not suitable, however, for chalk, sand, rock, etc. Holes from 2 to 12 in. diameter and in some cases even larger sizes can be made. (*The Postoffice Electrical Engineers' Journal*, vol. 14, no. 3, October 1921, pp. 181–188, 19 figs., *dA*)

Self-Contained Tunneling Machine

Tunneling Machine. Description of a tunneling machine comprising a tunnel shield with a boring head and a rotating tail attachment, by means of which the lining is placed as the machine progresses.

One motor drives the boring head and the rotating helix. The head is movable, which makes it possible to change the direction or grade of the tunnel.

As the helix rotates it produces in the caterpillar tread an advancing gap for inserting the concrete lining blocks, one at each end around the bore. The blocks, which are of peculiar shape, are set in spiral courses, so that as the helix revolves it forces the shield ahead by screw action. The same thrusting action closes up the lining joints and expands the lining ring through the space occupied by the shell of the shield. Fig. 9 shows the machine in operation.

One of these machines is now operated in an experimental tunnel in Philadelphia, Pa. The tunnel is through schist and has a 5-ft. bore. (*Engineering News-Record*, vol. 87, no. 14, Oct. 6, 1921, pp. 555–556, 3 figs., *d*)

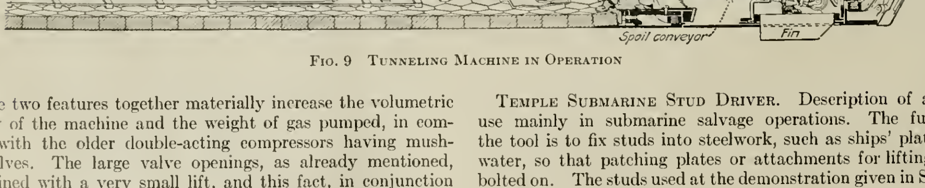


Fig. 9 Tunneling Machine in Operation

Temple Submarine Stud Driver. Description of a tool for use mainly in submarine salvage operations. The function of the tool is to fix studs into steelwork, such as ships' plates, under water, so that patching plates or attachments for lifting may be bolted on. The studs used at the demonstration given in September in London were of a tool steel tempered to a dark blue color, with one end bluntly pointed, after the manner of the old pattern of service projectile, and the other end having a screw thread cut on it.

The studs were about $3^1/_2$ in. long and $^5/_8$ in. in diameter. They were shot into a $^9/_{16}$-in. steel plate from the muzzle of a "gun," held in contact with the plate and pierced the latter so that about an equal length of the stud was left projecting on both sides.

and exit, the stud appearing quite uninjured. The operation of driving the stud was instantaneous and the noise hardly more than that of an air gun.

The Temple gun resembles a pneumatic hammer, but with the handle crosswise at the end like that of a spade. Pressure of the muzzle of the gun against the work causes the barrel to telescope slightly against the action of a spring, which causes a striking pin to detonate the cap and fire the explosive charge. The charge, which may consist of any ordinary propellant explosive, is contained in a cylindrical metal cup attached to the rear of the stud. (*Engineering*, vol. 112, no. 2909, Sept. 30, 1921, pp. 475, *d*)

SPECIAL PROCESSES (See also Fuels and Firing)

Hammer Welding

Hammer-Welding Plant of the Blaw-Knox Co., Ernest Edgar Thum. Description of the process used at the plant, of interest because of the fact that comparatively little information is available on hammer welding.

At the Blaw-Knox Co. tanks of various kinds are produced by this method, such as dephlegmators, stills for cracking gasoline, etc. In particular, the manufacture of a boiler shell, say, 8 ft. in diameter by 15 ft. long, is described. In the first place, a square plate of appropriate size is selected and the edges brushed vigorously with a wire brush to remove dirt or loose dust. The plate is then rolled into a cylindrical tube of correct diameter so that the edges overlap a distance about the thickness of the plate. As it is impossible to effect an exact closure of a long seam in the rolls, the plates are permitted to lap over each other in a blunt angle. Such a seam may often be welded immediately, especially if the bent plate is stiff enough so that there is little tendency for the two edges to spring apart when they are hammered. Shorter seams, heads and smaller fixtures are attached by screw clamps and "tacked" on with an oxy-acetylene flame, which means that the workman builds up short fillet welds at intervals of 3 or 4 ft.

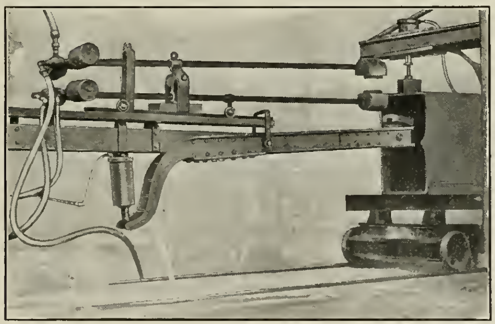


Fig. 10 Blaw-Knox Heating and Hammering Machine for Hammer Welding

A heating and hammering machine which is brought to the work consists essentially of two pivoted hammers (Fig. 10) carrying burners, another with an anvil, and a fourth may carry the air hammer, which may, however, also be held by a jib crane.

About five minutes is required to reach a welding heat on a 12-in. seam in $^7/_8$-in. plate. Fine sand or borax may be used as a flux, but if the flame is held with the slight deficiency of air, little trouble from slag or oxide is to be expected in low-carbon metal. When the proper temperature has been reached the gas and air are turned off, the burners swung to one side and their places immediately taken by the anvil beneath and the hammer above.

First light blows of the hammer are directed at the corner of the sheet, gradually working across the weld, ejecting any molten material in a sheet of white-hot sparks. High-speed blows at full air pressure are continued until the temperature has fallen to a faint red, when the force of the blow is lightened, but continued down the recalescence temperature to a black heat. The hammer this operation; the pipe meanwhile resting solidly on the horn, inertia in the hammer cylinder and arm absorbing the reaction from the blow. Air at 100 lb. per sq. in. is the motive power; the cylinder is 5 in. in diameter, the stroke is 11 in.; and a blow is struck 160 times per minute.

About half the length heated is welded in this operation, but in thick plate the region must be reheated and hammered twice more before the combined sheets are worked down to the thickness of the rest of the shell. This produces a lap joint which is at least 3 in. long in any sheet thicker than $^3/_8$ in. Flux is more liberally used in the second and third heatings. When this spot is finally joined to the foreman's satisfaction, the carriage is shifted and the same cycle of operations repeated on the continuation of the seam.

After the completion of welding the cylinder is replaced in the bending rolls. They are adjusted to give the exact curvature required and the seam rolled back and forth several times to bring this portion to correct shape. Water gas is used as a fuel. Good facilities are available for testing the welds. Among them is a long testing press for proving open-ended pipe up to 6 ft. in diameter and 40 ft. long at any pressure under 1500 lb. per sq. in. After a pressure of 50 to 100 per cent in excess of the working load has been supplied, the seam is struck vigorously several times with a 10-lb. sledge. This not only lays bare many a defect which would not be detected by a static load, but actually subjects the whole structure to a considerable impact as is evident by the pressure gage jumping about 100 lb. at each blow. It is important to note that such testing should never strain the vessel much more than 80 per cent of the proportional limit of the material, as otherwise the metal will become somewhat brittle due to cold work. (*Chemical and Metallurgical Engineering*, vol. 25, no. 16, Oct. 19, 1921, pp. 747–751, 8 figs., *d*)

Oil Cooling

Cooling Oil From Quenching Tanks, S. E. Derby. An article dealing chiefly with cooling the oil used in quenching steel, but in some of its parts applicable also to the general problem of cooling oil, such as that coming from the bearings of machinery.

In particular reference to the question of steel treatment, it is noted that proper speed of cooling is a determining factor in the degree of hardness attained in the steel. The rate of cooling depends primarily upon the size of the piece of metal, but also upon the composition of steel and the rapidity with which the cooling or quenching medium removes the heat. This rapidity is determined by the nature of the medium, its fluidity, specific heat and temperature. Because of this, oil in quenching tanks must be maintained at a certain temperature suitable for each particular kind of operation, and this means that the oil must be recooled.

Modern practice favors recooling by circulating the oil in a closed circuit and recooling it in a separate cooler. The original article describes some typical oil coolers.

Data presented in the original article show that the quenching speed varies considerably with the oil used and initial temperature of the bath. Thus G. W. Pressell found the figures given in Table 1.

The variation in temperatures as apparent from Table 1 indicates the importance of the proper system of oil recooling.

TABLE 1 QUENCHING SPEEDS OF OILS AT DIFFERENT INITIAL TEMPERATURES

Kind of Oil	Variation of quenching-bath temperatures	Variation in time required for the steel to cool from 1200 to 600 deg. fahr.
Fish oil, lot no. 1	88 to 255	97 to 120
Fish oil, lot no. 2	71 to 251	78 to 93
Linseed oil	84 to 261	94 to 107
Cottonseed oil	100 to 230	104 to 119
Heavy viscous drawing oil	75 to 229	154 to 181
Houghton's no. 2 soluble quenching oil	82 to 249	97 to 102

Fig. 11 (page 820) shows the ratio of water to oil for a typical oil cooler and another figure in the original article gives the heat-transfer rate with viscosity corrections for an oil cooler.

The general practice is to specify one gallon of oil for every pound of steel quenched per hour, and the original article gives practical methods for determining the size of cooler necessary and the quantity of circulating water. (*Forging and Heat Treating*, vol. 7, no. 10, pp. 528–530, 6 figs., *dg*)

Recent Improvements in the Manufacture of Welded Pipe, F. N. Speller, Mem. Am.Soc.M.E. After a general statement of the history of the manufacture of butt-welded pipe beginning with the work James Russell in England in 1824 and carried down to the Spellerizing process of recent years, the author proceeds to the discussion of the most modern method of scale removal.

Mill scale on butt-welded steel piping is of a peculiar character. It consists essentially of iron oxides, principally Fe_3O_4, with 7 or 8 per cent of silica and smaller amounts of C_2O and Al_2O_3 from the furnace bottom. At the welding temperature this scale is fluid and forms a natural flux for welding, as well as a protection to the metal against excessive oxidation from the furnace gases, so that this is a very essential factor in the welding of pipe—so much so that pipe steel is made primarily so that it will be self-fluxing by readily forming this fluid oxide at as low a temperature as possible. Wrought iron carries considerable excess of fusible slag and oxides intermixed with the metal, whereas pipe steel when properly made readily forms a suitable fluxing scale when heated to the welding temperature. The melting of the welding scale affords the welder a sharp indication of the temperature of the skelp, which is much better than any pyrometer for this purpose. On cooling, the welding scale passes through a viscous stage and then quickly becomes brittle at a temperature at which the steel is still quite easy to forge. Most of the scale on the outside is removed in the sizing and straightening rolls, but inside the pipe scale is often $^1/_{32}$ or $^1/_{16}$ in. thick in patches, and when cold is firmly attached to the metal like an enamel. Several means have been used to remove this scale to prepare the pipe for galvanizing and other coating operations. Pickling in acid is the most common

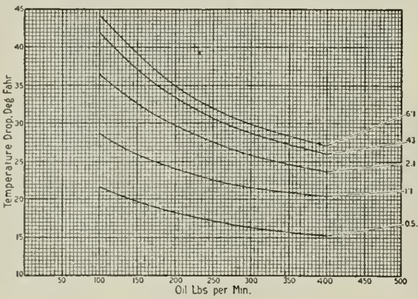


Fig. 11 Water-to-Oil Ratios for a Typical Oil Cooler

method employed but is the least effective on the inside of pipe where the scale is most firmly attached, and, further, as the scale is very irregular and rather thick in spots, portions of the metal are likely to be damaged by overpickling before all the metal is cleaned. Mechanical cleaning by sand blasting and cold rolling has been tried, but has not been thorough enough, besides being quite costly.

By making the diameter of the pipe larger and then reducing the size and elongating the pipe at the highest temperature at which the scale is brittle enough to remove, it has been found possible to clean the pipe in the process of hot finishing and at the same time produce a better material in other respects. This new process of finishing is very advantageous. It will be seen that two additional steps are introduced in the finishing operation in order to produce what is practically a scale-free pipe: (1) a partial cooling from about 2500 deg. to 1800 deg. fahr.; and (2) a reduction in diameter and elongation of about 10 per cent in length by means of a series of horizontal and vertical rolls, by which the brittle scale is cracked and separated from the steel. The pipe is then straightened and cooled as usual, during which a thin film of new oxide forms sufficient to protect the metal from rusting while being handled. A thin coating of suitable lacquer is now applied, which affords substantial protection to the pipe in storage. The main object of these scale-removing and cleaning operations is to make possible more uniform galvanizing. This also has an important bearing on the manufacture of all kinds of coated pipe and conduit for electrical purposes. (*The Blast Furnace and Steel Plant*, vol. 9, no. 10, October 1921, pp. 580–582, *d.* In connection with this article attention is called to a paper by the same author on Control of Corrosion in Iron and Steel Pipe, published in Mechanical Engineering, Oct. 1921, p. 661 et seq.)

THERMODYNAMICS

A New Thermal Testing Plate for Conduction and Surface Transmission, F. C. Houghton and A. J. Wood, Mem. Am.Soc. M.E. Summary of an investigation conducted jointly by the Engineering Experiment Station of the Pennsylvania State College and the Research Laboratory of the American Society of Heating and Ventilating Engineers at the thermal testing plant of the Pennsylvania State College.

Essentially the heating plate is similar to that used by the U. S. Bureau of Standards, with the difference, however, that in the plate employed at the Pennsylvania State College one side of the blank is exposed to the air in a cold room which is kept at a uniform temperature. This makes the plate method adaptable only when the room temperature can be controlled, but it permits determining at the same time both conductivity and surface transmission constants.

The plate is heated by an electric heating element, while the cold room is maintained at the proper temperature by brine circulation. The original article gives the methods of calculations and results of tests with temperature differences ranging from 52.4 to 71.5 deg. fahr., as well as the errors occurring in these measurements. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 27, no. 5, July 1921, pp. 529–542, 12 figs., *e;* also *Journal of the American Society of Refrigerating Engineers*, vol. 8, no. 1, July 1921, pp. 23–36, 12 figs., *e*)

TRANSPORTATION

Pipe-Line Transportation for Anthracite and Bituminous Coal, Geo. A. Orrok and W. S. Morrison, Members Am.Soc.M.E. Discussion of a plan of pumping coal from the coal fields to New York, with data as to the cost of plant and operating costs.

The idea is not new and has been under consideration since the early nineties. Transportation of material in a more or less finely divided state by a stream of water has long been known and practiced, and, among other things, is the method used in handling the vast deposits of phosphate rock in Florida located mostly under water.

It is proposed to have from place to place relay stations with four separate single-stage pumping units at each. The units are to be direct-connected, each to its own motor and arranged to operate in pairs in series with each other, with the discharge from the first pump taking its supply from the supply connected to the suction of the second and the discharge from the second delivering into the line main.

Three routes have been tentatively laid out: one from Scranton to Piermont on the Hudson, 130 miles; (2) from Scranton to Newark Meadows, 195 miles; (3) from Clearfield to Piermont, via Scranton, 322 miles.

The estimated cost of the plant varies from $12,100,000 for Route 1 to $31,830,000 for Route 3. The fixed charges and operating expenses together vary per ton from 62.8 cents for Route 1 to $1.47 for Route 3.

A 14-in. pipe line can handle an average of 6,000,000 tons of coal per year and three such lines would probably provide for the entire New York supply of both anthracite and bituminous coal.

In this estimate the cost of the necessary water is not included, though in some cases it might become an important item. It is not believed that there will be any material trouble in the corrosion of pipes resulting from sulphur content in the coal. (Address before the Association of Edison Illuminating Companies, Spring Lake, N. J., Sept. 12, 1921, abstracted through *Power*, vol. 54, no. 18, Nov. 1, 1921, pp. 699–700, *d.* Attention is also called to a brief editorial in the same issue of *Power* on p. 688.)

WOODWORKING MACHINERY

Machine for Railway Tie Making

Cross-Cutting, Adzing and Boring Machine for Railway Ties. Description of a machine built by a British concern for

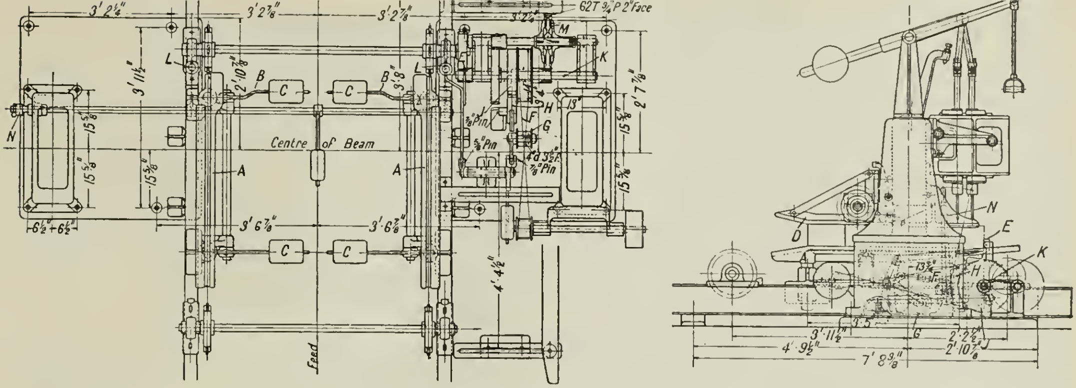


Fig. 12 Sleeper Cutting, Adzing and Boring Machine

the Indian State Railways designed for cross-cutting and boring ties up to 10 ft. long, 10 in. wide and 6 in. deep; it will also adz rail seatings up to 10 in. wide and 16 in. long. This machine is shown diagrammatically in Fig. 12, and the original article contains also two halftone views.

An interesting feature of the machine is the method employed to drive the boring spindles. For this purpose a series of four endless roller chains running in horizontal path are provided, each chain driving two spindles. The chains are of Renold's bush roller pattern. The gear box contains a pair of miter wheels running in an oil bath, the horizontal shaft being fitted with an outside driving pulley to receive motion by belt from the overhead countershaft. This type of drive was found convenient where universal adjustments of the spindles are necessary. (*The Engineer*, vol. 143, no. 3431, Sept. 30, 1921, pp. 348, 353–354, 3 figs., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

New Bolinder Engine

A notable improvement on the Bolinder semi-Diesel engine has been perfected, and one of these new engines fitted into a tugboat on the Thames, the boat being the largest motor tug in Great Britain. The improvement is in the ignition device and the fuel-injection apparatus. The new fuel injector, the use of compressed air for keeping the ignition bulb cool has been eliminated, the use of water for the same purpose having been discarded for some time. The new device consists essentially of a housing, injection nozzle, and a spindle, which is capable of adjustment from the starting platform. The device is fitted on top of the bulb, and it is possible to run the engine at full load with the ignition bulk so cool that it remains black. It is also possible to run the engine at light load indefinitely, the bulbs retaining sufficient heat for ignition. The ignition device, which is electrical, is mounted in a water-cooled housing, and by means of a sleeve can be projected into the ignition bulb or withdrawn as required. When it is withdrawn a valve on the sleeve seals the chamber containing the igniter, thus protecting it from the heat of combustion, and when it is pushed forward in the chamber for starting purposes, a valve on the other end of the sleeve closes the water-cooled housing. With this device starting from cold can be accomplished immediately, without the use of any lamps for warming the bulb. The makers claim that with the new fuel injection device the power is increased by 20 per cent. The new model is known as the N.E., and has been fitted in several vessels besides the one mentioned here. (*Marine Engineering of Canada,* vol. 11, no. 10, Oct. 1921, p. 21)

CODE ON DEFINITIONS AND VALUES

(*Continued from page 810*)

151 *Heat Input for Otto and Brayton Cycles* is expressed as

$$\text{B.t.u. per i.hp-hr. or b.hp-hr.} = \frac{2545}{E_o}$$

$$\text{B.t.u. per net kw-hr.} = \frac{3413}{E_o}$$

152 *Water Rate* of an engine, turbine, or complete steam plant is the pounds of steam at actual condition, per unit of output; it is to be corrected neither for moisture nor superheat.

153 *The Quality of Steam* or other vapor is specified in two ways: If the vapor is superheated, the quality is described by stating the number of degrees of superheat. If the vapor is wet, the quality is described by stating the dryness factor; for example, if steam contains $2^1/_2$ per cent of moisture, its dryness is 0.975.

Dry Steam, to which most steam conditions involving wet steam were formerly corrected, is that condition at which there is present no moisture and no superheat, and the heat content is that of the point of saturation. It is a condition which cannot be exactly realized commercially, and as the correction to dry steam has never been applied to superheated steam, it appears advisable to discontinue its use. This does not bar its employment, as a condition, together with a definite pressure (and back pressure or vacuum), for correcting guarantee tests to a common state.

154 *Fuel Rate*, for solid and liquid fuels, is defined as the pounds of fuel as fired, per unit of output per hour. For gaseous fuels it is defined as cubic feet of gas at 68 deg. fahr. and one atmosphere, per unit of output per hour. It should be qualified by reference to the unit of output.

155 *Drawbar Horsepower* is the product of the dynamometer pull in pounds at the drawbar, on level track, and the speed in feet per minute, divided by 33,000.

156 *One Ton-Mile* is defined as one short ton transported a horizontal distance of one mile; it is not a work unit. Similarly, one train-mile is defined as a complete train transported horizontally one mile. Both of these units are used in general data on performance in the Locomotive Code.

157 *Heat-Transmission Coefficient* is defined as the British thermal units transmitted per square foot of heating surface per degree mean temperature difference per hour.

158 *Cooling-Tower Efficiency* is expressed by the formula—

$$\text{Efficiency} = \frac{t_1 - t_2}{t_1 - t_w}$$

where t_1 = temperature of water before cooling
t_2 = temperature of water after cooling
t_w = temperature of wet bulb.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Theses

THE Research Committee has received from Prof. W. R. Eckart of Stanford University the following suggestions and would like to receive the opinion of those using this section of MECHANICAL ENGINEERING regarding the advisability of following them. The Committee would appreciate communications from those interested in the work of the engineering schools regarding the possibility of following out this plan in their own institutions:

1 In general, theses as presented to the universities are not in printed form and are not available for distribution. As a rule they are typewritten and about five copies represent the limit of successful duplication. One of these copies is retained by the university as a record and is available for reference in the library, other copies are retained by the student-authors themselves, and the remainder are ordinarily presented to members of the faculty under whose direction the work was performed.

2 Announcements in the Research Section have brought forth many requests for copies or for information. In most cases these requests cannot be complied with owing to prohibitive costs and lack of facilities for reproduction.

3 The result is, therefore, that much valuable technical information which might otherwise be available is tied up in the archives of the universities.

4 To remedy this situation it is suggested that the universities require their graduate or advanced students, at the expense of the university or departments of the same, to present in each case an additional copy of their thesis, which, if considered of sufficient merit is to be forwarded to the Library of The American Society of Mechanical Engineers. A copy would then be available for reference there or for publication either as a whole or in abstract in MECHANICAL ENGINEERING, and all requests for information regarding the same or for copies in part or in whole could be handled directly by the Society at the usual price for such work.

Committee for Scientific and Industrial Research

The Sixth Annual Report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1920–21 has just been issued. The report describes the activity of the Committee during the year, includes a list of the various associations of Great Britain and in Part II the question of national research and the development of research in and for the Empire is treated. Part III covers aided research, patents and publications of learned societies.

The report may be obtained for 1s. 2½d. from Imperial House, Kingsway, London, WC2.

A—RESEARCH RESULTS

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which, in the opinion of the investigators, do not warrant a paper.

Cement and Other Building Materials A14-21. FIRE TEST ON BUILDING COLUMNS. Technologic Paper 184 is devoted to Fire Tests on Building Columns. It is obtainable from the Superintendent of Documents at 75 cents per copy. The work was undertaken in coöperation with the Associated Factory Mutual Insurance Companies and the National Board of Underwriters. The column was placed in a gas-fired furnace and loaded to a safe working load. The loaded column was exposed to fire for a predetermined time, after which a hose stream was applied to the heated column. In other cases the column was heated. The columns were protected by various forms of fire-resisting materials and care was taken to duplicate actual building practice. Ninety-five fire tests were made and fifteen fire and water tests. The results of the tests are tabulated. Figures and diagrams are used to illustrate apparatus and results of the test. The results are summarized in terms of two-thirds of the average time in hours for the column under fire to have its strength reduced to failure. These periods varied from ten minutes for unprotected steel columns to 8 hours for columns covered with 4 in. of concrete made with fire-resistant aggregate and for reinforced columns made with the same aggregates. The series cover the range of current practice in structural-steel columns and the studies indicate that the results obtained are applicable to columns of various sizes. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Cement and Other Building Materials A15-21. COOLING OF FRESH CONCRETE IN ZERO WEATHER. Bulletin 123 of the Engineering Experiment Station, University of Illinois, by Tokujiro Yoshida, is on the subject of Studies on Cooling of Fresh Concrete in Freezing Weather. The investigation discusses the apparatus used for measuring temperature; concrete materials; mixing of concrete; general features of the experiments; preparation of test specimens; phenomena of experiments; rise in temperature during setting; calculation of the thermal constants of fresh concrete; effect of wood forms in protecting fresh concrete; effect of canvas in protecting fresh concrete; effect of amount of water used and summary of experimental results. This is followed by an analytical application to massive concrete, thin walls, beams and columns of rectangular and circular cross-sections, as well as some applications to work of concreting in freezing weather. The general conclusions are given as follows:

It is believed that the constants derived from the tests are applicable to the ordinary conditions of fresh concrete. The value of k, the diffusivity, is 0.0063; that of h, the ratio of the emissivity to the coefficient of conductivity, is 0.046.

From the cooling curves given for massive concrete, thin walls and slabs, and beams and columns, the time of cooling and the temperature attained by the concrete in any particular case may be estimated.

The protection afforded by board forms and by canvas is considerable, as was shown by the examples given.

If a canvas protection is used, care must be taken to prevent any circulation of cold air, and it is best to observe the temperature in the air space by means of a thermometer. Knowing this temperature, the time when the freezing temperature will penetrate into the concrete may be estimated from the diagrams and the necessity of using artificial heat determined.

The heating of the materials is seen to furnish an excellent method of insuring early hardening and delaying the fall in temperature. It is much to be preferred to the use of chemicals.

The effect of the wind should also be given consideration.

The diagrams are of some value in connection with the determination of the time for the removal of the forms, since they will enable the temperature attained by the concrete to be estimated. As the concrete gains strength much more slowly at a low temperature, and as frozen concrete is especially dangerous, information on the temperature attained is of value and the too early removal of forms may be avoided. If by this or other means the mean temperature of the concrete for a given time is known, the comparative strength of the concrete may be estimated from the diagrams given by Prof. A. B. McDaniel in Bulletin 81 of the Engineering Experiment Station of the University of Illinois, which shows the influence of temperature on the strength of concrete, and thus the judgment may be aided in deciding on the safe time to remove the forms. Address Dean C. R. Richards, University of Illinois, Urbana, Ill.

Fire Prevention A2-21. SPECIFICATIONS FOR FIRE HOSE. Circular 114 of the Bureau of Standards is devoted to specifications for fire hose. Specification was made to the Rubber Association of America and had received the official endorsement of its Committee on Technical Specifications. The specification covers cotton-lined hose of single, double- and triple-jacketed types. The chemical and physical tests to which hose must conform are described in detail. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Fuel Utilization A1-21. ATMOSPHERIC BURNERS. The Bureau of Standards has recently published Technologic Paper 193 on Design of Atmospheric Gas Burners. This may be obtained from the Superintendent of Documents, Washington, D. C. This paper does not give any presentation of theory, but it does give the effects of various factors on the operation of burners. These are shown by means of tables and curves based on experimental data. To arrive at these results it was found necessary to study the theory of the flow of gas through different types of orifices, the principles governing the rate of injection of air into the burner, the design of the injecting tube, the rate of consumption of burners for different port areas and the effect of adjustment of the air shutter. The paper points out that the atmospheric burner is well adapted for domestic and small industrial purposes on account of its

Metallurgy and Metallography A18-21. Metallographic Testing. The second edition of Circular 42 of the Bureau of Standards on Metallographic Testing may be obtained from the Superintendent of Documents, Washington, D. C. Metallographic examination gives broader information of materials of engineering than the mere determination of mechanical properties. The circular describes briefly the conditions which effect the properties of metallic metals under the following headings: Microscopy and structure; thermal analysis and heat treatment; mechanical working of metals; chemical and metallurgical factors and conditions of melting. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Petroleum, Asphalt and Wood Products A8-21. Buried Steel Fuel-Oil Tanks. The Associated Factory Mutual Fire Insurance Companies have recently determined data regarding the life of buried fuel-oil tanks. The investigation covered the study of tanks which had been in service from 18 months to 26 years and were buried from 10 in. to 9 ft. below ground level. The soils were of sand, gravel, loam, clay or cinders or mixtures of these. In some cases ground water was present and in few cases salt tidewater. The tanks varied in capacity from 1,100 to 22,000 gal. In a few instances the tanks were entirely uncovered in making the investigation, while in other cases a section only was exposed. This section included one side to the center line and one end to same point. The character of corrosion, condition and thickness of shell were noted, and in a few cases the scale was examined for analysis. The results of the investigation are given in the following table:

Number in Report	Age in years	Depth of top below ground	Protection and condition	Character of soil surrounding tank	Location of tank
1	1½	2 ft.	Red lead & asphalt Excellent	Salt marsh lower half, fill above	Everett, Mass.
2	7	2 ft.	Red lead	Clay, sand, trace of cinders	So. Boston, Mass.
9	10	2 ft.	Excellent		
3	7	5 ft.	Probably asphalt Fair	Clay, sand and cinders. Salt tidewater	New Bedford, Mass
4	7	7 ft.	Red lead & asphalt Excellent	Sand and gravel ground water	Waterbury, Conn.
5	8	3 ft.	Asphalt Good	Sand, loam and gravel	Lowell, Mass.
6	9	2 ft.	Probably asphalt Good	Sand, gravel and cinders.	Worcester, Mass.
7	9	3 ft.	Asphalt Fair	Sand, gravel, loam, cinders	Waltham, Mass.
8	10	4 ft.	Probably asphalt Good	Sand, loam, trace of cinders	Waterville, Conn.
10	11	7 ft.	Thick coat asphalt Excellent	Sand, gravel, few cinders	Waterbury, Conn.
11	11	4 ft.	Asphalt Good	Clay and sand	So. Auburn, R. I.
12	12	5 ft.	Asphalt Excellent	Oil-saturated sand. Salt tide water	New Bedford, Mass.
13	12	8 ft.	Concrete Good	Encased in concrete except at manhole. Ground water	Taunton, Mass.
14	13	2 ft.	Red lead asphalt Excellent	Sand and loam	Waterbury, Conn.
15	13	2 ft.	Red lead	Oily saturated sand and clay. Ground water	Lowell, Mass.
16	13	2 ft.	Good		
17	14	6 ft.	Probably asphalt Poor	Sand, gravel, cinders trace of oil. Ground water and acid	Waterbury, Conn.
18	15	2 ft.	Red lead Excellent	Black mud, formerly salt marsh. Ground water	Lynn, Mass.
19	15	9 ft.	Red lead & asphalt Excellent	Oily sand, brackish ground water	Taunton, Mass.
20	15	2 ft.	Asphalt Excellent	Clay, sand, trace of cinders	So. Boston, Mass.
21	16	3 ft.	Probably asphalt Good	Sand, cinders	Fitchburg, Mass.
22	17	5 ft.	None Fair	Sand, gravel, cinders	Pawtucket, R. I.
23 & 24	18	9 ft.	Red lead and tar Poor inside	Salt water, some cinders	Brooklyn, N. Y.
25	20	1 ft.	Red lead Excellent	Sand and gravel	Providence, R. I.
26	20	2 ft.	Asphalt Excellent	Loam, clay and cinders	Cambridge, Mass.
27	20	2 ft.	Probably none Good	Clay and sand Ground water	Whitins, Mass.
28	26	2 ft.	Red lead Good	Sand and gravel	Whitins, Mass.

The electrolytic theory of corrosion is the most acceptable one. Before iron can oxidize it must pass into solution liberating oxygen. Wet places with acids stimulate this. Corrosion will not take place without oxygen being present, hence tanks should be buried where conditions will not stimulate corrosion.

Fill. Cinders stimulate corrosion. Acid may be present in this soil. Loam is a better type of fill than cinders although it may stimulate filling. It is generally damp and prevents corrosion because it holds the water in a stagnant condition. Sand is the best filler as it prevents surface impurities from reaching the tank. Oily sand gives the best protection. Gravel is not quite as good as sand.

Protective Coating. Red lead when used alone allows contact between metal and corroding medium as film may be easily punctured. Asphalt when used alone also permits contact. Red lead followed by asphalt gives good results. All tanks reported in excellent condition were protected by red lead, asphalt or both. No tanks examined were entirely encased in concrete. It is reasonable to suppose that concrete would offer a good protection.

Tidewater and Ground Water. Tidewater and ground water do not stimulate corrosion to any great extent. Salt water usually forms a hard encrustation. Ground water acts similar but may stimulate corrosion when the oxygen content is great.

Depth of Bury. If a tank is buried below the zone of active oxygen it is usually below the zone of corrosion. As the depth of bury increases the tendency to corrode decreases.

Stray Electrical Currents. Stray electrical currents stimulate corrosion but these are not frequent.

Conclusions. Steel tanks buried under favorable conditions may last more than 30 years. In damp ground they will last from 15 to 20 years. To best resist corrosion steel tanks should be coated with red lead and asphalt buried in clean sand three feet deep or more below surface, avoiding ground water and tidewater if possible. Address Factory Mutual Laboratories, C. W. Mowry, Director, Boston, Mass.

Petroleum, Asphalt and Wood Products A9-21. Petroleum Laws. Petroleum laws of all America is the subject of Bulletin 206 of the Bureau of Mines. The work contains 645 pages and gives the national and state laws of the various countries. Address Bureau of Mines, Washington, D. C. H. Foster Bain, Director.

Petroleum, Asphalt and Wood Products A10-21. Sanitation. Oil-Camp Sanitation is the subject of Technical Paper 261 by C. P. Bowie. This bulletin of 32 pages discusses the construction of buildings and various conveniences and the matter of mosquitoes and flies, as well as the location of camps, spacing of buildings, water supply and disposal of garbage, sewage and refuse. Bureau of Mines, Washington, D. C. Address H. Foster Bain.

Properties of Engineering Materials A6-21. Manila Ropes. The Bureau of Standards has recently issued Technologic Paper 198 on Tests of Manila Rope. This may be obtained from the Superintendent of Documents, Washington, D. C. Ropes tested range from diameters of ½ in. to 4½ in. and consisted of commercial, three-strand, regular-lay ropes. The breaking load, weight per linear foot, number of yarns and the lay of the rope and strands as well as the elongation were measured. The average breaking load is given by the equation

$$L = cd\ (d + 1)$$

where L = load in pounds
c = constant = 500
d = diameter of rope in inches.

The modulus of elasticity was not constant. There is no well-defined elastic limit. The number of yarns in a rope is usually given by the equation

$$N = 50 \times d(d + 0.4)$$

where N = number of yarns
d = diameter of rope in inches.

Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

B—Research in Progress

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Automotive Vehicles and Equipment B7-21. Equipment for Testing Automobile Brake Linings. The Bureau of Standards is developing apparatus for the purpose of testing brake linings. Blueprints of the apparatus have been sent to manufacturers of linings. It is hoped to standardize the method of testing this important product. Bureau of Standards, Washington, D. C. Address S. W. Stratton, Director.

Friction B1-21. Effect of Oil Grooves in Bearings of Varying Sizes and Speeds. This investigation is being carried on by Mr. Lessels, of the Mechanical Laboratory of the Carnegie Institute of Technology. Address David C. Saylor, Instructor, Mechanical Laboratory, Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.

Heat B22-21. Heat Conductivity. An investigation on heat conductivity is being undertaken by Mr. Mawhinney in the Mechanical Laboratory of the Carnegie Institute of Technology. Address David C. Saylor, Instructor, Mechanical Laboratory, Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.

Internal-Combustion Motors B10-21. Solid Injection of Fuel in Oil Engines. Solid injection of fuel oil is being investigated by Mr. Zeisham of the Carnegie Institute of Technology. Address David C. Saylor,

Instructor, Mechanical Laboratory, Carnegie Institute of Technology, Schenley Park, Pittsburgh, Pa.

C—Research Problems

The purpose of this section of Engineering Research is to bring together persons who desire coöperation in research work or to bring together those who have problems and no equipment with those who are equipped to carry on research. It is hoped that those desiring coöperation or aid will state problems for publication in this section.

D—Research Equipment

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories so that persons desiring special investigations may know where such work may be done.

E—Research Personnel

The purpose of this section of Engineering Research is to give notes of a personal nature regarding the personnel of various laboratories, methods of procedure for commercial work or notes regarding the conduct of various laboratories.

F—Bibliographies

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in Mechanical Engineering.

Below are given the interpretations of the Committee in Cases Nos. 364 to 369 inclusive, as formulated at the meeting of September 12, 1921, and approved by the Council. In accordance with the Committee's customary practice, the names of inquirers have been omitted.

Case No. 364

Inquiry: Is it necessary, as indicated in the index to the Boiler Code, to use an extra thick tube for the fusible plug when used with a vertical fire-tube boiler, in accordance with the requirements of Pars. 429 and 430?

Reply: It is the opinion of the Committee that inasmuch as Par. 429 permits of the use of a $^3/_8$-in. fusible plug, it would be desirable to insert it in a tube having a thickness of not less than 0.22 in. in order to allow insertion of at least four threads of the fusible plug.

Case No. 365

(In the hands of the Committee)

Cases No. 366 and 367

(Annulled)

Case No. 368

Inquiry: Is it permissible, under the requirements of Par. 185 of the Boiler Code, to plane or mill down the plates forming the laps of circumferential joints to less than $^1/_2$ in. thickness?

Reply: It is the opinion of the Committee that there is no objection to planing down the laps of circumferential joints to a thickness less than $^1/_2$ in., provided, however, there is sufficient strength left in the joint to conform with the requirements of Par. 184.

Case No. 369

Inquiry: Is it necessary, under the requirement of Par. 195 of the Boiler Code, to increase the thickness of a dished head $^1/_8$ in. when a manhole is inserted and provided the manhole opening is reinforced?

Reply: It is the opinion of the Committee that the requirement in Par. 195 for increase of $^1/_8$ in. in thickness is applicable in any case when a manhole is inserted in a dished head.

Public Hearing on Proposed Code for Air Tanks and Pressure Vessels

The Boiler Code Committee announces progress in the formulation of the proposed code for air tanks and pressure vessels intended to form Section IV of the A.S.M.E. Boiler Code, and that a Public Hearing will be held in connection with the coming A.S.M.E. Annual Meeting in order that all interested in unfired pressure vessels may have an opportunity to participate in the discussion of the proposed rules.

The Hearing will be held in the United Engineering Societies Building, 29 W. 39th St., New York, N. Y., on Monday, December 5, at 9.30 a.m., the opening day of the Annual Meeting. Every one interested in the formulation of this code is cordially invited by the Committee to attend and join in the discussion.

A revised draft of this proposed code is now under preparation and every effort will be made by the Committee to distribute copies thereof to its large mailing list of boiler and tank users and manufacturers well in advance of the Hearing. Copies thereof will also be available for distribution at the Hearing.

Public Hearing on Proposed Code for Miniature Boilers

The Boiler Code Committee announces also that the proposed code for the construction of miniature boilers has been completely revised and will be presented at a Public Hearing to be held in the United Engineering Societies Building, on Tuesday, December 6, at 9.30 a.m. This code is greatly in demand due to the increasing use of the small types of boilers for vulcanizing, clothes-pressing and laundry purposes, and has been looked forward to with interest; this code has not previously been brought before the Society for public discussion. Every one interested in the details of this Code are cordially invited by the Committee to attend and take part in the discussion.

Section of Code on Boilers of Locomotives Completed

Those who have been interested in the formulation of rules for the construction of boilers of locomotives will no doubt be interested to learn that this difficult undertaking has been completed and the Code is being published initially in pamphlet form for distribution independent of the regular edition of the Boiler Code. It will be at first issued in a limited edition with distinctive paper cover but will, upon completion of the 1922 revision of the Code, be incorporated therein and form Section III thereof. This section of the Code is on sale and may be obtained upon application to the office of the Society.

(Continued from page 796)

iliary load, which are, of course, reflected in the house-turbine load. A series of experiments were recently conducted to determine how closely this system could be regulated and what the lag might be between the time that the load on the house turbine was changed and the time when the effect was noticed in the feedwater tank. It was found that any degree of regulation was possible. The house-turbine load could be varied in steps of 10 kw., it being impossible to read variations less than this. The feedwater temperature could be varied by amounts as low as 0.5 deg. fahr., which is as close as an ordinary thermometer can be read.

Table 1 of the complete paper shows actual operating figures for five days, chosen so as to show the operating conditions over a range of loads from 30,000 to 60,000 kw. The quantities shown in Fig. 2 are taken from this table.

MATERIAL HANDLING AN IMPORTANT FACTOR IN THE ELIMINATION OF INDUSTRIAL WASTE

(Continued from page 804)

assign a value to this item after thorough observation and careful consideration. Let us call it X per cent.

The variables in the investment value may be classed as follows:

A = interest charges on investment, per cent
B = interest to provide for upkeep of apparatus installed, per cent
C = interest to provide for depreciation due to age, per cent
D = interest to provide for progress in the art of the particular device proposed (subsequent inventions), per cent
E = interest to provide for extensions to service, per cent
H = additional superintendence and overhead expenses due to change in method, per cent
K = interest to provide for taxes, per cent
F = cost of power, supplies and other variable items in dollars per year

Let S = yearly saving in labor in dollars
and Z = investment in dollars justified by the foregoing considerations

$$\text{then } Z = \frac{S\ (X \text{ per cent}) - F}{(A + B + C + D + E + H + K) \text{ per cent}}$$

Working this out for an assumed set of conditions, assume that the work which under the present methods of moving materials requires four men employed at \$3 per day, 300 days per year, at a yearly cost of \$3600, can be done according to the new method by one man, costing \$900, thus saving \$2700 per year. The plant operates on shift, men employed 80 per cent of the year.

Then	X = 80 per cent	C = 15 per cent	H = 3 per cent
	S = \$2,700	D = 10 per cent	K = 3 per cent
	A = 6 per cent	E = 3 per cent	F = \$400
	B = 20 per cent		

$$\text{and} \quad Z = \frac{(\$2{,}700 \times 0.80) - 400}{0.60}$$

$$= \$2{,}933.33$$

This means, then, that equipment costing under \$2,900 will earn maintenance, interest, depreciation, obsolescence and tax charges and show a saving besides.

Assuming that an electric-storage-battery industrial truck costing \$1,750 will meet the conditions, the yearly operating cost would be as follows:

I = cost of equipment = \$1,750
Y = yearly operating cost
$= I\ (A + B + C + D + E + H + K) + F$
$= (\$1{,}750 \times 0.60) + 400 = \$1{,}450$

Then
$S = \$2{,}700 - \$1{,}450 = \$1{,}250$

This is an actual saving of \$1,250 a year, a return of approximately 71 per cent on the investment over and above all interest charges, upkeep, deterioration and obsolescence.

Only by some such analysis can a real solution of the problem orders, and managers in their ignorance of the underlying conditions, sometimes overlook some of the factors in the problem with the result that anticipated savings are not obtained.

Too much thought and consideration cannot be given to the selection of equipment that not only shows a saving but fits into the general operating conditions of the plant, or suits physical conditions imposed by plant or location, and yet at the same time fits into plans for future extension, development or rehabilitation of the plant. A \$25,000 locomotive crane will last a long time if properly cared for. If future development of the plant does not provide space enough for the utilization of the crane to its best advantage, then the crane may not be the piece of equipment to select initially, even though it will satisfy all of the initial conditions.

A.S.M.E. TO PUBLISH LIFE OF GEORGE WESTINGHOUSE

The mere fact that a Life of George Westinghouse is to be published is an item of interest to every engineer who glories in the great men of his profession. Added interest is given to the announcement, however, by the fact that Col. Henry G. Prout, the author of this biography soon to be published in a limited subscription edition by The American Society of Mechanical Engineers,

George Westinghouse

has used his consummate skill and intimate knowledge of his subject to build a book at once interesting, inspiring and permanent.

This limited edition, which will appear in both morocco and buckram binding, was offered simultaneously to the members of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Although subscriptions to this edition were to be closed November 15, delay at the printers makes it possible to accept subscriptions up to December 6, and A.S.M.E. members who have not done so are urged to secure a copy of this valuable book by writing to Secretary Calvin W. Rice at once. The subscription binding in buckram with gilt top and silk headband can be procured for \$3.50 postpaid. A special half morocco binding will be sent for \$6.00.

Later a popular edition will be issued and copies of this edition, it is expected, will be available about February, 1922.

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers and Proceedings of

The American Society of Mechanical Engineers

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Armament Reduction and the Engineer

THE engineering profession ought to be in favor of a reduction of armament, not alone because it will tend to make it more difficult to begin a war, but also for essentially technical reasons.

From an engineering point of view the actual production of many classes of munitions in anticipation of a war which may not occur for a long time appears to be a wasteful and highly undesirable proceeding.

G. E. Tripp

Such a policy is necessary only as a defence against surprise attack, but it is not true preparedness, and it really tends to weaken the ability of the nation to withstand external aggression.

Modern warfare is not only a contest between the armies and navies of the belligerents, as was the case some three score years ago, but one between the entire industrial and scientific structures of nations.

A truck or tractor factory, a foundry, a plant making motors, fabrics or chemicals, is as much an essential and often deciding part of the military establishment of a nation as is a gun factory. The high maintenance of the productive facilities of a country rests, therefore, at the very foundation of its ability to defend itself against external aggression.

Development of the productive facilities of a country, assuming, as in the case of the United States, the presence of ample natural resources and good natural stock of population, requires two things primarily, and they are ample capital and extensive educational facilities for the people.

Neither of these two conditions can be easily satisfied when Government expenditures reach the disquieting figure of four billions of dollars or more per annum, and when roughly three-quarters of this vast sum is expended for purposes of a military character.

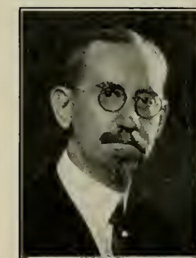
Engineers, more than any other class, realize how much still needs to be done to develop the natural resources of this country, and they also realize that it is by the development of natural resources in the past that the United States attained the state of prosperity and industrial efficiency which permitted it to raise and equip an army of nearly two million men in less than twelve months and to spend without essential embarrassment twenty-five billion dollars in two years for war expenditures.

Armament expenditures as carried out today undermine the ability of countries to attain their highest ideals of national education and industrial development, so that from the point of view of the engineer any agreement to disarm would tend to minimize the possibility of future conflicts and at the same time actually increase the ability of the great powers to protect themselves in case of unprovoked aggression.

The engineer is more and more acquiring a position of intellectual leadership in American communities, and his attitude toward reduction of armament as one of the fundamental questions affecting the industrial and intellectual growth and welfare of the world will have a tremendous influence.

G. E. Tripp.

The Superpower Report



W. S. Murray

NO OBSERVANT person, whether he be a banker, a railroad operator, a manufacturer or an engineer, can have lived or traveled within the boundaries that have been recently marked as those comprising the Superpower Zone without the consciousness that this territory is the most remarkable in the world in its relation to power and transportation requirement.

The United States Government created as effective on July 1, 1920, and engineering organization to investigate and report upon the "possible economy of fuel, labor and material, resulting from the use in the Boston-Washington region of a comprehensive system for generating and distributing electricity to transportation lines and industries." This organization, known as the Superpower Survey, was promptly organized as of that date; all data were collected and assembled, and its report transmitted on June 30, 1921, to Dr. George Otis Smith, Director of the U. S. Geological Survey, under the auspices of whose department the work was conducted.

The usual editing of report text and elimination of surface errors were accomplished in a remarkably short time by Director Smith's department and the report was transmitted to the President by Secretary of the Interior Fall on November 5, 1921, and has become the people's document known as Professional Paper 123.

As chairman of the Superpower Survey I was naturally brought into close personal and professional touch with the engineering associates that I was permitted to select. The report is divided into three major sections of investigation:

1 Electric power production and transmission
2 Railway electrification
3 Industrial electrification.

Respectively at the heads of these departments of investigation were Mr. Lorin E. Imlay, Dr. Cary T. Hutchinson, and Mr. Henry W. Butler. Mr. Henry Flood, Jr., as engineer-secretary of the Superpower Survey, was assigned to the duty of collaborating with these three departments and preparing the data in as near form to report text as possible.

To these men, their able assistants and other outside associated eminent engineers, belongs the credit for the report, for it was clear that only through the utmost coöperative effort and full agreement on the part of the entire engineering staff could it be produced within the time assigned by Congress.

During the early period of the work, engineering staff meetings were called every two weeks. Procedure and progress in all departments of the work were discussed at these meetings, and as it advanced the interval of time between them was increased. Eighteen engineering staff meetings were held. Contemporaneously, but at intervals of two months instead of two weeks, the Advisory Board was convened and our progress discussed. Too much cannot be said for the loyal attendance and assistance resulting from these well-attended Advisory Board meetings led by Prof. L. P. Breckenridge, head of the department of mechanical

chairman of the Advisory Board.

The report is summarized in its first pages, where among the conclusions presented it is stated that no later than 1930, through the unionization of electric utility, power production and the electrification of certain divisions of the railroads within the zone, and the acceptance of electric power from the electric utilities by the isolated industries in lieu of individual plant generation of their power, over $500,000,000 can be saved annually, and that the investment to cover will yield not less than 30 per cent. Such a possibility supported by the fact that in so doing 49,000,000 tons of coal can be saved annually, makes not only the engineer but any citizen in the zone feel that there may indeed be some truth in the oft-repeated statement that three prime powers in Europe could live in comparative luxury on the wastes of this nation.

W. S. Murray.

Problems and Progress of Iron and Steel Metallurgy in France.

THE Great War ended three years ago, but the iron and steel industry in France still feels its effects and will feel them for many years to come. The results have been terrible.

Prof. Jacques Cavalier

For more than four years the enemy occupied about seven per cent of the territory of my country, the parts thus invaded being among the most important and the richest above all for metallurgy. It is just as if in the United States the metallurgical industry had been deprived of the states of Pennsylvania, Ohio, Maryland, Virginia, Carolina and Georgia.

A few figures will serve to show the influence of the invasion on production.

	—Production in 1913—		
	Total	Invaded zone	Proportion in the country invaded
Coal[1]	40,844,000 tons	20,000,000 tons	50 per cent
Coke	4,000,000 tons	3,080,000 tons	76 per cent
Iron ores	22,000,000 tons	18,000,000 tons	86 per cent
Cast iron	5,207,000 tons	3,336,000 tons	64 per cent
Steel	4,686,000 tons	2,934,000 tons	63 per cent
Blast furnaces	170	85	50 per cent
Open-hearth furnaces	164	48	30 per cent
Bessemer converters	100	53	53 per cent

[1] Besides the twenty million tons in the invaded country, seven million of the region of the north were under the fire of the enemy.

This enormous cutting down of the means of production would not have been very serious if, as the leaders of the different armies had expected, the war had been short and had been conducted with only the munitions on hand. But after the Battle of the Marne these munitions were exhausted, and it became necessary to organize for a war of indeterminate length and to assure an unfailing supply of munitions to the armies.

At the beginning provision was made for a production of ten to twenty thousand shells a day; toward the middle of 1917 there were being turned out every twenty-four hours 300,000 shells for 75-mm. guns, 30,000 for 120-mm., and 50,000 for 155-mm. guns, without counting projectiles of larger caliber. In this our first effort we asked foreign countries, friendly or neutral, for the necessary metal. The American industries furnished us with considerable quantities of steel, and thus gave us help of inestimable value.

At the same time we sought to increase the means of production of metal and new installations were put in with a speed which doubtless is usual in the United States, but which is much rarer in Europe. In February, 1916, La Société Normande de Métallurgie resumed the work it had started in the neighborhood of Caen at the beginning of the War; in January, 1917, it put into operation a battery of coke ovens; in August a 400-ton blast furnace; and in, June, 1918, a steel works begun in January, 1917, and comprising five 30-ton converters and five 30-ton open-hearth furnaces.

Other industrial establishments made like efforts and as a result during the War there were built in France:

	Production, Tons
12 Blast furnaces	600,000
103 Open-hearth furnaces	1,560,000
47 Converters	242,000
21 Electric furnaces	56,000

Before the War France had 24 electric furnaces.

If, after the victory of the Allied Armies and the liberation of the invaded territory France had found her workshops intact, the effort made during the War would have been followed by a growth of her industrial power. We know that this was not so. In the invaded regions of the north the Germans had wiped out the greater part of the coal mines and had destroyed 11,500 plants. This destruction had no military purpose; it was methodical and studied, the object being to place our country in a position of inferiority in the economic scale. I know personally of a small establishment in the suburbs of Lille where the Germans, not having time to destroy the steam plant, rendered it useless by filling it with concrete.

The work of rebuilding the destroyed factories is now under way and will require several years, especially in the case of the collieries. On the other hand, numerous plants in the interior of the country have increased in size and have put in more modern and better equipment. In general, however, this work has been held up for a year or so by the rise in prices and by the industrial crisis common to all industrial countries.

At the end of the period of which I have attempted to show some essential characteristics, the dominating idea was to produce at a maximum by the usual methods without seeking new ones. At the same time, it is necessary to point out several things relating to the progress of the iron and steel industry.

First, the development of the electric furnace. Among European nations France is one of the richest in hydraulic power, the total energy available being from eight to ten million horsepower. At the beginning of the War, however, only a little more than a million horsepower had been harnessed, of which 750,000 was in the Alps and 150,000 in the Pyrenees.

The power resources of Pyrenees are not only much less than those of the Alps but proportionally they have been less developed. This is about to be corrected.

The building and equipment of a hydroelectric system generally requires many months, often several years; we hesitated to undertake the work as long as it was believed that the War would be of short duration, and it was only about 1916 that it was begun. We have thus been able to equip in addition to what we already had about 400,000 hp., while 400,000 hp. more are in process of installation. It is necessary to take into consideration also the projects which are now being studied for the harnessing of the Rhone and the Rhine. Only a part of this new energy has been applied to the steel industry; the electric furnace has above all been reserved for high-grade or special steels, and for the preparation of ferro-alloys and silicon alloys for which it is indispensable. The greater part of the electric energy was destined for purely chemical manufacture: electrolytic chlorine, chlorates and perchlorates, and especially synthetic nitric acid, for which we laid out and commenced to realize a vast program when the enormous increase in the number of ships torpedoed caused us to have serious fear for the continuation of our supply of nitrate of soda from Chile.

With the ending of the War these latter needs have almost disappeared. The plants equipped or in process of installation have become available for other uses, namely, railway electrification, metallurgy, etc. Indeed, the writer can cite in the neighborhood of Toulouse two such plants, that of Pamiers and the La Société du Saut du Tarn à St. Juery, near Albi, that have recently made important installations of electric furnaces for the manufacture of steel.

In another plant in the Pyrenees region it is proposed to install a closed furnace for the direct treatment of ore, particularly pyrite cinder. Although the electric furnace is well adapted to the treatment of sulphide residues, it is nevertheless questionable whether the direct production of cast iron can be accomplished economically in a country where electric energy finds so many remunerative uses.

Second, the electric furnace is used for the manufacture of

synthetic cast iron according to the process outlined by Keller long before 1914 and which was made use of during the War. An electric furnace is charged with turnings and small scrap of iron and steel with a given quantity of coal in the presence of a slag which makes the operation more regular and in addition can bring about desulphurization. If it is necessary to increase the silicon content, silica and the corresponding quantity of coke are added. The cast iron thus obtained is according to specification and very pure, particularly in regard to the sulphur content. The process has the advantage of permitting the easy utilization of turnings, of which there was a great abundance during the War, and it has furnished large quantities of cast iron for the manufacture of projectiles. I have lately seen in the Pyrenees a plant normally making silico-manganese which, not being able to get rid of its stock on account of the industrial crisis, utilizes part of its electric furnaces for the manufacture of synthetic cast iron. At the present prices of good cast iron and of scrap and turnings it is actually a paying operation, but whether it will be when conditions have become normal once more, is a question.

Third, the development of the use of scientific methods. The progress realized by systematic study in the laboratory usually penetrates slowly into industrial practice. Producers in the average industry have a tendency to consider the laboratory as a luxury which does not pay.

The War, in bringing together for the national defense the industrialists and the men of science in the process of intensive production of metal, has powerfully contributed to the employment and to the diffusion of new and precise methods of work and of control.

The measurement of high temperatures has become very general, especially for the heat treatment of shells.

Microscopic examination has been carried out systematically, as, for example, in the manufacture of cartridge cases, where the brass undergoes successive annealings. A simple and rapid microscopic examination shows whether annealing has been done at the right temperature and under the right conditions, or if it is necessary to reanneal before further mechanical working.

In regard to the mechanical tests which are commonly used, special mention should be made of the Brinell test and the shock test on notched bars. The Brinell test has been used particularly to control the heat treatment of shells; it is employed before any treatment, after quenching, and at the end of the treatment after drawing. Special schemes have been studied and put in practice for eliminating the influence of time in this test in order to allow great rapidity of execution without affecting precision. On a series of pieces 600 impressions an hour have been easily obtained. During the period when the manufacture of shells reached its maximum, say, 300,000 to 400,000 a day, it can be said that there were 800,000 Brinell tests made in the same time. The shock test on notched bars made its appearance before the War, but it was introduced very timidly and met with much opposition on the part of the manufacturers. During the War the Aeronautical Branch, which had need of exceptional guarantees, found the introduction of this test indispensable in the inspection of crankshafts and connecting rods for aviation motors. These rods had to reach a number corresponding to 9 to 10 kg-m. on a test bar having a section of 10 by 10 mm. with a notch 2 by 2 mm. and rounded at the bottom.

While these different methods were doubtless employed before the War in a small measure, they rapidly became common during the conflict, even in the most old-fashioned workshops. By a constant and accurate control they caused a large reduction of rejections and in this way speeded up production. Manufacturers come to accept clauses in specifications with which they would have nothing to do previously.

Without doubt these good industrial habits which were acquired under the force of circumstances will continue. And thus the War will have contributed to the progress of our metallurgical industry, even though it be in a measure which only compensates to a slight extent for the great losses resulting from the destruction of our factories.

Jacques Cavalier.[1]

[1] Rector of the University of Toulouse, Toulouse, France; French Exchange Professor, at present at School of Mines, Columbia University, New York.

An Interprofessional Conference

On October 27 representatives from each of eight important professional groups met at luncheon at the City Club in Philadelphia, as guests of the American Academy of Political and Social Science, for the purpose of ascertaining the present status as to ethical standards in each of the professions, and also for the purpose of securing suggestions as to whether or not public welfare could be advanced in any way at the present time by a discussion of both the need for better standards and the achievements as to standards in each of the professions. Of course questions of organization as an aid in the development of ethical conduct played an important part in the discussions.

At this conference Calvin W. Rice and Morris L. Cooke represented the engineers; W. E. Mikell and Roland S. Morris, the lawyers; Graham Taylor and Mary Van Kleeck, the social workers; R. D. Kohn and C. C. Zantzinger, the architects; W. D. Lewis and Clyde L. King, the teachers; A. D. Whiting, the doctors; Edmond Sterling, the journalists; and C. J. Rhoads, the business men.

The conference decided unanimously that the Academy should issue a symposium as soon as possible dealing with the ideals and practice as to ethical standards in each of the leading professions. More important still, the conference was requested by the Academy to act as a permanent agency to plan interprofessional activities and to seek to inspire organizations to create and enforce ethical standards in the professions not yet very thoroughly organized. Thus, it was the opinion of the conference that there was no reason why journalists should not have an organization and ethical standards comparable to those of the engineers and notably of the architects. The need was also pointed out for such organization among social workers and particularly among business men. The Academy agreed to publish such a symposium this coming May, and steps have already been taken toward that end. Steps are also being taken to advance the establishment and the maintenance of recognized ethical standards among journalists, teachers, social workers and business men. Interprofessional gatherings similar to this Philadelphia meeting are projected in a number of cities.

The keynote of the meeting was the maintaining of a public point of view looking toward a standard of conduct which will protect society from any menace from the professions as well as make the professions conscious of their public obligations and opportunities. It was very eloquently pointed out at this meeting that the professions are in a very peculiar sense the custodians of the service motive, and that if civilization is to be served the professions must see to it that this service motive is visualized and made dominant in every form of human activity.

Clyde E. King.[1]

New Member of Engineering Foundation Board

Arthur Lucian Walker, professor of metallurgy in the Schools of Mines, Engineering and Chemistry of Columbia University, New York, has been appointed representative of the American Institute of Mining and Metallurgical Engineers on the Engineering Foundation Board, to succeed Dr. Joseph W. Richards, deceased.

Professor Walker was engaged in chemical and engineering work until 1887, when he became general superintendent of the Old Dominion Copper Co., Arizona. Six years later he was appointed manager of the Baltimore Electrolytic Refining Company and in 1899 manager of the Perth Amboy, N. J., plant of the American Smelting & Refining Company, of which he was director from 1906 to 1907. He has been professor of metallurgy at Columbia since 1908. He served as consulting metallurgist at large for ordnance, War Department, 1917–1918.

In 1898 Professor Walker invented the Walker mechanical casting machine, which revolutionized methods used for casting copper into refined shapes and is now extensively used in all copper-producing countries in the world. In 1902 he invented a new system of tank-room arrangement, for use in electrolytic copper refining, which has been installed in practically all copper-refining plants built since that time. He has been retained by a number of large companies as consulting metallurgist, specializing in copper.

[1] Editor of the Annals of The Academy of Political and Social Science.

Two Strong Speakers Will Address Leading Session—Important Meetings on Education Scheduled—Interesting Social Features and Excursions Planned

Speakers for Principal Session

Two speakers have been announced for the principal session of the meeting on Monday afternoon. Fred J. Miller, Past-President of the Society, will interpret the spirit of the report of the Committee on Elimination of Waste in Industry. He will be followed by W. H. Sullivan, Vice-President and General Manager of the Great Southern Lumber Company of Bogalusa, La., who will outline the principles followed in the elimination of wastes in the Bogalusa development of the Great Southern Lumber Company, which is an outstanding example of what can be done in an industry which has suffered from great wastes that have seemed unavoidable.

Education

Attention is again called to the two notable sessions on Education. Monday evening, Education and Training in the Industries will be considered. Thursday afternoon the Society for the Promotion of Engineering Education will hold a joint session with The American Society of Mechanical Engineers, at which the needs of Professional Education for the Industries will be discussed by F. C. Pratt, vice-president of the General Electric Company and president of the Yale Engineering Association; J. E. Otterson, president of the Winchester Repeating Arms Company; Dexter S. Kimball, dean of the College of Engineering, Cornell University, and president-elect A.S.M.E.; and A. G. Christie, professor of mechanical engineering at Johns Hopkins University, and chairman of the A.S.M.E. Power Division.

Many Features to Interest Ladies

The technical side of the meeting has been well developed and its success from this point of view is assured. The interest of the ladies, however, is greatly desired so that the social features which have been given careful consideration in the plans for this meeting will be equally successful. Many ladies who have become enthusiasts of A.S.M.E. meetings complain that they are obliged to seek diligently for the information they want about the meeting activities that will be of interest to them. To avoid this criticism, each member should take his circular home and go over the points of interest that will be of value to the ladies of the family.

Changes in Tentative Program

As indicated in the circular which was sent to the membership during November, a General Session will be held on Thursday afternoon and another General Session on Friday afternoon. The paper by Major Gilbert D. Fish on Stresses and Deformations in Flat Circular Cylinder Heads, a Mathematical Analysis, and the paper by R. F. Wood on Control of Centrifugal Castings by Calculation, have been assigned to the Thursday afternoon session. The Friday afternoon session will be devoted to the paper by F. W. Dean on Tests on Emergency Fleet Boilers Using Oil Fuel. At the same session a paper by Messrs. L. A. Quayle and E. H. Brown giving Results of Tests on Pumping Engines of the City Water Works of Cleveland and a paper on Steam Condensing Plants by Paul A. Bancel, will be presented. The paper presented by Messrs. Quayle and Brown gives noteworthy results of tests on pumping engines, the thermal efficiency of the engine tested comparing more than favorably with any other prime movers that have been tested recently. Mr. Bancel's paper will be presented by title and the meeting will be thrown open to a discussion thereof.

The Aeronautic Division has completed its program and will have three papers as follows:

- Study of the Elastic Properties of Small-Size Wire Cable, R. R. Moore
- Commercial Operation of Airplanes, Maj. L. B. Lent
- Problems of Commercial Operation in the Light of European Experience, R. B. C. Noorduyn

A paper of vital importance in the Diesel field will be presented at the Gas Power Session. Elmer A. Sperry, after twenty years of experiment, has completed a successful compound Diesel engine and will make public the results of his work. It can be confidently stated that the presentation of particulars of this epoch-making device will be of great interest and will develop important discussion.

The Fuel Division will complement its program by showing moving pictures of stoker operation. This film, prepared by R. Stanford Riley, of Worcester, Mass., and viewed by several representatives of the Society, all of whom are enthusiastic in their statements as to its value, will show actual combustion conditions in underfeed stoker operation. Mr. Riley will introduce the film with an account of the experiments which made this moving picture possible.

Student Session

The student members of the Society will hold a session on Thursday morning. A paper will be presented by W. K. Ramsay of M. I. T. on Draft-Tube Design, and another by George E. Lyon of Rensselaer Polytechnic Institute. This session gives the older members a fine opportunity to show their interest in the valuable work being carried on by the Student Branches of the Society.

Excursions and Social Features

The excursion program so far arranged offers opportunities to visit the Essex Power Station of the New Jersey Public Service Company, and the plant of the Seaboard By-Product Company of Jersey City which obtains numerous by-products in addition to coke and gas from coal. Their plant will be of considerable interest to the Fuel, Power and Gas Power Divisions. On Friday afternoon an excursion will be made to the White Star liner *Olympic*. Members of the Society will be given the opportunity to inspect the entire ship and the passenger accommodations will be open to the ladies of the party. Afternoon tea will be served in the dining saloon.

Great enthusiasm is developing for the social events to be held in connection with the meeting. The dinner-dance which will be held Thursday night at the Hotel Astor gives promise of being one of the most successful functions that the Society has held. The chairman of the committee in charge of this event is Major Edward Van Winkle, who has had much experience with affairs of this sort, and he has given assurance that the entire function will be interesting.

College Reunions

The graduates of technical schools are looking forward to the various reunions to be held on Friday evening of the Meeting. Notices will be sent out by each of the alumni organizations regarding their respective affairs. The Cornell men are planning an exceptional event in a dinner to be held on this evening at the Waldorf-Astoria in honor of Dr. Farrand, newly installed president of the University, and Dean Kimball, head of the College of Engineering, who will take office as president of The American Society of Mechanical Engineers during this Annual Meeting. Other institutions which will hold reunions are the University of Illinois, Massachusetts Institute of Technology, Purdue University, Rensselaer Polytechnic Institute, Stevens Institute of Technology, Worcester Polytechnic Institute, and also the Princeton Engineering Society.

Business Meeting

The discussion of the Constitution and of various Society policies which has been planned for the Business Meeting has already aroused the attention of the membership. A stirring meeting is assured. Further particulars of the meeting will be found on pages 133 and 134 of Section II of this issue.

The Federated American Engineering Societies

Review of Progress Made by Federation during First Year—Summary of Committee Activities—Solidarity of Engineers the Chief Objective—The American Engineering Council to Meet at Washington Early in January

With the completion of the first year of The Federated American Engineering Societies it is well to review the progress made in consolidating the engineers of the country and providing a medium through which they may act as a unit in rendering public service involving engineering knowledge and experience. Such a review covers growth in membership, development of organization, definite work accomplished, and projects in hand, and may include plans for the future.

The Federation is a growing organization. Of the 30 national and 41 local and regional organizations which met in Washington on June 3 and 4, 1920, to create the F.A.E.S., representatives of 21 member societies and 9 organizations considering membership were present at the first meeting of the American Engineering Council, the governing body of the Federation, held in Washington Nov. 18–20, 1920. There are now 29 member societies, representing over 45,000 engineers, and applications for membership are receiving action at every meeting of the Executive Board of the American Engineering Council.

The work of the Federation is carried on under the direction of its governing body, and through standing and special committees representative of the member societies. Frequent requests for assistance in various state and national activities have resulted in the creation of many new committees during the past year. The present organization is shown by the accompanying chart, which indicates the relation of the committees to the governing body and to each other and gives their personnel.

It will be noted that the majority of the committees are dealing with matters of national importance. The value of the assistance that can be rendered by such an organization representing some of the best engineering minds of the nation, is immeasurable. The fact that governmental officials, both legislative and executive, heads of governmental departments, U. S. Chamber of Commerce, manufacturers' associations, etc., are constantly turning to the Federation for assistance, information and suggestions, indicates that it is recognized as an influential and constructive body.

One of the most constructive pieces of work accomplished by the Federation is the investigation conducted by its Committee on the Elimination of Waste in Industry. The report of this committee, which has recently been published, has attracted wide and favorable attention, has been of great assistance in various conferences, and has stimulated further action in several organizations. Several committees of the Unemployment Conference found the report valuable in their work. Messrs. Edward E. Hunt and Sanford E. Thompson, both members of the Waste Committee, were members of the conference, the former as secretary. The boot and shoe, the ready-made clothing, the building, and the printing reports have all been used in connection with the settlement of labor troubles in these respective industries. The findings of the Waste Report have been or will be considered by the following groups in their annual or semi-annual meetings: National Cost Accountants Association; Society of Industrial Engineers; Industrial Management Council of the Chamber of Commerce, Rochester, N. Y.; United Typothetae of America; and The American Society of Mechanical Engineers. Official inquiries have come from Australia, Canada, Czecho-Slovakia, and England concerning the purpose, methods, and results of the investigation. The Department of Commerce has given careful consideration to the Waste Report and through the Bureau of Standards will carry on some of the investigations recommended therein.

At the present time there are several bills pending in Congress in which the Federation is taking an active interest. Among these are the War Minerals Liberalization Act, and bills concerning topographic mapping, the status of sanitary engineers, and patents. The first-named would reopen cases adjusted by the War Minerals Relief Commission, of which Philip N. Moore and Horace G. Pomeroy were engineer-members. The F.A.E.S. is opposing this act and is supporting a resolution introduced to provide for the return to the U. S. Treasury of the fund of several million left by the Commission. A bill providing a definite plan for the completion of a topographical map of the entire United States is also being supported by the Federation; and it has helped draft and had introduced a bill securing commissioned status for sanitary engineers of the U. S. Public Health Service. Through its Patents Committee, it is opposing the Stanley bill and supporting the Lampert Bill. Previous issues of Mechanical Engineering have contained details concerning these items of legislation. Owing to the activities of the Patents Committee the Stanley Bill has been recommitted to the Patents Committee of the Senate, and hearings will be held at which representatives of the F.A.E.S. Patents Committee will be present.

Representatives of the F.A.E.S. have coöperated with the Department of Commerce in organizing a conference of highway engineers to consider the advisability of "fall-letting" of highway construction contracts. The statement prepared by this conference formed the basis of a letter addressed by the Secretary of Commerce to the governors of all the states, in response to which favorable comment and action have been forthcoming.

Information is also being gathered pertaining to letting of fall contracts for other types of construction than that of highways.

The F.A.E.S. has supported activities leading to the creation of a Department of Public Works. Present indications are that civil engineering functions of the Government will be placed under one head and that the Department of the Interior will be divided into two divisions, one of public domain, and one of public works. In the latter division will be assembled almost all the governmental activities that the engineers have advocated should go into a Department of Public Works.

Members of the Federation's Registration Committee and Executive Board have taken active part in hearings and appeared before legislative committees dealing with the registration of engineers, exercising their influence to have a uniform law passed.

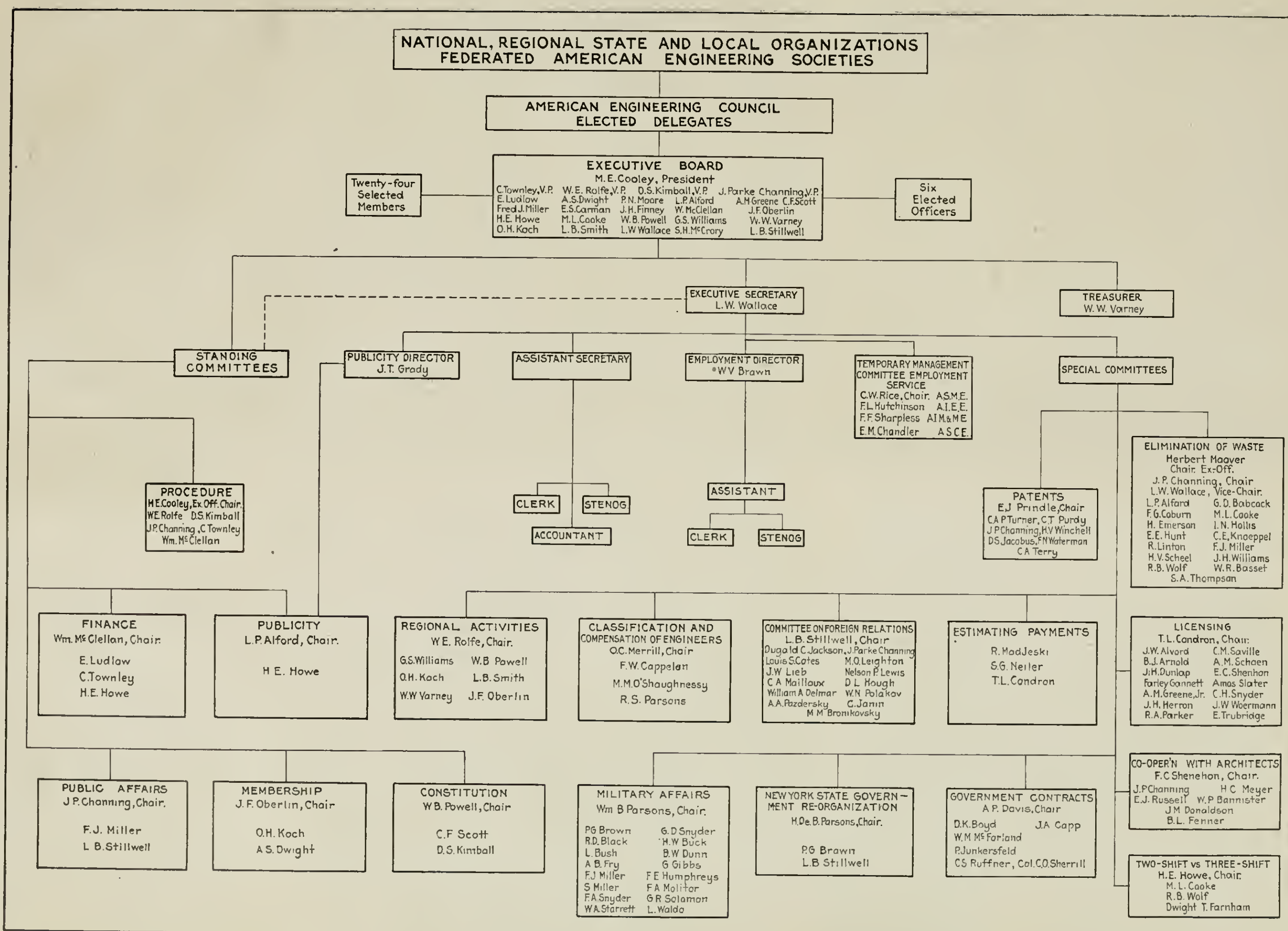
The Federation has maintained an employment bureau in New York and has coöperated with various agencies of similar intent in an effort to reduce unemployment. Recent action was reported in the November issue of Mechanical Engineering.

Among other undertakings in which committees and representatives of the Federation have assisted are the following:

- Classification and Compensation of Engineers
- National Board of Jurisdictional Awards in the Building Industry
- New York State Government Reorganization
- Types of Government Contracts
- Length of Shifts in Continuous Industry.

As a means of distributing information concerning the activities of the Federation, a weekly digest has been issued to engineering organizations, colleges, government offices, and individuals. Over 1400 of these are now being sent out weekly. While Congress is in session weekly digests on legislative and departmental news are also issued to those desiring them. Over 400 stories have been sent out to the press by the publicity director since January 1, and the major waste stories have had a circulation each of at least 14,000,000. The state administrative committees to be organized will be a further means of publicity and closer contact with individual engineers.

The chief objective of the Federation for the next few months will be to solidify its membership. It is realized that the individual engineer is not thoroughly acquainted with the purposes and activities of the Federation. Until engineers in general are more fully informed, the F.A.E.S. cannot hope to function to the best advantage. Arrangements are therefore being made to have some member of the Executive Board appear before every member society during the next two months, bringing to the individual engineer of each society the thought that the purpose of the Federation is



NATIONAL, REGIONAL STATE AND LOCAL ORGANIZATIONS
FEDERATED AMERICAN ENGINEERING SOCIETIES
AMERICAN ENGINEERING COUNCIL
ELECTED DELEGATES
Twenty-four Selected Members
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Fred J. Miller E.S. Carman J.H. Finney W. McClellan J.F. Oberlin
H.E. Howe M.L. Cooke W.B. Powell G.S. Williams W.W. Varney
O.H. Koch L.B. Smith L.W. Wallace S.H. McCrory L.B. Stillwell
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TREASURER
W.W. Varney
STANDING COMMITTEES
PUBLICITY DIRECTOR
J.T. Grady
ASSISTANT SECRETARY
EMPLOYMENT DIRECTOR
*W.V. Brown
TEMPORARY MANAGEMENT COMMITTEE EMPLOYMENT SERVICE
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F.L. Hutchinson A.I.E.E.
F.F. Sharpless A.I.M.&M.E.
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Wm. McClellan
CLERK
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ACCOUNTANT
ASSISTANT
CLERK
STENOG
PATENTS
E.J. Prindle, Chair
C.A.P. Turner, C.T. Purdy
J.P. Channing, H.V. Winchell
D.S. Jacobus, F.N. Waterman
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Herbert Hoover
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H.V. Scheel J.H. Williams
R.B. Wolf W.R. Basset
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M.M. O'Shaughnessy
R.S. Parsons
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C.A. Maillaux D.L. Hough
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F.A. Snyder G.R. Solomon
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NEW YORK STATE GOVERNMENT RE-ORGANIZATION
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GOVERNMENT CONTRACTS
A.P. Davis, Chair
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W.M. McFarland
P. Junkersfeld
C.S. Ruffner, Col. C.O. Sherrill
TWO-SHIFT vs THREE-SHIFT
H.E. Howe, Chair.
M.L. Cooke
R.B. Wolf
Dwight T. Farnham

to enable him to render the public service that his training and experience affords.

The Committee on Regional Activities has recommended that the number of districts be increased from 6 to 8; in arranging these districts unity of local interest will be the paramount object.

The Executive Board for 1922 will be composed of 30 members, 16 representatives from national societies, 8 regional directors through which local societies will be represented, and 6 elected officers.

The next meeting of the American Engineering Council will be held at Washington, January 5 and 6, 1922. It will mark a new chapter in the history of the organization. With its plans of organization largely disposed of, the experience of a year back of it, and its work guided by a most efficient personnel, the Federation need not be apprehensive of the future.

The Waste Report

On October 20, 1921, The Federated American Engineering Societies issued printed copies of the report of the Committee on Elimination of Waste in Industry. This book of over four hundred pages contains the reports of a committee of engineers on their investigations of the building industry, men's clothing manufacturing, shoe manufacturing, printing, metal trades and textile manufacturing, as well as general reports on unemployment, strikes and lockouts, legal machinery for adjusting disputes, industrial accidents, health of industrial workers, eye conservation and purchasing and sales policies.

These reports are preceded by a summary which shows sources and causes of wastes and gives recommendations for the elimination of waste. The questionnaire and valuation sheet used by the field engineers in collecting information on which they based their reports are also explained in detail. Each of the engineers' field reports contains the evaluation sheet for the plant investigated.

The foreword by Herbert Hoover sums up the purpose and character of the book:

> This reconnaisance report on waste in industry is the result of five months of intensive study, carefully planned and rapidly executed. A part of its value lies in the speed with which the work has been done, and the promptness with which it presents definite lines for future action. It reveals facts which may serve as a foundation for an advance in American industry. It has a special message for government officials, financial, industrial and commercial leaders, labor organizations, economists, engineers and research groups, the general public and the press.
>
> We have probably the highest ingenuity and efficiency in the operation of our industries of any nation. Yet our industrial machine is far from perfect. The wastes of unemployment during depressions; from speculation and overproduction in booms; from labor turnover; from labor conflicts, from intermittent failure of transportation of supplies of fuel and power; from excessive seasonal operation; from lack of standardization; from loss in our processed and materials—all combine to represent a huge deduction from the goods and services that we might all enjoy if we could do a better job of it.

Section I of the report, which summarized the findings of the Committee, was abstracted in the September issue of MECHANICAL ENGINEERING. The entire report will be reviewed in greater detail in the January issue. The book is on sale through the McGraw-Hill Book Co., Inc., New York.

The Financing and Managing of Large Undertakings

Problems of Raising Money and Choosing Leaders Considered by Joint Meeting of New York Sections of the Four National Engineering Societies

A NOTABLE scheme of coöperative meetings has been developed by the New York Sections of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Institute of Electrical Engineers and The American Society of Mechanical Engineers. Topics of interest to the entire engineering profession will be presented at four joint meetings during the fall and winter. The first meeting, devoted to the subject The Engineer in Finance and Management, was held October 19 in the Engineering Societies Building and the subject and speakers drew an audience that filled the auditorium to capacity.

Farley Osgood, chairman of the New York Section of the American Institute of Electrical Engineers, presided and introduced as the first speaker Mr. Arthur B. Leach of the A. B. Leach Company, whose subject was The Financing of Large Engineering Undertakings.

THE FINANCING OF LARGE UNDERTAKINGS

In his opening remarks Mr. Leach emphasized the principle that individuals and the country as a whole are subject to and limited by environment. The country storekeeper cannot hope to do the business of a Wanamaker, so when considering the important subject of the financing of great developments, environment must be faced, and the speaker proceeded to portray present conditions which limit the financing of engineering projects.

As a basis for his picture of present-day limitations, Mr. Leach quoted as follows from a magazine article printed in 1914:

> The year 1914 has marked a culmination of the area of high finance which set in over fifteen years ago. Practically all the "bubbles" growing out of that extraordinary period have now burst and security values as a whole have returned to approximate bases of actual values.
>
> Public opinion, which for ten years has generally been antagonistic to corporate interests, this antagonism naturally growing out of the high-finance policy, has now definitely veered and the pendulum is about to swing the other way. The Federal Reserve Banking System has for the first time in history given legitimate business opportunity a firm basis on which to build, and has eliminated all dangers of financial panic of the style of 1873 and 1907.

Since 1914 the per capita debt in the United States has grown from \$9.63 to \$224.81, in Great Britain from \$75.03 to \$814.08, and in other European countries in a similar manner. Money rates have advanced since 1914 from 3 5/8 to 6 3/8 per cent for call money and from 4 7/8 to 7 1/8 per cent for time money, a fact that must be faced in determining the wisdom of financing an enterprise.

Mr. Leach stated that an estimate of tonnage now afloat indicates a total in excess of 60,000,000 gross tons, approximately 11,000,000 gross tons over the figure for June 30, 1914. This condition coupled with a lessened volume of international trade has forced shipping rates to unprofitable levels, with the resultant tying up of great sums of money.

In discussing the financing of railroads, Mr. Leach enunciated the axiom that it was necessary for an enterprise to be reasonably profitable, and pointed out that the investment return in railroads had dropped from 5.68 per cent for the year ending June 30, 1910, to 3.68 per cent for the year ending December 31, 1918, and to 0.78 per cent for the year ending December 31, 1920.

Ohio needs \$118,000,000 for its public utilities and 170,000 new homes for 850,000 people, but Mr. Leach showed that for every dollar earned in Ohio ten cents is taken in local taxes. In New York City the stock watering of the rapid-transit companies upon their combination many years ago caused a loss of public confidence which has never been regained. In the operation of street railways, Mr. Leach showed that recent increases in fares have brought about considerable improvement.

Quoting Abraham Lincoln, who said that "public sentiment is everything, with it nothing can fail, without it nothing can succeed," Mr. Leach made the plea that greater publicity be given by public-utility managers.

The large foreign loans at high rates of interest have also rendered domestic financing more difficult. Foreign governments need money and are willing to pay for it at rates that domestic enterprises cannot meet.

Mr. Leach pointed to the exceedingly low wage rates in Germany as a vital reason for developing every per cent of usefulness in our present industrial installations to protect us from an overwhelming influx of foreign goods. He pointed out the case of the Government expenditure of \$72,000,000 for a powder plant at Nitro, W. Va., and emphasized the need for the determination of the most economic use of the development.

Mr. Leach summed up his thesis in the following words:

enterprises which have been overdeveloped, a surplus will come, and then the market place will have funds for the development of new enterprises. But first, we must make all of our operations efficient, we must get down to a basis where we can compete with foreigners, who are going to ship large quantities of goods here on account of the low prices of labor abroad. We must make efficient and economic in their operation these great plants which the Government or individuals built under wartime pressure; because in all of our operations of an industrial or commercial or a financial character, we must aim to be efficient in as high a degree as we can. Before any new enterprises can be started and completed, we must force home to the public what was coming to be true in 1914, we must get rid of this antagonism for new development, and we must make common among all of the people the belief that these enterprises are for the common good, and for the good of everybody.

If we are to get to the place where great financial plans can be carried out, we must not lose time being glad that the other fellow has had a devil of a time in the last three or four years, but we must spend more time trying to work out these problems that the war has left on our hands, so that we shall get back to a normal basis of mutual confidence, or mutual belief that this country is going ahead, and that we are going to be able to build again that temple which our fathers started, and which has been stopped by this crisis of world fury and world hate.

The Engineer's Shortcomings as a Financial Manager

The Chairman then introduced Philip Cabot, of Boston, a member of the firm of White, Weld and Company, who spoke on the subject The Engineer a Failure as a Financial Manager. His remarks were in part as follows:

Essentially the great engineer as born and trained in our times is of the scientific, studious type, disciplined, severe, ascetic by nature and by training in the schools and in life.

Your builder and leader of great industrial enterprises is cast in a different mold. He is essentially an idealist, imaginative, enthusiastic, impulsive intensely human, a dreamer of dreams with the power to make the dreams come true. In short, an artist capable both of great imaginative conception, and fine technical execution; possessed of the power both to conceive and do.

A glance at the history of American industry during the last fifty years will show that the great figures are all men of this type; Vanderbilt, Hill, Ripley, Carnegie, Schwab, Rosenwald, Woolworth, Armour, McCormick, McElwain, Endicott, Ford, Westinghouse, Coffin, Vail. As one example, take Vail, of the telephone company. Distinctly less remarkable than some of his predecessors in intellectual power, and scientific training, he took the company when to some of us it seemed about to go upon the financial rocks and left it the most shining success of any public utility in the world. His success was due, not to commanding intelligence but to imaginative power and the capacity to select and direct men.

And look at our dear Henry Ford with all his sins of ignorance upon his head, who has, as it were, over night leaped from nowhere into the multi-millionaire class, leading an automobile industry as large in some dimensions as all others in the country put together, and perhaps the one successful one.

The reason why such men succeed is obvious. They have faith; they believe in things they cannot prove, possess the courage to stake their reputation and their future on their ability to make their dreams come true, and obtained from these qualities the power to inspire with enthusiasm and loyalty the great body of men under their command who are their necessary tools, controlling them with the precision and power with which the great painter handles his brush.

Such a spirit in an organization is an essential (one is tempted to say *the one* essential) of industrial, as of military, success; unquestioning loyalty and the willingness to take desperate chances at the word of command. Leadership in any field demands this type of man, this power to inspire. With it success will come in spite of many weaknesses. Without it success will be difficult except for commanding genius.

The foregoing are examples of shining success and the reasons for it. But we learn more, as a rule, from our failures, and it will be instructive to note some of these. Perhaps the most striking illustration of failure which we have today is the railroad business. The present condition of these public utilities contrasts very sharply with the condition of the telephone company as it grew under the leadership of Mr. Vail. Many reasons are assigned for the collapse of the railroads, and like all other human things, there is doubtless no one cause, the result being the product of many causes. But it is very striking to note the change in the type of men who now lead the great railroad systems, as compared with the men who led them when they were successful. Formerly the railroad leaders were traffic men and salesmen and builders, today the railroads are run by operating men, engineers, and the traffic men have been pushed aside. The failure of the railway executives to meet the demands of the times is not exactly their fault. They have been subject to state regulations and federal regulations, which has put them under an impossible handicap. They have the nominal position of responsibility without power, and no wonder they fail in successful leadership, but it is inevitable that they should fail. The huge army which these men command, far from being inspired by the enthusiasm and loyalty which are essential to success, is admittedly upon the verge of mutiny. For years the relation of the great railroad executives to their employees has been such as to breed disloyalty. The effect of Government regulation as designed and administered during the last twenty years has been to develop in railway executives and in leaders of the great railway unions the most conspicuous and magnificent example which the world has ever seen of the great game of "Anti" and "pass the buck."

I do not say, nor do I believe, that it is impossible for an engineer to be natural handicap is increased by our present methods of training to such an extent as to make him an unpromising candidate for promotion to such positions, and I say this with full knowledge of the fact that his selection to fill them has become increasingly common of late years, especially in public-service corporations.

If this fact seems to you extraordinary the reason is not far to seek. The directors and officers of corporations are in theory elected by the owners, (to wit, the stockholders) but nothing is further from the fact. Stockholders are in practice a flock of sheep incapable of concerted, intelligent action, but eager to follow any leader, so that the task of selecting corporation managements falls upon the banker, or financial godfather of the enterprise. Such men, cautious by nature, and made doubly so by experience, yearn for a sure thing and welcome the engineer with his mathematical accuracy. Your engineer at least will not exceed his estimates, will tell them in advance what he will do and do it, while your most visionary promoter must forever be watched and guided. With an engineer at the wheel the company will run itself and the banker and director can sleep in peace. At least he thinks so, and for a time he can. But there is apt to be a rude awakening when he discovers that the business has gradually evaporated, wages have shown a disconcerting tendency to eat up profits, and customers are becoming surly.

In this case, as in all others, the search for the sure thing fails; temporary peace is purchased at the cost of ultimate failure, and the practice must be abandoned. The bankers must select men of enthusiasm, courage and vision and must put over them boards of directors who are capable and willing to direct. Your dreamer without direction will wreck you faster and more certainly than your man of science. But with adequate direction and control he is your safest man, and if our engineers are to occupy such positions with success their education and training must be profoundly modified.

The great builders and leaders of large industries in the United States have all possessed the following qualities:

1 Imagination, giving
 - *a* The power to see with remarkable clearness the customer of the market
 - *b* Power of leadership, the ability to inspire loyalty and enthusiasm in subordinates
 - *c* Judgment of men; the ability to pick subordinates of power.

2 Administrative ability, technique, the power to use tools—to do work through others.

These qualities are essential because large industries involve the use of large bodies of men who must be led and cannot be driven. They must be always kept growing, which requires vision of the changing conditions of the market; the promotion stage is never over.

I am not an engineer, but have known engineers and have lived with them, slept with them, have worked with them, and I admire them. They are great men, but as we train our engineers today, we handicap them as managers. If they are to be great managers, you have got to modify their training.

John H. Williams, consulting engineer, of Philadelphia, commented on the development by Mr. Leach of the need for the thoughtful type and by Mr. Cabot for the enthusiastic, and stated as his opinion that the need was for a man whose one great characteristic is flexibility. Mr. Williams in commenting on Mr. Cabot's analysis of the failure of the railroad men because of their responsibility without authority pointed out that an ability to enforce judgments peacefully was of greater value than authority.

Calvert Townley, vice-president of the Westinghouse Electric and Manufacturing Company, discussed the recent change in conception of an engineer's function. He pointed out that the reason for the growing demand for engineers is because engineering training leads to the search for facts and conclusions based on these facts. The engineer attacks the problem from the quantitative rather than the qualitative point of view. Mr. Townley stated as his opinion that the position of the railroads today is due to the former promoters whose broad vision was not bounded by facts and figures.

Lewis H. Nash expressed his approval of the discussion of finance by engineers. He emphasized the importance of a knowledge of finance by the engineer as the primary part of any enterprise. Inasmuch as the engineer is by education particularly fitted to look upon an enterprise from the point of view of efficiency, it is his duty to see that the best materials and the best devices are selected for the purposes desired and that the costs are reasonable. It is his duty to supervise the handling and distribution costs. From his point of view finance is one of the tools to be used and the engineer is by education and temperament particularly fitted to have charge of the finance of an honest enterprise.

Abraham Korminsky and Blamey Stevens emphasized the important function of the engineer in straightening out the kinks in present condition of affairs, not only by developing proper effectiveness of our industries but also by taking part in the careful analysis of general business conditions.

NEWS OF OTHER SOCIETIES

National Safety Council

According to figures contained in resolutions adopted by the National Safety Council at the Tenth Annual Safety Congress, held in Boston, Mass., Sept. 26, some 80,000 accidental deaths and millions of injuries occur annually. National experience has demonstrated that 75 per cent of industrial accidents are preventable. Experimental campaigns in seven cities have resulted in the reduction of public accidents by 25 to 40 per cent and further efforts it is stated, will undoubtedly result in even greater progress. The direct economic cost of accidents in industry alone exceeds one billion dollars annually and greater indirect losses are caused by the curtailment of production and lowering of morale. The National Safety Council advocates the safeguarding of all dangerous machinery and places, the redesigning and reconstruction of factory equipment when necessary, the education of all workmen and their supervisors in safe methods and habits of work, safety education of school children and of college and university students, and the mobilization of all community forces for intensive and permanent campaigns against accidents of all types.

At a meeting of the Executive Committee of the Council, the organization of a Drop Forge Section and a Petroleum Section to conduct accident prevention in these industries was approved.

W. H. Cameron, formerly secretary-treasurer of the National Workmen Compensation Service Bureau, New York City, was elected executive secretary of the Council.

Society of Industrial Engineers

The fall convention of the Society of Industrial Engineers was held at Springfield, Mass., Oct. 5 to 7. The leading topic of the meeting was Industrial Stability, and sectional meetings dealt with the sub-topics of education, manufacturing and selling, financing and accounting, and industrial relations.

L. W. Wallace, president of the society, and executive secretary of The Federated American Engineering Societies, opened the meeting with a discussion of the chief causes of industrial unsettlement. F. M. Feiker, assistant to Secretary of Commerce Hoover, spoke of the need of a barometer of business analogous to the Weather Bureau. At an evening session the first day of the meeting, E. St. Elmo Lewis, of New York, gave an interesting address on Setting Sales Standards.

Among the speakers on the second day were Dr. Ira N. Hollis, of Worcester Polytechnic Institute, on harmonious relations between factory owners, managements and employees; Arthur T. Davenport, of Sweet, Orr & Co., New York, on The Importance to the Factory of Constant Output, and Harry A. Hopf, organization counsel for the Federal Reserve Bank of New York, on Standardization of Salaries of Administrative Employees.

At a meeting on Friday afternoon Robert B. Wolf, of New York, discussed The Elimination of Waste in Industry by Standardization, and Frank B. Gilbreth, of Montclair, N. J., spoke on Standardization of the Task.

The speakers at the final session Friday evening were Reuben A. Lundquist, chief of the electrical division of the Federal Department of Commerce, who dealt with The Influence of Foreign Trade on Industrial Stability, and Floyd Parsons, of Philadelphia, who discussed the education of the public for industrial stability.

Inspection trips were made to the principal manufacturing plants of Springfield and vicinity.

Officers of the Society for 1922 were elected as follows: President, Joseph W. Roe, head of the industrial engineering department of New York University; treasurer, F. C. Schwedtman, vice-president National City Bank, New York; secretary, W. G. Sheehan, Detroit; and business manager, George C. Dent, Chicago.

American Gear Manufacturers' Association

At the semi-annual meeting of the American Gear Manufacturers' Association held at Rochester, N. Y., Oct. 13, 14, and 15, reports of committees carrying on special investigations were heard and discussed, some standards were adopted as recommended practices, and definite steps were taken by committees toward coöperative work with standardization bodies of such organizations as the American Society for Testing Materials, The American Society of Mechanical Engineers, and the Society of Automotive Engineers, all of which organizations are working under the Rules of the American Engineering Standards Committee. Sessions at which committee reports were presented were opened with the reading of papers, the majority of which dealt with gear-making problems. Among the speakers were S. O. White, chief engineer of the Warner Gear Co., Muncie, Ind., R. W. Daniels of the Baush Machine Tool Co., Springfield, Mass., and E. W. Miller, chief engineer of the Fellows Gear Shaper Co., Springfield, Vt. E. S. Sawtelle, assistant general manager of the Tool Steel Gear & Pinion Co., Cincinnati, told of his experiences and observations in a recent European trip.

The results of a questionnaire sent to the membership by the Committee on Uniform Cost Accounting are of interest. Nearly 55 per sent of the 44 companies replying stated that they were in favor of the committee's classification of accounts. The machine-hour rate of distributing the factory overhead expenses is employed by 16 of the companies and one percentage of direct labor for the entire plant is in use in 14 companies. In the distribution of administrative, general and selling expenses to costs apply a percentage of the factory costs while seven combine these expenses with the shop overhead and make the distribution as a percentage if the direct labor. The committee is of the opinion that the shop overhead expenses should be distributed to machines, groups of machines or manufacturing departments and that such expenses as special tools and patterns should be charged direct to the job for which they are made or purchased. The committee recommended that commercial expenses be distributed on a percentage of factory cost basis.

The report of the Herringbone Gear Sub-Committee on a recommended practice providing for tooth calculation on the basis of diametral pitch in the plane of rotation was approved. However, it is not likely that this practice will be broadly followed until the committee has submitted recommendations to make it possible for gear makers to use certain standard stock hobs in cutting according to the new standard.

An interesting feature of the meeting was an inspection trip to the Gleason Works, where a number of new machines were seen in operation.

National Machine Tool Builders' Association

The National Machine Tool Builders' Association held its annual meeting in New York City, October 18, 19 and 20. In his report August H. Tuechter, president, reviewed the history of the association, and discussed the general lines of work which he believed it should follow.

The report of the general manager, Ernest F. DuBrul, dealt with association activities in general, with particular reference to statistical service, giving suggestions for the improvement of the business-barometer charts which the association has been issuing every month.

Mr. DuBrul, Prof. David F. Jordan of New York University, and C. L. Cameron of Gould & Eberhardt, Newark, N. J., discussed business cycles, especially as affecting machine-tool builders. Hon. Charles L. Underhill, congressman from Massachusetts, spoke on the subject of How Present Political Policies Affect Business.

W. H. Rastall, chief of the Industrial Machinery Division, U. S. Dept. of Commerce, and J. H. Drury, treasurer, Union Twist Drill Co., Athol, Mass., told of the conditions in the machine-tool industry in the Orient and in Europe, respectively. J. E. Andress, secretary, Barnes Drill Co., Rockford, Ill., discussed the granting of long-term credit with proper guarantees or insurance in foreign trade.

H. L. Flather, treasurer, Flather & Co., Inc., Nashua, N. H., discussed the possibility of utilizing machine-tool plants during slack times, and E. M. Brotherhood, vice-president, Manning, Maxwell & Moore, Inc., New York, expressed his opinion on the possibilities of reduction in the cost of machine tools in 1922.

Mr. Teuchter will continue to serve as president, and Mr. DuBrul as general manager; H. W. Dunbar, sales manager, the Norton Company, Worcester, Mass., was elected secretary to succeed Carl F. Dietz, resigned. The next Spring Convention will be held at Atlantic City.

(Continued on page 836)

Economics of Bridgework

Economics of Bridgework. By Dr. J. A. L. Waddell, John Wiley & Sons, Inc., New York, 1921. Cloth, 6×9 in. 512 pp., illus., $6.

Although written primarily for bridge specialists, as the author informs us, this book is not unworthy of some consideration by the mechanical engineer, for of the forty-five chapters at least twelve are of wider application than may have been intended in their conception. Economics of Bridgework may be read with profit by the electrical and mechanical as well as the civil engineer.

There is much food for thought and doubtless for experimentation in the chapter on alloy steels. Some of the data given seem fairly well substantiated, others are more or less problematical and require the corroboration of actual analysis.

The names chosen for some of the proposed alloys are weird to say the least, "chrovanmol," "nichro," etc., reminding one of the "Jabberwock" of Alice's Adventures; but if an alloy of chromium vanadium and molybdenum can be commercially produced to develop without heat treatment and without excessive cost, the characteristics assigned to it by the author, among them 170,000 lb. elastic limit, it should make great changes in the weights of engineering structures, and we can forgive it its name.

As the author himself says, his chapter dealing with the economics of operating machinery and power is "limited to a dissertation covering general conditions and the offering of a few pertinent suggestions." Among the latter a few are particularly worthy of note.

The author highly recommends as his ideal apparatus "two high-speed gas engines each with hydraulic transmission gear and worm gear, the two engines together sufficient to operate the bridge at maximum required speed, and one alone (by means of the hydraulic reducing gear) capable of running it at a slower speed." It would appear that there should be a field for such apparatus but that the use of the worm drive should be limited to fairly small units, operating at sufficiently high speed to allow of a reasonably efficient worm design. Where electric power is not available, the gas engine seems to offer the best source of power, but the control features possible with the former, such as limit switches, interlocks, etc., while perhaps not impossible with the latter, are certainly not so elastic of application or so practicable.

In closing his chapter on Economics of Operating Machinery, the author justly criticises a practice among engineers of covering the design of the machinery for movable bridges by a general specification not necessarily applicable to the specific case in hand, thus producing mechanism far too heavy for actual needs. He refers to the requirement that brakes on bascule spans be designed to resist a wind of fifteen or twenty pounds per square foot on the area of the open leaf in cases where no such condition is at all likely to exist due to protection from surrounding hills, and without any allowance for increase in unit stresses for such a condition. This point is certainly very well taken.

The book is full of good suggestions and is a fitting supplement to the author's monumental work, Bridge Engineering.—H. P. Van C.

Analytical Mechanics for Engineers. By Fred B. Seely and Newton E. Ensign. John Wiley & Sons, Inc., New York, 1921. Cloth, 6 × 9 in., 486 pp., diagrams, $4.

The aim in this book has been to make the principles of mechanics stand out clearly, to build them up as much as possible from common experience, to apply the principles to concrete problems of practical value, and to emphasize the physical rather than the mathematical interpretation of them. Statics, kinematics and kinetics are included, the two latter being developed with regard for the increasing importance of dynamics to engineers. The treatment of kinetics, while extensive, has been restricted to the more common types of motion found in engineering practice.

Berichte Und Abhandlungen der Wissenschaftlichen Gesellschaft Fur Luftfahrt. (Beihefte zur "Zeitschrift Flugtechnik und Motorluftschiffahrt.") R. Oldenbourg, Munich, 1921. Paper, 9 × 12 in., 81 pp., illus., 32 marks.

This supplement contains the proceedings of the sixth meeting of the Society, at Charlottenburg, October 15, 1920. In addition to the official actions of the meeting, it contains the technical papers presented, which treat of the relation between the design of power plants for aircraft and safety in flight. The results of research in aerology and atmospheric electricity by flights, the formation of eddies by planes and advances in space telegraphy and telephony.

Chemical and Metallographic Examination of Iron, Steel and Brass. By William T. Hall and Robert S. Williams. First edition McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 5 × 8 in. 501 pp., illus., $5.

This work is divided into two parts. The first gives a careful selection of methods for the chemical analysis of iron and steel, brass and bronze. Special attention is given to explanation of the chemical reactions involved in the methods given and to the discussion of their accuracy. Emphasis is placed on those that are both accurate and rapid. Part two considers the physical inspection of metals. In it the methods for preparing and examining polished surfaces are described. A brief introduction to metallography, as applied to the inspection of alloys, is included.

Drawing Room Practice. By Frank A. Stanley. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 253 pp., illus., $2.50.

This book deals with the making of drawings, from the simplest constructions to complete assembly and working drawings of various classes. It is based on experience in a number of leading American and European drawing rooms, and in teaching students. The difficulty in visualizing the work represented by a drawing, which many students undergo, has led the author to present photographs of the objects represented by the working drawings discussed in the book.

Economic Aspects of the Great Lakes-St. Lawrence Ship Channel, By Roy S. MacElwee, Alfred H. Ritter. The Ronald Press Co.. New York, 1921. Cloth, 6×9 in., 291 pp., maps, tables, $4.

This work is a study of the local and national advantages to be gained from opening the Great Lakes to ocean traffic. It attempts to coördinate the information on the commercial and economic aspects of the proposed ship channel, as presented at the hearings held throughout the country by the International Joint Commission and to present the vital facts affecting the advisability of the construction of the proposed improvement.

Grinding Machines and Their Use. By Thos. R. Shaw. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Technical primer series.) Cloth, 4×6 in., 114 pp., illus., $0.85.

A concise review of the main principles of workshop precision grinding, based on long experience in the design and construction of grinding machines and close observation of their utility. Suitable as an introduction to the subject.

Manhood of Humanity. By Alfred Korzybski. E. P. Dutton & Co., New York, 1921. Cloth, 6 × 8 in., 264 pp., $3.

This book is primarily a study of man and ultimately embraces all the great qualities and problems of man. The author approaches the problem from a mathematical, an engineering, point of view, with the object of ascertaining what man's real nature is and what the basic laws of his nature are, and hopes thus to point the way to a science of directing human energies and capacities to the advancement of human welfare.

The Mechanical Production of Cold. By Sir J. A. Ewing. Second edition. University Press, Cambridge, 1921. Cloth, 6 × 9 in., 204 pp., diagrams, $8. (Gift of The Macmillan Co., N. Y.)

This book contains the "Howard" Lectures delivered before the Society of Arts in 1897, as revised and reprinted in 1908. It provides a general account of refrigeration, in which stress is laid on the thermodynamic aspect of the subject, and an attempt is made to render this aspect intelligible without unnecessary mathematics.

The changes in this edition are the correction of certain errata and the clearing up of some obscure points.

Mechanics. By James E. Boyd. First edition. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 417 pp., diagrms., $3.50

Intended to give a working knowledge of the principles of mechanics and to supply a foundation upon which intelligent study of the strength of materials, stresses in structures, machine design and other more technical courses may rest. In the development of the subject, emphasis is put upon the physical character of the ideas expressed.

Mechanism. By Robert McArdle. McGraw-Hill Book Co., Inc., New York, 1921. Cloth, 6 × 9 in., 173 pp., illus., diagrms., $2.25.

A brief course for students of engineering. Commences with a short discussion of motions and velocities, which is followed by a study of linkages, cams, gearing, belting and intermittent motions. In this revision difficult points have been made clearer and many problems have been added.

Modern Building Superintendence and the Writing of Specifications. By David B. Emerson. Charles Scribner's Sons, New York, 1921. Cloth, 4 × 7 in., 247 pp., $1.75.

This volume is intended to aid the young engineer in superintending construction and in writing building specifications. The author outlines, step by step, the duties of the superintendent during the erection of a typical modern twenty-story office building, calling attention to the matters that must be watched. In similar fashion, he outlines the proper procedure in writing specifications for a small dwelling.

Modern Central Stations. By Charles W. Marshall. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Technical primer series.) Cloth, 4 × 6 in., 115 pp., illus., $0.85.

A brief description of the principal features of British central-station practice, intended for young engineers. Includes the coal- and ash-handling plant, boiler house, engine room, switch and protective gear, plant operation and testing.

Oil Flow in Pipe Lines. By R. S. Danforth. King Knight Co., San Francisco, 1921. Paper, 9 × 12 in., 12 pp., charts, $3.

These charts have been compiled to facilitate the solution of problems in oil pumping. They are derived from the formulas and method of computation used by the author in his monograph entitled Friction Losses in Oil Pipe Lines and are based on the law of the flow of liquids in pipe lines deduced at the National Physical Laboratory of Great Britain. The charts will apply to the flow of any liquid or gas in cases where the inside surface of the pipe is of the roughness ordinarily found in oil-pipe lines.

The Orifice Meter and Gas Measurement. By Willis C. Brown and Malcolm B. Hall. The Foxboro Co., Inc., Foxboro, Mass., 1921, Cloth 5 × 8 in., 112 pp., tables, illus., $3.50.

This book, published by the manufactures of the first commercial orifice meter, gives authentic information on orifice coefficients and their derivation, together with complete details of the mechanical construction of their own meter.

Power House Design. By Sir John F. C. Snell. Second edition. Longmans, Green & Co., New York, 1921. (Electrical engineering series.) Cloth, 6 × 9 in., 535 pp., illus., diagrams, tables, $14.

In preparing this book, the author has drawn upon his own experience of over twenty years and has collected and classified the experience of other engineers. The information thus acquired has been carefully sifted and condensed in the present volume, which the writer believes to contain all the requisite practical information on its subject. The principles and information given cover the design and equipment of central stations and isolated plants for supplying light and power to cities, factories, mines, railroads, etc., and are accompanied by typical examples of modern installations. This edition has been thoroughly revised and to a considerable extent rewritten

Pneumatic Conveying. By E. G. Phillips. Sir Isaac Pitman & Sons, Ltd., London and New York, 1921. (Technical primer series.) Cloth, 4 × 6 in., 108 pp., illus., $0.85.

A general survey of the information available on machinery and methods form handling coal, ashes, grain and other heavy solids, with brief references to air-lift pumping, vacuum cleaning, etc.

Wirtschaftliches Schleifen. Compiled by G. Schlesinger. Julius Springer, Berlin, 1921. Paper, 9 × 12 in., 103 pp., illus., 24 M.

A collection of essays on grinding machines and processes, based on German and American shop practice, and intended to call attention to the advantages of grinding, its use for various purposes, the machines employed, and the methods used. The articles first appeared in Vols. 11 to 15 of *Werkstattstechnik*.

NEWS OF OTHER SOCIETIES

(Continued from page 834)

Industrial Relations Conference

An industrial relations conference was held at Harrisburg, Pa., Oct. 24–27, under the auspices of the Pennsylvania State Department of Labor. Among the speakers were L. W. Wallace, executive secretary of American Engineering Council, representing The Federated American Engineering Societies, who discussed industrial waste from the standpoint of unemployment, and Dr. John M. Thomas, president of Pennsylvania State College, who dealt with industrial education in college and university.

Industrial Relations Association of America

The annual convention of the Industrial Relations Association of America was held in New York City November 1–4, 1921. During the first three days there were a number of important round-table discussions, and sectional meetings dealing with some of the problems of the various industries in handling personnel. Business conditions, the basic principles of sound employment practice, department costs, fundamental principles of human relations in industry, unemployment, essential labor statistics and their uses, and determination of wage rates were among subjects discussed at other sessions. Magnus W. Alexander, managing director of the National Industrial Conference Board, George E. Roberts, vice-president of the National City Bank, W. H. Nichols, Jr., president of the General Chemical Company, C. R. Dooley and C. J. Hicks, of the Standard Oil Company, E. B. Merriam, director of industrial relations of the General Electric Company, and Loyall A. Osborne, president of the Westinghouse Electric Company, were among the speakers at these sessions.

The last two days of the convention were held in conjunction with the Academy of Political Science. There were five main sessions, three on Nov. 4 and two on Nov. 5. The first two considered the subjects of personnel work and coöperation within industrial plants and industry-wide coöperation.

One of the most important of these joint sessions was that held on Friday evening, Nov. 4, dealing with good-will and coöperation in industry. The presiding officer was Herbert Hoover, who called attention to the growing tendency on the part of the public to demand that its interests be heard in the settlement of strikes, and emphasized the importance of making such demands in a way which will secure good-will as well as justice. B. Seebohm Rowntree, York, England, discussed conditions essential to industrial coöperation from a British employer's point of view, while Hugh Frayne, general organizer, American Federation of Labor, dealt with the worker's point of view. Industrial coöperation in Canada was the subject of an address by Hon. G. C. Robertson, Minister of Labor, Ottawa, Canada. Secretary of Labor Davis, in an address on government counselors and efforts to promote coöperation, stated as his belief that the living wage was not enough and that the country is benefited if its workmen are able to save.

The two sessions on Nov. 5 covered industrial relations in governmental employment and in financial institutions, and governmental and other organized counsel for the better promotion of industrial relations. Personnel work in the Post Office Department, Rock Island Arsenal, prisons and state institutions, Federal Civil Service, and financial institutions were considered at the first of these sessions. At the second, Alexander C. Brown, president of the Brown Hoisting Machinery Co., Cleveland, and president of Cleveland Chamber of Commerce, discussed the part of the chamber of commerce in promoting better industrial relations, and D. S. Kimball, dean of the College of Engineering, Cornell University, president-elect, A.S.M.E., the part of the universities and technical schools. Other speakers outlined specific work being carried on in Philadelphia and New York.

THE ENGINEERING INDEX

(Registered U. S. Patent Office and Canadian Patent Office.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photostatic copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents per page, plus postage. A separate print is required for each page of the larger periodicals, but wherever possible two small or medium-sized pages will be photographed together on the same print. The bill will be mailed with the print. When ordering photostats identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ABRASIVE WHEELS

Selection and Grading. Grinding Wheels, James Shaddock and Alfred Herbert. Eng. Production, vol. 3, no. 48, Sept. 1, 1921, pp. 198–200, 2 figs. Notes on selection and grading. Gives list of wheels suitable for use on Norton machines for external grinding, and on Heald machines for internal grinding.

ACCOUNTING

Power Plants. Power-Plant Accounts—I, II, III, IV and V, Wilfred E. Miller. Power, vol. 54, nos. 11, 12, 13, 14 and 15, Sept. 13, 20, 27, Oct. 4 and 11, 1921, pp. 408–410, 448–451, 489–491, 528–530 and 558–560, 13 figs., Sept. 13: Tells what accounting is and shows how to keep records of labor, fuel, water, lubricants, ash removal, repairs, scale removal, etc. Sept. 20 and 27: Use of journal and ledger. Oct. 4 and 11: Indirect expense.

AERODYNAMICS

Air-Flow Theory. Recent Progress in the Aerodynamic Air-Flow Theory (Die neueren Fortschritte der flugtechnischen Strömungslehre), L. Prandtl. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 37, Sept. 10, 1921, pp. 959–965, 16 figs. Notes on recent development of hydrodynamic theory of air resistance. Points out that Newton theory is not in accordance with actual behavior. Motion of air resembles that of a volumetrically constant liquid. Most important laws for such flows are presented, and their application to airship bodies and airplane surfaces explained. Tests are said to confirm results of investigation.

AERONAUTICS

Technical Problems. Some Technical Problems in Aeronautics. Mech. Eng., vol. 43, no. 8, Aug. 1921, pp. 526–528 and 562, 8 figs. Aluminum cylinder castings, air-cooled airplane engines, airplane carburetors and radiators, aerial photography, machine-gun synchronizers, etc., as discussed at joint visit of Am. Soc. Mech. Engrs. and Soc. Automotive Engrs. to McCook Field.

AEROPLANE ENGINES

Benz. The 300-hp. Benz Aircraft Engine, A. Heller. Flight, vol. 13, no. 32, August 11, 1921, pp. 537–542, 34 figs. Describes in detail latest type made by Benz & Co. Engine has 12 cylinders of 135 mm. bore and 150 mm. stroke. Trans. from Zeit. des Vereines Deutscher Ingenieure.

Comparative Data. Comparative Aircraft Engine Data. Automotive Industries, vol. 45, no. 10, Sept. 8, 1921, p. 457. Gives figures as to power of engines, compression ratio, fuel consumption, mean effective pressures, weight per hp. working stresses, etc. From La Technique Moderne.

Laboratory, Testing. A Laboratory for Aircraft Engine Testing, Herbert Chase. Automotive Industries, vol. 45, no. 11, Sept. 15, 1921, pp. 520–522, 3 figs. Describes laboratory of Wright Aeronautical Corp. and their facilities for testing engines.

Types. Aero Engines, Alan E. L. Chorlton. Jl. Roy. Soc. Arts, vol. 69, no. 3589, Sept. 2, 1921, pp. 689–705, 17 figs. Discusses various types of engines and gives tables of test data of leading engines in 1914, both British war office trials and German aeroplane engine trials.

AEROPLANES

Balancing. The Design of Aeroplane Control Surfaces, with Special Reference to Balancing, H. B. Irving. Aeronautical Jl., vol. 25, no. 130, Oct. 1921, pp. 537–555, 13 figs. Discusses three methods of balancing, all of which have been adopted in varying measure in practice: The "horn" method; "backward hinge" method; and Avro patent method.

Barnhart Twin 15. The Barnhart Twin 15 "Wampus-Kat." Aviation, vol. 11, no. 11, Sept. 2, 1921, pp. 309–311, 2 figs. Airplane built by C. R. Little; 180 hp.; gives data and describes principal features.

Bristol 10-Seater. The "Bristol" Ten-Seater Airplane. Aviation, vol. 11, no. 8, August 22, 1921, pp. 229, 1 fig. Gives dimensions, weights, loading and performance data; 450-hp. Napier engine.

Commercial. The Commercial Airplane, L. B. Lent. Aviation, vol. 11, no. 7, August 15, 1921, pp. 188–189. Discusses speed, carrying capacity, distribution of load, etc.

Handley-Page. The Handley-Page Airplane V/1500 (Das Handley Page-Flugzeug V/1500). Motorwagen, vol. 24, no. 23, Aug. 20, 1921, pp. 474–476, 3 figs. Discusses its salient features and compares it with German machines of similar type.

Helicopters. See HELICOPTERS.

Landing. The Manoeuvres of Getting Off and Landing, R. M. Hill. Aeronautical Jl., vol. 25, no. 130, Oct. 1921, pp. 510–536, 2 figs. Discusses factors influencing getting off and landing, and experiments with mechanical devices to assist landing, such as the Palethorpe tail skid and the Noakes ground indicator.

Safety Factors in Design. Safety Factors in Airplane Design, Alfred S. Niles. Eng. News-Rec., vol. 87, no. 12, Sept. 22, 1921, pp. 490–491. Reasons for adoption of low factors based on abnormal conditions. Successful use of long columns.

Single-Engined Cabin. Single-Engined Cabin Airplanes, Donald W. McIlhiney. Aviation, vol. 11, no. 13, Sept. 26, 1921, pp. 364–365, 1 fig. Includes table giving data concerning forty-two machines of this type.

Struts. Non-Injurious Ultimate-Strength Tests for Interplane Struts, E. R. Maurer. Jl. Soc. Automotive Engrs., vol. 9, no. 3, Sept. 1921, pp. 201–207, 10 figs. Describes direct test by subjecting the strut to ordinary test for maximum load, and indirect test, consisting in making a simple bending test for certain data.

Zeppelin-Staaken. The Monoplane "Zeppelin-Staaken" (Le Monoplan "Zeppelin-Staaken"), E.-H. Lemonon. L'Aerophile, vol. 29, no. 13–14, July 1–15, 1921, pp. 203–208, 12 figs. Gives data of dimensions and tests and describes main features; has 4 Mayhach 290-hp. engines.

AIRCRAFT

High-Altitude. High Altitude Aircraft of the Future, C. Eberhardt. Automotive Ind., vol. 45, no. 9, Sept. 1, 1921, pp. 418–420, 3 figs. Discusses possibility of keeping engine output constant at high altitudes. Translated from Der Motorwagen.

AIRCRAFT CONSTRUCTION MATERIALS

Plywood. Making Plywood in South Africa. So. African Jl. of Industries, vol. 4, no. 7, August 1921, pp. 613–618, 5 figs. Discusses preparation of logs, peeling process, gluing of sheets, uses of plywood, etc.

AIRSHIPS

Transatlantic. Airships for a Transatlantic Service, Ralph Upson. Aviation, vol. 11, no. 13, Sept. 26, 1921, pp. 374–376, 1 fig. Discusses advantages and disadvantages and works out average flying data for New York-London routes.

ALCOHOL

Corncobs as Source. A Fermentation Process for the Production of Acetone, Alcohol, and Volatile Acids from Corncobs, W. H. Petersan, E. B. Fred and J. H. Verhulst. Jl. Industrial & Eng. Chem., vol. 13, no. 9, Sept. 1921, pp. 757–759. Concludes that corncobs may be utilized to produce acetone, ethyl alcohol, formic acid, and acetic acid, by fermenting a syrup made from corncobs by hydrolysis with dilute sulphuric acid.

Fuel. Alcohol as a Combustion Fuel, E. C. Freeland and W. G. Harry. Sugar, vol. 23, no. 9, Sept. 1921, pp. 474–476. Concludes that alcohol is destined to supplant gasoline. (Continuation of serial.)

Molasses as Source. Use of Alcohol Made From Final Molasses As Motor Power in Cuba, R. G. Tillery. La. Planter & Sugar Manufacturer, vol. 67, no. 9, August 27, 1921, pp. 142–143.

ALIGNMENT CHARTS

Principles and Uses. The Alignment Chart, C. W. Crockett. Automotive Industries, vol. 45, no. 13, Sept. 29, 1921, pp. 614–618, 5 figs. Exposition of principles underlying construction of alignment charts. Used for graphical representation of many mathematical relations.

ALLOY STEEL

Heat Treatment. Three Types of Alloy Sheet Steel—II and III, Horace C. Knerr. Iron Age, vol. 108, nos. 11 and 12, Sept. 15 and 22, 1921, pp. 655–658 and 725–728, 7 figs. Sept. 15: Details of heat treatment necessary to attain highest tensile strength; hardness and other data. Sept. 22: Electric and acetylene welding details and their effect on physical properties; chrome-vanadium steel adopted.

ALLOYS

Metamorphosis. Metamorphosis in Metal Alloys (Ueber Umwandlungen an Metallegierungen), F. Hauser. Zeit. für Physik, vol. 5, no. 4, June 23, 1921, pp. 220–226, 7 figs. Writer has succeeded in following process of transformation, occurring in certain metals and alloys after congealing, under a metal microscope and of making photographic reproductions thereof.

Physical Properties. Thermal, Electrical and Magnetic Properties of Alloys, Alpheus W. Smith. Jl. Franklin Inst., vol. 192, nos. 1 and 2, July and Aug. 1921, pp. 69–105 and 157–202, 57 figs. Deals with metals insoluble in each other, completely soluble in each other, with limited solubility in each other, and forming compounds with each other. Notes on change of thermoelectromotive force with temperature; theories of resistance and thermoelectric forces, and resistance and hardness.

White-Metal Bearings. White Metal Bearing Alloys, John R. Freeman, Jr. and R. W. Woodward. Metal Ind., vol. 19, no. 9, August 26, 1921, pp. 149–

Note.—The abbreviations used in indexing are as follows:
Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

152, 3 figs. Discusses design of new apparatus and results of tests to determine mechanical properties in compression and Brinell hardness at elevated temperatures. Technologic paper Bur. Standards, No. 188.

[See also ALUMINUM ALLOYS; BEARING METALS; BRASS; BRONZES; COPPER ALLOYS; MAGNESIUM ALLOYS; NICKEL ALLOYS; ZINC ALLOYS.]

ALUMINUM

Castings. Aluminum Casting, F. A. Livermore. Brass Wld., vol. 17, no. 8, August 1921, pp. 231–233. Discusses hardness and composition of alloys, also welding aluminum.

Uses. Aluminum and Its Uses (L'aluminium et ses applications), Sigma. La Metallurgie, vol. 53, nos. 35 and 36, Sept. 1 and 8, 1921, pp. 1663–1664 and 1701–1702. Discusses its properties and application in aeronautics. (Concluded.)

ALUMINUM ALLOYS

Aluminum-Copper. Aluminum-Copper Alloys, Robert J. Anderson. Am. Electrochemical Soc. advance paper no. 16, for Meeting, Sept. 29–Oct. 1, 1921, pp. 207–236, 1 fig. General information with regard to manufacture, properties, and uses of commercial aluminum-copper alloys employed in United States. Bibliography.

Aluminum-Magnesium-Silicon. The Constitution and Age-Hardening of the Alloys of Aluminium with Magnesium and Silicon, D. Hanson and Marie L. V. Gayler. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 10, 35 pp., 47 figs. Results of investigation, summarized in diagrams, are said to leave little doubt that ageing of these alloys is due to fact that, on quenching, magnesium and silicon are retained, probably in solution, in an unstable condition, from which they tend to revert to a more stable form.

Iron-Pot Melting. Iron-Pot Melting Practice for Aluminum Alloys—IV, Robert J. Anderson. Metal Ind. (N. Y.), vol. 19, no. 9, Sept. 1921, pp. 360–362, 2 figs. Discusses size and capacity of furnaces, furnace linings and their life. (To be continued.)

Production. Experiments in the Production of Alloys for Aluminium Sheets, W. Schulte. Metal Ind. (Lond.), vol. 19, no. 8, August 19, 1921, pp. 131–134. Gives physical properties of a large number of alloys of different composition. Translated from Die Metallbörse.

AUTOGENOUS WELDING

Copper. Autogenous Copper Welding (Autogene Kupferschweissungen), Adolf Bothe. Betrieb, vol. 3, no. 22, Aug. 13, 1921, pp. 689–693, 6 figs. Describes how new or damaged copper engine or boiler parts, even when highly stressed, can be joined together or repaired through autogenous welding, quickly and durably, and with minimum cost.

Autogenous Welding of Copper Locomotive Fireboxes (Autogenschweissung von kupfernen Lokomotivfeuerbüchsen), H. Weese. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 36, Sept. 3, 1921, pp. 945–947, 11 figs. Account of work done in main railway shop in Magdeburg-Buckbau, Germany. Advantages of welding work which can be carried out in short time and without detachment of boiler. Experiences with oxy-acetylene welding. Success of different welding operations.

AUTOMOBILE ENGINES

Crankshafts. The Rolls-Royce Crankshaft, Fred H. Colvin. Am. Mach., vol. 55, no. 12, Sept. 22, 1921, pp. 453–454, 4 figs. Main bearings rough turned, crankpins ground from the rough. Finishing completed unit of crankshaft, flywheel and clutch ring.

Jordan. Important Changes Feature the New Jordan Model, J. Edward Schipper. Automotive Industries, vol. 45, no. 14, Oct. 6, 1921, pp. 654–657, 7 figs. New design of Jordan engine, incorporating chain drive and hollow shaft lubrication. Exposed metal parts are rustproofed.

Machining. Machining Motor-car Engine Flywheels. Machinery (Lond.), vol. 18, no. 465, August 25, 1921, pp. 641–645, 13 figs. Use of vertical automatic lathes for finishing all surfaces at two settings of work.

Pistons. Manufacturing Automobile Pistons in a Jobbing Shop, Robert Mawson. Am. Mach., vol. 55, no. 13, Sept. 29, 1921, pp. 493–496, 11 figs. Manufacturing on small scale made possible in job shop by use of simple tools and fixtures.

AUTOMOBILE FUELS

Alcohol. Production of 95–97 per cent Alcohol for Motor Fuel. Int. Sugar Jl., vol. 23, no. 273, Sept. 1921, pp. 513–516, 1 fig. Describes improved triple column continuous still made by Blair, Campbell & McLean of Glasgow for production of Natilite.

See also ALCOHOL.

Producer Gas. Producer Gas as a Fuel for Automotive Vehicles, P. M. Heldt. Automotive Industries, vol. 45, nos. 10 and 11, Sept. 8 and 15, 1921, pp. 461–464 and 507–511, 7 figs. Discusses theoretical and practical aspect of possibility of operating truck or similar internal-combustion engines on gas derived directly from coal. Describes three British systems and their method of operation.

[See also GASOLINE.]

AUTOMOBILES

Air-Propeller-Driven. Air Screw Drive for Cars, W. F. Bradley. Autocar, vol. 47, no. 1351, Sept. 10, 1921, pp. 448–449, 4 figs. Describes recent developments with wind cars in Paris.

Australian Use. A Car Especially Designed for Use in Australia. Automotive Ind., vol. 45, no. 9, Sept. 1, 1921, pp. 409–410, 3 figs. Designed to meet tropical climate and adverse road conditions.

Horstman. The 10.5 Hp. Horstman Chasis. Automobile Engr., vol. 11, no. 153, August 1921, pp. 273–277, 13 figs. Original detail design and full cantilever springing fore and aft.

Hudson. Refinements in Control Characterize the New Hudson, J. Edward Schipper. Automotive Industries, vol. 45, no. 13, Sept. 29, 1921, pp. 604–606, 8 figs. Clutch and brake controls and steering gear have been redesigned to facilitate ease in handling; carbureter air is preheated.

G. Irat. The G. Irat Car (La voiture G. Irat), A. Contet. La Vie Automobile, vol. 17, no. 763, August 25, 1921, pp. 293–295, 6 figs. Designed for greatest economy without sacrificing speed. Four cylinder engine 70 × 130.

Interaction of Wheels, Springs and Roads. Holding The Road, J. L. Napier. Automobile Engr., vol. 11, no. 153, August 1921, pp. 266–272, 12 figs. Discussion of fundamental principles affecting interaction of wheels, springs and roads.

Machining Methods. Special Fixtures in the Peerless Shop. Am. Mach., vol. 55, no. 14, Oct. 6, 1921, pp. 549–550, 7 figs. Milling fixtures for continuous work; fixture for grinding ball ends; radius milling and threading; drilling connecting rods.

Plywood Bodies. Plywood as Material for Automobile Body Construction, Armin Elmendorf. Automotive Ind., vol. 45, no. 9, Sept. 1, 1921, pp. 414–417, 8 figs. Discusses waterproof glue development and advantages of plywood.

Rear-Axle Casing. Machining Rear Axle Casings. Machinery (Lond.), vol. 18, no. 470, Sept. 29, 1921, pp. 781–786, 11 figs. Discusses methods of machining a malleable iron casting for motor rear-axle casing. Production costs.

Rear-Axle Housing. Machining Two Peerless Rear-Axle Parts, Fred H. Colvin. Am. Mach., vol. 55, no. 13, Sept. 29, 1921, pp. 510–512, 9 figs. Notes on machining and assembly of rear-axle housing; fixtures used in production brake spider.

Repairing Methods and Equipment. Automotive Service Methods and Equipment, Howard Campbell. Am. Mach., vol. 55, no. 16, Oct. 20, 1921, pp. 619–623, 11 figs. Tools and methods used at New York Packard service plant, including testing fixtures, special reamers and other tools. "Maximum estimate" system.

Rhode Light Car. The Rhode Light Car. Auto, vol. 26, no. 37, Sept. 15, 1921, pp. 797–800, 11 figs. A 10-hp. car built by Mebes & Mebes, London, W. Describes engine (four-cylinder monoblock type with overhead valves inverted in detachable bead), transmission, suspension, and equipment.

Rover Runabout. Engineering Features of a Popular British Runabout, M. W. Bourdon. Automotive Ind., vol. 45, no. 9, Sept. 1, 1921, pp. 404–406, 3 figs. Describes 8-hp. air-cooled Rover.

Shop Practice, Daimler. The Works of the Daimler Co., Ltd. Automobile Engr., vol. 11, no. 153, August 1921, pp. 285–290, 20 figs. Interesting examples of shop practice on special work, at Coventry, Eng.

Suspension. Acme Spring Suspension. Autocar, vol. 47, no. 1350, Sept. 3, 1921, pp. 427–428, 4 figs. Describes three cantilever spring system for insulation from rough shocks.

Suspensions for Automobiles (Le problème de la suspension des voitures automobiles), M. Broulhiet. Révue de l'Industrie Minérale, no. 17, Sept. 1, 1921, pp. 93–100, 7 figs. It is shown that perfection can be attained in this as well as in other parts of automobile. (Concluded.)

Wheels. The Production of Pressed Steel Wheels Is Successfully Accomplished, J. Edward Schipper. Automotive Industries, vol. 45, no. 14, Oct. 6, 1921, pp. 668–671, 9 figs. Describes the various operations required in fabricating Gier pressed steel disk wheel.

[See also CARBURETORS.]

AVIATION

Civil. Developing a Ground Organization for Civil Aviation—II, W. F. Bradley. Automotive Industries, vol. 45, no. 13, Sept. 29, 1921, pp. 622–626, 6 figs. Discusses commercial aviation in France based on system of government subsidies. Particulars of air traffic; diagrams of 1st, 2nd, 3rd and 4th class landing fields. (Concluded.)

European Air Routes. The European Air Traffic Network (Das europäische Luftverkehrsnetz), George P. Neumann. Verkehrstechnik, vol. 38, May-June, 1921, pp. 218–221, 1 fig. Includes map showing air routes already in operation and those for which preparations have been made.

Future Prospects. The Future of Aerial Transport in the Public Services (L'Avvenire dei Trasporti Aerei Nei Servizi Pubblici), Umberto Nobile. Giornale del Genio Civile, vol. 59, May 31, 1921, pp. 270–304, 1 fig. Discusses security of aeroplanes, aerotransports and dirigibles; regularity of service; cost of aerial transportation compared with other systems; replacing of aerial material; etc.

B

BALANCING

Unbalance, Static and Dynamic. Four Years of Balancing Practice, N. W. Akimoff. Shipbldg. & Shipg. Rec., vol. 18, no. 10, Sept. 8, 1921, pp. 311–314, 6 figs. Discusses static unbalance, dynamic unbalance, obstacles in the development of the art, etc. (From Jl. Am. Soc. Naval Engrs.)

BEARING METALS

Bronze. Bronze for Bearing Metal, E. T. Keenan. Power, vol. 54, no. 9, Aug. 30, 1921, pp. 322–323. States that satisfactory results for general use was obtained with alloy consisting of copper 75 per cent, lead 17 per cent, zinc 5 per cent, tin 3 per cent.

BEARINGS, BALL

Manufacture. Ball and Roller Bearing Manufacture —I, J. D. Scaife. Eng. Production, vol. 3, nos. 52, 53 and 54, Sept 29, Oct. 6 and 13, 1921, pp. 290–293, 314–319 and 340–343, 25 figs. Methods employed. Paper presented before Instn. Production Engrs. Oct. 13: Discussion.

The Ball Bearing: In The Making, Under Test, and on Service, Henry L. Heathcote. Mech. Wld., vol. 70, nos. 1808 and 1811, Aug. 26 and Sept. 16, 1921, pp. 159–161, 3 figs. and 220–222, 3 figs. (Continuation of serial.) Paper read before Instn. Automobile Engrs.

BEARINGS, ENGINE

Machine for Fitting. Lapping and Running-in Machine. Machinery (Lond.), vol. 18, no. 470, Sept. 29, 1921, pp. 791–793, 4 figs. Discusses running-in and lapping processes in connection with fitting automobile engine bearings.

BELTING

Quarter-Twist. On an Irregular Behavior of Ordinary Quarter Twist Belt and Its Prevention, Hosaku Iwaoka. Jl. Soc. Mech. Engrs. & Soc. Nav. Architects, Sept. 1921. (In Japanese.)

BLAST FURNACES

Crane Iron Works, Pa. New Blast Furnace of the Crane Iron Works, Richard Peters. Iron Age, vol. 108, no. 31, Sept. 29, 1921, pp. 814–817, 5 figs.; also Iron Trade Rev., vol. 69, no. 13, Sept. 29, 1921, pp. 803–806, 4 figs. Plant at Catasauqua, Pa., modernized. Coke is now used as fuel. New stack is designed to produce foundry, forge and basic iron from mixture of 65 per cent magnetite ore and 35 per cent non-bessemer Mesabi ore.

Crane Operation. Crane Operating Costs at Blast Furnaces, George L. Collord. Iron Age, vol. 108, no. 15, Oct. 13, 1921, pp. 935–936, 1 fig. Locomotive and ore-bridge cranes shown to save much money, compared with hand methods formerly used. Analyses of costs.

Design. Completes New 600-Ton Blast Furnace in Ten Months. Iron Trade Rev., vol. 69, no. 11, Sept. 15, 1921, pp. 688–693, 6 figs.; also Iron Age, vol. 108, no. 11, Sept. 15, 1921, pp. 673–679, 9 figs. Details of plant of Trumbull-Cliffs Furnace Co. for delivery of hot metal to mixer at open-hearth building of Trumbull Steel Co.

Special Features of Blast Furnace Plant. Iron Age, vol. 108, no. 12, Sept. 22, 1921, pp. 730–732, 2 figs. Auxiliary features of new blast-furnace plant of Trumbull-Cliffs Furnace Co., Warren, Ohio, including methods of firing boilers, regulating blast and of handling water.

St. Louis. Blast-Furnace Plant of the St. Louis Coke and Chemical Company. Iron & Coal Trades Rev., vol. 103, no. 2791, Aug. 26, 1921, pp. 257–258, 6 figs. Describes general equipment. Includes two batteries of 40 coke ovens each.

Zinc. A Blast Furnace for Zinc, Evans W. Buskett. Eng. & Min. Jl., vol. 112, no. 11, Sept. 10, 1921, pp. 409–410. Experiments in smelting of ores under pressure suggested which might result in economies over present methods.

BOILER FEEDWATER

Grease in. Grease in Boiler Feed Water, Edward Ingham. Colliery Guardian, vol. 122, no. 3163, August 12, 1921, pp. 447–448. Explains how grease gets into boiler, its deleterious effect, and how to remove grease.

Softening. Boiler Feed Water Purification—II. Eng. & Indus. Management, vol. 6, no. 9, Sept. 1, 1921, pp. 230–231. Outlines respective merits of various methods used for boiler-feedwater treatment, with special reference to advantage of the Zeolite water-softening process.

Treatment. Boiler Feed Water Treatment and Treatment Control, E. G. Bashore. Combustion, vol. 5, no. 4, Oct. 1921, pp. 163–166. Discusses boiler compounds, feedwater heaters, continuous tank systems, intermittent tank system, zeolite, and internal treatment. (Abstract.) Paper read before Chem. Exposition.

Boiler Water Treatment Plants, Robert June. Blast Furnace & Steel Plant, vol. 9, no. 9, Sept. 1921, pp. 564–566. Formulates specifications for ideal water-purification plants.

The Treatment of Boiler Feed Water, Robert June. Power House, vol. 14, no. 17, Sept. 5, 1921, pp. 21–23, 2 figs. Discusses treatment with boiler compounds, graphite, kerosene, zinc, boiler metal treatment, water softening and purifying systems.

Water Treatment for Boilers, Julian S. Simsohn. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 597–600 and 606, 2 figs. Various methods of water softening. Treatment of excessive concentration of soluble salts in boiler. Corrosion of boilers and economizers due to decomposition of organic compounds at high temperatures accompanying present steam pressures and superheats, etc.

BOILER OPERATION

Control. The Control of Boiler Operation, Walter N. Flanagan. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 9, Sept. 1921, pp. 453–469, 5 figs. Discusses hand and automatic control, a.c. and d.c. drive for auxiliaries.

Efficiency as Affected by Draft. Boiler Efficiency

between efficiency, evaporative power and stokehold air pressure in steam boiler, in light of results of series of twelve exhaustive tests carried out by five authorities upon a marine boiler of Inglis type.

Efficient. Successful Boiler Operation, Guy L. Warden. Combustion, vol. 5, no. 3, Sept. 1921, pp. 116–117. Discusses type of equipment, its arrangement for operation, operators and their instructions, accessories and instruments.

Industrial. The Practical Operation of Industrial Boilers, W. E. Snyder. Mech. World, vol. 70, no. 1811, Sept. 16, 1921, pp. 231–232. Discusses instruments in boiler room and their proper use, training of operators, etc. (Continued.)

BOILER PLANTS

Equipment. Modern Boiler House Arrangement and Equipment, R. M. Gordon. Combustion, vol. 5, no. 4, Oct. 1921, pp. 159–161, 8 figs. Describes boiler plant of Solvay Process Co., an outgrowth of several smaller plants. (Abstract.) Paper read before Chem. Exposition.

BOILERS

Electrically Heated. Electrically Heated Steam Boilers, Eric A. Lof. Power Plant Eng., vol. 25, no. 18, Sept. 15, 1921, pp. 919–920, 3 figs. Electric boiler problem in general does not offer any technical difficulties; used where power is very cheap.

Hand-Fired. Hand-Fired-Boiler Performance in France, Carroll F. Merriam. Power, vol. 54, no. 13, Sept. 27, 1921, pp. 473–474. Contains abstract of report of First Subcommittee of Commission for Utilization of Fuels, published in Revue Générale de l'Électricité; and comparison of American and French boiler performances.

Steam-Heating. Largest Boiler to Supply Steam for Heating, J. H. Walker. Power, vol. 54, no. 13, Sept. 27, 1921, pp. 477–478, 2 figs. Details of saturated-steam boiler unit having 29,820 sq. ft. of steam-making surface, being installed in heating plant of Detroit Edison Co. Volume of combustion chamber, 11,440 cu. ft. Two 14-retort motor-driven underfeed stokers have fuel-burning capacity of 33,600 to 39,200 lb. of coal per hr.

BOILERS, WATER-TUBE

New Designs. The Three New Designs of Water Tube Boilers, Tsuruzo Matsumura. Jl. Soc. Mech. Engrs. & Soc. Nav. Architects, Sept. 1921. (In Japanese.)

BRAKES

Engine-Testing. Air-brakes for Engine Testing, Etc., A. T. Cross. Mech. Wld., vol. 70, no. 1808, August 26, 1921, pp. 168–169, 5 figs. Describes a cheap and simple method of constructing an absorption brake for determining the b.hp. of any size engine.

BRASS

Pickling of Strip. Continuous Pickling of Strip Brass, Wadsworth Doster. Metal Ind. (Lond.), vol. 19, no. 8, August 19, 1921, pp. 137–138, 4 figs. Describes the automatic strip cleaning machine used in brass rolling mills.

Red, Lead in. The Influence of Lead in Red Brass (Der Einfluss des Bleies im Rotguss), J. Czochralski. Zeit. fur Metallkunde, vol. 13, no. 7, Apr. 1921, pp. 171–178, 13 figs. Investigation of its influence on tensile strength, dilatation, hardness, torsional strength, and shock resistance.

Tempering with Tin Content. Tempering Brasses With a Tin Content (La Trempe des laitons à l'étain), Leon Guillet. Revue de Métallurgie, vol. 18, no. 7, July 1921, pp. 445–458, 26 figs. Concludes that one per cent of tin does not have the bad effect on mechanical properties generally attributed to it.

BRASS FOUNDING

Casting of Ingots. The Casting of Brass Ingots, R. Genders. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 3, 4 pp., 2 figs.; also Engineering, vol. 112, no. 2908, Sept. 23, 1921, p. 452, 2 figs. Results of experiments carried out to minimize occurrence of non-metallic inclusions. Describes method involving use of short broad tapered ingots with dozzle feed, by use of which, it is claimed, failures and wastage were considerably reduced.

England. Modern Developments in the British Brass Industry, Ernest A. Smith. Am. Electrochemical Soc. advance paper, no. 24, for Meeting, Sept. 29–Oct. 1, 1921, pp. 301–326. Discusses electric brass furnaces in England; extrusion, hot pressing and forging of brass; rolling-mill practice; annealing; composition of industrial brasses; and treatment and utilization of scrap brass.

BRONZES

Low-Tin. The Effect of Progressive Cold-Drawing upon Some of the Physical Properties of Low-Tin Bronze, W. E. Alkins and W. Cartwright. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 6, 23 pp., 17 figs. Experimental data is summarized in diagrams showing variation during cold-drawing of the three properties, tensile strength, specific volume, and scleroscope hardness.

Manganese. Casting Manganese Bronze Test Bars, E. H. Dix, Jr. Foundry, vol. 49, no. 18, Sept. 15, 1921, pp. 734–736, 1 fig. Discusses several methods of casting and compares results of physical tests.

C

CAR WHEELS

Molding. Molds Car Wheels on Jolt Machines. Systems for transferring molds, flasks and sand.

Novel Mechanical Molding of Car Wheels. Iron Age, vol. 108, no. 11, Sept. 15, 1921, pp. 662–664, 6 figs. Foundry of Brown Car Wheel Works, Inc., Buffalo, N. Y., has moving platform to handle molds from molding machines, through pouring stage and to shake-out machines.

Tires. British Standard Specification for Tramway Tyres. British Eng. Standards Assn., no. 101, July 1921, 11 pp., 7 figs. Includes conversion table from tons to pounds; appendix giving forms of British standard tensile test pieces; and diagram illustrating British standard tires for tramway driving and pony wheels.

CARBURETORS

Zenith Triple-Diffuser. A New Carburetor (Un Nouveau Carburateur), R. Villers. La Nature, no. 2471, August 13, 1921, pp. 100–104, 7 figs. Describes Zenith triple-diffuser carburetor.

CARS

Frames. A Study of Carriage Frames (Etude des Chassis de Wagons), M. Le Touzé. Revue Générale des Chemins de Fer, vol. 40, no. 9, Sept. 1921, pp. 185–205, 11 figs. Calculates stresses in car or carriage frames when over 10–12 in. long and describes successful method of construction by Compagnie de l'Est.

CARS, PASSENGER

Insulation-of. Insulation of Passenger and Refrigerator Cars, Arthur J. Wood. Ry. Mech. Engr., vol. 95, no. 9, Sept. 1921, pp. 547–549. Discussion of principles involved in determining heat transmission under various conditions.

CARS, REFRIGERATOR

Temperature Control. Controlling Refrigerator Car Temperature in Winter Months. Ry. Rev., vol. 69, no. 10, Sept. 3, 1921, pp. 293–297, 9 figs. Department of Agriculture makes practical suggestions for reducing loss and damage to fruit shipped in refrigerator cars during winter months.

CASTINGS

Breaking and Deformation. Breaking and Deformation of Castings Whose Thickness Varies Very Much (Rotture e Deformazione Nei Getti di Ghisa a Spessori Assai Diversi), Piero Gatti. L'Industria, vol. 35, no. 14, July 31, 1921, pp. 319–321, 2 figs. Discusses design, patterns, quality of metal, drill molds.

Specification and Testing. The Specification and Testing of Castings, Walter Rosenhain. Automotive Industries, vol. 45, no. 5, August 4, 1921, pp. 217–219. Analyzes various methods and indicates best practice under present conditions.

CENTRAL STATIONS

Power in Middle West. Location and Distribution of the Central-Station Power of the Middle West, W. L. Abbott. Mech. Eng., vol. 43, no. 7, July 1921, pp. 443–444 and 458, 2 figs. Notes on location of water powers; question of power plants at mine mouth; location of power stations and distribution lines.

CHAIN DRIVE

Roller Chain. The Development of the Roller Chain Drive, G. M. Bartlett. Automotive Industries, vol. 45, no 8, August 25, 1921, pp. 363–366, 6 figs. Discusses changes in design and construction of chains and sprockets and a new form of roller-chain sprocket tooth. From paper presented at meeting of Gear Manufacturers' Assn.

CHROME-NICKEL STEEL

Heat Treatment and Characteristics. Nickel-chromium Steels: Their Heat-Treatment and Characteristics, W. E. Murphy. Machinery (Lond.), vol. 18, no. 465, August 25, 1921, pp. 638–639, 2 figs. Gives mechanical properties; shows effect after oil-hardening and air-hardening.

CHUCKS

Magnetic. Magnetic Chucks Require Careful Mounting, F. Horner. Can. Machy., vol. 26, no. 9, Sept. 1, 1921, pp. 33–35, 7 figs. Mounting can be of permanent or temporary character; magnetic holding faces of chuck must be absolutely correct.

COAL HANDLING

Locomotive Cranes. Economical Coal Handling With Locomotive Cranes, H. D. Fisher. Combustion, vol. 5, no. 3, Sept. 1921, pp. 108–110, 4 figs.

Power Installation. Power Installation at Coverdale Mine, Charles M. Means. Trans. Am. Inst. Min. & Metallurgical Engrs., no. 1101-C, Sept. 1921, 14 pp., 3 figs. Details of coal-handling system installed at Pittsburgh Terminal R. R. & Coal Co.'s new shaft. Main hoist is first Ilgner-Ward-Leonard hoisting installation in Pittsburgh district. Operating conditions: Total lift, 405 ft.; inclination of shaft to horizontal, 90 deg.; weight of cage, 20,000 lb.; weight of load (coal) 10,000 lb., (slate) 16,000 lb.; weight of cars, 5000 lb.

COLD STORAGE

English Docks. The Development of Cold Storage at the Avonmouth Docks, Thomas A. Peace. Cold Storage & Ice Assn. Proc., vol. 17, no. 2, 1921, pp. 17–32 and (discussion) 33–40, 3 figs. on supp. plates. Describes cold storage in various transit sheds, refrigerating machinery in Avonmouth and Royal Edward docks, and electrical arrangements.

Mechanical Handling of Meats and Produce. The Mechanical Handling of Meat and Produce in Cold Storage, S. G. Calladine. Cold Storage & Ice Assn. Proc., vol. 17, no. 2, 1921, pp. 43–50 conveyors used, comparative cost, etc.

Piping for Rooms. Piping Required in Cold Storage Rooms, Benj. J. Masters. Southern Engr., vol. 36, no. 1, Sept. 1921, pp. 38–41. Calculates piping for various conditions.

COMBUSTION

New Theories. New Combustion Theories (Nyare Förbränningsteorier), Hilding Håkanson Teknisk Tidskrift (Veckoupplagan), vol. 51, no. 37, Sept. 17, 1921, pp. 381–387, 6 figs. Discusses theories of Nusselt, Neumann, Aufhäuser.

CONDENSERS, STEAM

Air Pumps for. Recent Improvements in Condensing Apparatus for Steam Engines (Recents perfectionnements des appareils de condensation des machines a vapeur d'eau), L. Jauch. Chaleur et Industrie, vol. 2, no. 16, August 1921, pp. 501–508, 13 figs. Discusses air pumps of various types. (Continuation of serial.)

Scale Prevention. Installations for the Prevention of Scale Formation in Surface Condensers (Anlagen zur Verhütung von Wassersteinbildung in Oberflächen-Kondensationen), Hans Rissmann. Zeit. des Oberschlesischen Berg- u Hüttenmännischen Vereins, vol. 59, no. 6, 1920, pp. 185–205, 33 figs. The Balcke inoculation process as modern protection against incrustation and silting up with mud, and its economic advantages. Process so-called because it renders cooling water immune from influence of scale-producing salts.

Surface. Surface Condenser Operation, George C. Cook. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 365–367. Notes on vacuum decrease with temperature increase; quantity of circulating water required; air and steam distribution; removing deposits from inside surfaces; and other methods of cleaning.

Surface and Jet. Modern Surface and Jet Condensers, K. Hoefer. Eng. Progress, vol. 1, no. 7–8, July-August 1920, pp. 237–242, 14 figs. Describes various types, results of tests, cleaning during running.

Tests of Various Types. Relative Efficiency of Various Types of Condensing Apparatus, Allen F. Brewer and Frank A. Stivers. Mech. Eng., vol. 43, no. 10, Oct. 1921, pp. 672–673. Results of comparative tests carried out on double-pipe coils, submerged coils with and without manifolds, and cooling towers, and of value as guide in selection and design of most efficient type of condenser.

Water-Distributing Device. New Water Distributing Device For Condensers, George M. Kleucker. Ice & Refrigeration, vol. 61, no. 2, August 1921, p. 84, 1 fig. Discusses U. S. Patent 1,291,926.

CONNECTING RODS

Machining. Machining Connecting Rods. Machinery (Lond.), vol. 18, no. 369, Sept. 22, 1921, pp. 759–763, 13 figs. Manufacturing methods employed by Austin Motor Co., Longbridge Works, Birmingham, for producing balanced connecting rods.

COPPER ALLOYS

Copper-Zinc. The Density of the Copper-Zinc Alloys, T. C. Bamford. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 4, 12 pp., 4 figs. Results of investigation of both chill and sand-cast billets show that with only one exception the densities of sand-cast specimens are less than those of chill-cast ones.

COST ACCOUNTING

Mechanical. Cost Accounting by Machinery, E. W. Workman. Eng. & Indus. Management, vol. 6, no. 12, Sept. 22, 1921, pp. 314–318, 4 figs. Describes Hollerith systems of mechanical sorting and tabulating, application of these systems to problems of collecting labor and overhead expenses, and applying them to costs of manufactured articles, etc.

Methods. The Necessity of Proper Cost Accounting, J. B. Sehl. Forging & Heat Treating, vol. 7, no. 8, August 1921, pp. 432–434. Methods of distributing expense over product are, the percentage, man hour, sold hour, list percentage and machine rate for production center methods.

Overhead, Allocation of. The Correct Allocation of On-Costs, H. Varley. Eng. & Indus. Management, vol. 6, no. 9, Sept. 1, 1921, pp. 241–242. Where reductions can be made.

Uniform System. Uniform Cost System Use Advised, Robert E. Belt. Iron Trade Rev., vol. 69, no. 13, Sept. 29, 1921, pp. 807–809. Points out benefits to be derived by introduction of such a system; too much detail has proved detrimental. States that accountant should be familiar with manufacturing methods.

CRANES

Harbor. Modern Harbour Cranes, Richard Hänchen. Eng. Progress, vol. 1, no. 6, June 1920, pp. 203–210, 10 figs. Describes slewing, travelling, gantry, and double cranes.

Level Luffing. A Level Luffing Crane. Engineer, vol. 132, no. 3431, Sept. 30, 1921, p. 354, 2 figs. Outstanding feature of crane supplied to Great Western Ry. Co. by Wellman Smith Owen Eng. Corp., Ltd., London, is arrangement provided for moving load along a horizontal path while jib of crane is being luffed, thus saving both time and power in manipulating it.

Operator's Manual. Crane Operator's Manual, L. F. Galbraith. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 9, Sept. 1921, pp. 437–452, 12 figs. Duties

of crane operators, including inspection, reports, operations, etc. (Report of Educational Committee for 1921.)

Shipyard. Mammoth Cranes For Shipyard and Harbour Service, Richard Hänchen. Eng. Progress, vol. 1, no. 11, November 1920, pp. 335–339, 11 figs. Describes stationary cranes, their construction and development, including cantilever jib cranes of 250 tons carrying capacity.

Steam Goliath. 20-Ton Steam Goliath Crane. Engineer, vol. 132, no. 3432, Oct. 7, 1921, p. 381, 2 figs. on p. 374. Built for 60-ft. span with clear lift of 32 ft. Engines are of double-cylinder and boiler of vertical type.

CUTTING TOOLS

Selection and Use. Selection and Proper Use of Cutting Tools. Can. Machy., vol. 26, no. 9, Sept. 1, 1921, pp. 36–40, 15 figs. Discusses design, use in operation, maintenance, etc.

CYLINDERS

Steel, Tests of. Experiments on the Effects of Extremely High Pressures, P. W. Bridgman. Compressed Air Mag., vol. 26, no. 9, Sept. 1921, pp. 10223–10225, 4 figs. Describes experimental tests of tool steel and mild steel cylinders, the former rupturing at 40,000 atmospheres.

D

DIE CASTING

Advantages. Die Casting—I and II, A. G. Hopking. Engineer, vol. 132, nos. 3429 and 3430, Sept. 16 and 23, 1921, pp. 281–282 and 309–311, 5 figs. Description and advantages of die-casting process, and some of its uses.

DIES

Die-Sinking Machines. Die Sinking and Metal Patternmaking by Automatic Machine, Joseph F. Keller. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 584–588 and 606, 16 figs. Discusses dies used for stamping, forging, embossing, pressing, etc. Notes on various methods employed in die sinking; automatic die-sinking machines; duplicating machines; advantages and relative cost of machine-cut dies.

Die-Sinking Machine. Engineering, vol. 112, no. 2905, Sept. 2, 1921, pp. 341–342, 4 figs. Constructed by Bryant Symons & Co., London, for cutting dies used in drop-forging work.

Electrical Terminals and Connectors. Dies for Electrical Terminals and Connectors. Machinery (Lond.), vol. 18, no. 468, Sept. 15, 1921, pp. 733–736, 10 figs. Discusses piercing, trimming and forming dies, and dies for making band clamp ends.

Self-Opening Die Heads. Self-Opening Die Heads. Eng. Production, vol. 3, nos. 51 and 52, Sept. 22 and 29, 1921, pp. 269–274 and 296–300, 35 figs. Design, construction and application.

DIESEL ENGINES

Construction and Lubrication. Diesel Engine Practice—I, A. H. Pritchard. Power Plant Eng., vol. 25, no. 18, Sept. 15, 1921, pp. 901–903, 4 figs. Discusses Diesel oil engine, construction and lubrication.

Ignition. Internal-Combustion Engines, Charles E. Lucke. Power, vol. 54, no. 13, Sept. 27, 1921, pp. 479–483, 18 figs. Ignition problems in semi-Diesel and Diesel oil engines.

Improvements. Innovations in Diesel Engine Construction. Mar. Eng., vol. 26, no. 9, Sept. 1921, pp. 700–701, 1 fig. German builders introducing novelties in Burmeister and Wain design; Blohm and Voss building new double acting engine.

Knocks. Knocks in Diesel Engines, Louis R. Ford. Power, vol. 54, no. 9, Aug. 30, 1921, pp. 327–328. Deals with worn bearing knocks, knocks in valve gear, and within cylinder. Characteristics and causes.

Marine. Diesel and Semi-Diesel Marine Engines—Renault System (Les moteurs Diesel et Semi-Diesel Marine—système Renault), Ch. Dantin. Le Génie Civil, vol. 79, no. 11, Sept. 10, 1921, pp. 221–225, 10 figs. Discusses large increase in heavy-oil engines; describes Renault 300-hp. Diesel and 80-hp. semi-Diesel.

Marine Diesel Engine Operation (La conduite des moteurs Diesel marins), Y. Le Gallou. Bulletin Technique du Bureau Veritas, vol. 3, no. 7, July 1921, pp. 160–163. Studies causes of bad functioning, including air compressors and their influence, lubricating, etc. (Concluded.)

Overhauling. Overhauling an Oil Engine, G. Grow. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 375–377, 7 figs. Author's experience in overhauling a Diesel engine.

DROP FORGING

Design of Parts. The Art of Drop Forging with Examples of Work. Can. Machy., vol. 26, no. 12, Sept. 22, 1921, pp. 25–28, 4 figs. Discusses design of parts, additional strength due to drop forging, etc.

Dies. Design and Making of Drop-forging Dies. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 123–124. Methods of heating, quenching and drawing carbon and alloy-steel dies.

Design and Making of Drop-forging Dies. Machinery (Lond.), vol. 18, no. 469, Sept. 22, 1921, pp. 749–752, 7 figs. Methods employed in modern drop-forging plants; die-sinking machines, two-impression dies, trimming, etc.

Drop Forgings—I. Machinery (Lond.), vol. 18, no. 468, Sept. 15, 1921, pp. 738–739, 3 figs. Discusses quantity required, quality of steel in drop forgings, simplicity or otherwise of dies required, and die cutting or sinking.

DRYING

Methods and Machines. Drying (Das Trocknen), H. Hausbrand. Zeit. des Vereines deutscher Ingenieure, vol. 65, nos. 33, 37 and 38, Aug. 13, Sept. 10 and 17, 1921, pp. 863–868, 966–970 and 994–998, 85 figs. Discusses various different properties of materials affecting their behavior during process of drying. Deals with drying through direct contact with heating surfaces, and with air drying. Schematic presentation of number of devices and machines used in drying.

E

EDUCATION

General, Needs of. General Education and the Engineering Profession, H. E. Miles. Mech. Eng., vol. 43, no. 8, Aug. 1921, pp. 517–520 and 550, 7 figs. Points out lack of vocational schools in United States and need for longer school year. Notes on continuation schools and training of teachers.

EDUCATION, INDUSTRIAL

Training of Metal Workers. The National Metal Trades Association and Industrial Education, Harold C. Smith. Mech. Eng., vol. 43, no. 8, Aug. 1921, pp. 521–522 and 550. Outline of its activities in training of new workers, with opinions of its committee on industrial education regarding apprenticeship, trade and continuation schools, instruction of foremen, training in plant, and vestibule schools.

ELECTRIC DRIVE

Mechanical Difficulties. Reducing Mechanical Difficulties With Motor-Driven Applications, Raoul Pruger and Louis A. Deesz. Elec. Jl., vol. 18, no. 9, Sept. 1921, pp. 408–413, 9 figs. Considers belted, geared, chain-driven and direct-connected drives, cushioned and uncushioned loads, etc.

ELECTRIC FURNACES

Annealing. Design Electric Annealing Furnace, C. E. Chaney. Foundry, vol. 49, no. 18, Sept. 15, 1921, pp. 720–723, 6 figs. Malleable iron is annealed in 42 hours.

Fuel-Fired vs. Comparison of Electric Furnace Practice with Fuel-Fired Furnace Practice, N. K. B. Patch. Am. Electrochemical Soc. advance paper, no. 22, for Meeting, Sept. 29–Oct. 1, 1921, pp. 287–290. Author's experiences are that cost of metal melted, melting losses, and solution of gases in metal, are substantially the same in electric and fuel-fired furnace, provided intelligent operation is pursued.

Girod. Electric Furnaces for Making Steel—VI, Alfred Stansfield. Blast Furnace & Steel Plant, vol. 9, no. 9, Sept. 1921, pp. 550–552, 1 fig. Describes Girod electrode-hearth arc-furnace at Bethlehem Steel Co.

Gray-Iron. Electric Furnace Gray Iron, Jas. L. Cawthon, Jr. Elec. Jl., vol. 18, no. 9, Sept. 1921, pp. 396–400, 4 figs. Discusses economies compared with cupola, addition of silicon, temperature control, etc.

Heat-Treating. Electric Furnaces and Heat Treatment, Edwin F. Cone. Iron Age, vol. 108, no. 11, Sept. 15, 1921, pp. 643–648, 10 figs. Survey of their commercial application to steel and other industries.

Levoz. The Electric Furnace (Le four électrique). Révue d'Electrochimie & d'Electrometallurgie, vol. 15, no. 3–4, March–April, 1921, pp. 57–61. Describes Levoz furnace which is capable of producing a good quality of metal with a minimum expenditure of electric power.

Muffled-Arc-Type. Recent Developments in Electric Furnaces of the Muffled Arc Type, H. A. Winne. Am. Electrochemical Soc., advance paper, no. 19, for Meeting, Sept. 29–Oct. 1, 1921, pp. 263–272, 5 figs. Smaller units of 1500 lb. and 100 lb. per hr. capacity are described in comparison to larger rectangular shell-type furnace. Discusses advantages of muffled-arc furnaces.

Non-Ferrous Metals. The Influence of the Electric Furnace on the Metallurgy of Non-Ferrous Metals, H. M. St. John. Am. Electrochemical Soc., advance copy, no. 3, pp. 55–75. Discusses gradual breaking down of secretiveness as to methods and results, melting of high-quality brass and bronze in ton lots, more convenient and economical handling of charges, etc. (Abstract.)

Progress in 1921. Electric Furnace Progress in 1921, E. T. Moore. Iron Age, vol. 108, no. 12, Sept. 22, 1921, pp. 723–724. Discusses merits of dual voltages for melting steel and for refining. Heat losses and electrodes are considered. Report submitted to Assn. Iron & Steel Elec. Engrs.

Resistance-Type. Electric Resistance Furnaces, E. P. Barfield. Elec. Rev. (Lond.), vol. 89, no. 2286, Sept. 16, 1921, p. 364. Discusses heat treatment of steel by electricity and other applications, power cost, etc.

Resistance Type Electric Furnace in the Melting of Brass and Other Non-Ferrous Metals, T. F. Baily. Am. Electrochemical Soc., advance paper, no. 20, for Meeting, Sept. 29–Oct. 1, 1921, pp. 273–279. Discusses various features to be considered, and summarizes advantages and disadvantages of resistance-type as compared with other types.

Rotary. Rotary Electric Furnace Shows Marked Advantages, Alan D. Dauch. Elec. Wld., vol. 78, no. 12, Sept. 17, 1921, pp. 565–566, 2 figs. This furnace replaces oil-fired furnaces for continuous heat treating, annealing and carbonizing.

Superheats in. Superheats in the Electric Furnace, George K. Elliott. Foundry, vol. 49, no. 18, Sept. 15, 1921, pp. 714–719. Discusses temperature losses, temperature limit for cupola iron, deoxidation, limits of sulphur, etc.

Types. Electric Furnaces, Ezer Griffiths. Beama, vol. 9, nos. 2 and 3, Aug. and Sept. 1921, pp. 145–150, 5 figs., and 254–259, 4 figs. Describes carbon-resistor furnace, vacuum furnace, furnaces for testing refractories and for experiments under high gaseous pressures; arc, induction high-frequency induction and vacuum cathode ray furnaces.

ELECTRIC LOCOMOTIVES

Operating Characteristics. Operating Characteristics of the Electric Locomotive, N. W. Storer. Ry. Rev., vol 69, no. 6, August 6, 1921, pp. 169–173, 5 figs. Discusses changes due to general adoption of electrification and adaptability of electric locomotives.

Swiss. Electric Locomotives of the Bernese Railway (Locomotives électriques des chemins de fer Bernois), Lucien A. -H. Pahin. L'Industrie Electrique, vol. 30, no. 701, Sept. 10, 1921, pp. 328–331. Data on 2–4+4–2 locomotives of 8000 kg. tractive effort, also mechanical and electrical equipment.

Electric Traction in Switzerland. Electrician, vol. 87, no. 2261, Sept. 16, 1921, pp. 348–352, 7 figs. Discusses freight-locomotive details, express locomotives 1-C-1 and 1-B+B-1, freight locomotive 1-C+C-1, and their electrical equipment. (Concluded.)

Vibration of. Diagram of the Vibrations of an Electric Locomotive with Coupling Rods (Diagramm der Schuttelschwingungen einer elektrischen Lokomotive mit Stangenantrieb), A. Wichert. Elektrotechnische Zeit., vol. 42, no. 17, Apr. 28, 1921, pp. 427–430, 2 figs. Torsion diagrams are presented which were taken on an electric locomotive with a single motor after it had been at work 18 months, and which, in author's belief, tend to confirm theories already advanced by him. Various vibrations, as shown on torsion diagram, are examined with view to tracing connection between their periodicity and other variables of problem.

Modern Theories on the Vibration Phenomena of Electric Locomotives with Parallel-Crank Drives (Neuere Theorien der Schüttelerscheinungen elektrischer Lokomotiven mit Paralellkurbelgetrieben), A. Wichert. Elektrotechnische Zeit., vol. 42, nos. 5, 6 and 7, Feb. 3, 10 and 17, 1921, pp. 103–107, 128–132 and 151–154, 19 figs. Gives mechanical analysis and criticism of observations and data made by seven different European authors on complex problems of vibrations of rod-driven electric locomotives. Viewpoints of different writers in their attempt to analyze and remedy dangerous vibrations on such drives.

ELECTRIC WELDING

Oil Tanks. Electric Welding of Oil Storage Tanks, William Schenstrom. Welding Engr., vol. 6, no. 9, Sept. 1921, pp. 49–52, 7 figs. Discusses advantages of welded over riveted, and need for standardized methods. Paper read before Am. Welding Soc.

ELECTRIC WELDING, ARC

Electrodes. Electric Arc Welding With Metal Electrode (Lysbuesvejsning med Metalelektroder), J. Clausen. Teknisk Tidsskrift (Elektroteknisk), vol. 17, no. 32, August 10, 1921, pp. 117–122, 4 figs. Reviews development of this method and discusses quality of electrodes, power required and efficiency of weld. (To be continued.)

ELECTRON METAL

See MAGNESIUM ALLOYS, Electron Metal.

ELEVATORS

Electric. Electric Elevator Machinery—Elevator Cables, Their Care and Inspection, M. A. Myers. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 369–371, 7 figs. Types of elevator rope, machines and accessories. Cable measurement.

Motor-Control Equipment. Motor-Control Equipment Used in Elevator Service—I, G. J. Kirkgasser and E. W. Seeger. Elec. Rev. (Chicago), vol. 79, no. 13, Sept. 24, 1921, pp. 465–468, 8 figs. Machines, roping, brakes and motors employed in operation of elevators; features of magnetic and mechanical controllers; diagrams and illustrations of circuits and control devices. (To be continued.)

EMPLOYMENT MANAGEMENT

Employment System. A Modern Factory Employment System, W. H. Rohr. Wood-Worker, vol. 40, no. 7, Sept. 1921, pp. 27–29, 8 figs. Discusses the question of reducing labor turnover.

Hiring System. Efficient System of Hiring Men, Russel J. Waldo. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 135–137, 7 figs. Methods adopted by large manufacturing plant for insuring selection of applicants best suited for work.

ENGINEERS

Education and. Making Better Engineers of College Men. Elec. Wld., vol. 78, no. 12, Sept. 17, 1921, pp. 567–569. Power to think is more important than mind filled with facts.

The Character of the Engineer. Times Eng. Supp., no. 563, Sept. 1921, p. 259. Discusses natural qualifications and education as training. Believes there is room for all really fit.

ETHYLENE

Preparation from Acetylene. The Preparation of Ethylene by Hydrogenation of Acetylene, William H Ross, James B. Culbertson and J. P. Parsons. Jl. Industrial & Eng. Chem., vol. 13, no. 9, Sept. 1921, pp. 775–778, 3 figs. Discusses preparation

EVAPORATORS

Design. Studies in Evaporator Design—V, W. L. Badger. Chem. & Met. Eng., vol. 25, no. 10, Sept. 7, 1921, pp. 459–463, 5 figs. Experimental data for horizontal-tube evaporator showing relation between hydrostatic head, temperature drop and heat transmission.

EXTRUSION OF METALS

Extrusion Defect. The Extrusion Defect, R. Genders. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 7, 9 pp., 12 figs.; also Engineering, vol. 112, no. 2909, Sept. 30, 1921, pp. 487–489, 12 figs. Describes method which is said to be successful in avoiding formation of extrusion defect, and is in use in many places for production of tubes and rod from soft metals such as lead and aluminum. Writer suggests its use for extrusion of copper alloys.

F

FACTORIES

Hygienic Arrangements. Modern Industrial-Hygienic Arrangements for Factories (Zeitgemässe gewerbehygienische Einrichtungen für Fabrikbauten), Otto Brandt. Betrieb, vol. 3, no. 23, Aug. 27, 1921, pp. 728–738, 22 figs. Points to necessity of maintaining pure air in work rooms. Most dangerous kinds of dust found in industrial works are visualized with aid of photomicrographs, and installations for removal of dust, smoke, gases, vapors, and arrangements for supplying moisture to air are described. In connection with dust-removal plants, installations for recovery of valuable kinds of dust from dust-laden air and metallurgical gases are discussed.

Layout. Production Plans and Layout of Factories (Fabrikbauten und Umstellungen), Otto Hardung. Betrieb, vol. 3, no. 23, Aug. 27, 1921, pp. 751–759, 6 figs. Determination of working periods, dimensions, required machines and materials, based on complete production plant in a new system and separate working systems. Discusses desiderata for selection of factory site and layout.

Maintenance. Factory and Plant Maintenance—II, Arnold A. Arnold. Mech. World, vol. 70, no. 1811, Sept. 16, 1921, pp. 222–223. Discusses various works plans that it may be advisable to keep and information they record, also inventory of machinery and plant. (To be continued.)

FLAME PROPAGATION

Definition. Flame, C. A. French. Jl. Soc. Automotive Engrs., vol. 9, no. 3, Sept. 1921, pp. 182–185 and (discussion) 185–188, 1 fig. Discusses definition of atomic theory, combustion, oxidation and flame propagation.

FLIGHT

Circling. Control in Circling Flight, F. H. Norton and E. T. Allen. Natl. Advisory Committee For Aeronautics, Report no. 112, 22 pp., 52 figs. Results of investigation for the purpose of developing instruments that would record forces and positions of all three controls and to obtain data on behavior of an airplane in turns.

FORGINGS

Ordnance, Heat Treatment of. Observations Made in the Heat Treatment of Ordnance Forgings, Paul E. McKinney. Trans. Am. Soc. for Steel Treating, vol. 1, no. 12, Sept. 1921, pp. 738–745, 3 figs. Shows the necessity of having most complete data on material handled for successful heat treatment and to avoid erroneous deductions.

Press. A Method of Designing Press Forgings, W. R. Ward. Forging & Heat Treating, vol. 7, no. 8, August 1921, pp. 428–430. Combination of practical and theoretical gives best results working from finished forging back to billet.

FOUNDRIES

Core Rooms. Improved Core Output from Smaller Space. Iron Age, vol. 108, no. 15, Oct. 13, 1921, pp. 927–929, 4 figs. By providing improved working conditions for girl core makers, better product and higher type of employee have been secured.

Electric Suspension Travelers. Electric Suspension Traveller in Foundries, Richard Hänchen. Eng. Progress, vol. 1, no. 5, May 1920, pp. 181–185, 10 figs. Describes types made by various manufacturers.

Ford Motor Co. New Ford Foundry Plant at River Rouge, L. B. Breedlove. Iron Age, vol. 108, no. 13, Sept. 29, 1921, pp. 787–793, 7 figs. Laid out for quantity production. Uses direct blast-furnace metal mixed with cupola metal in definite proportions as required. Conveyor systems highly developed.

Malleable Iron. Equipment Features Malleable Shop, H. E. Diller. Iron Trade Rev., vol. 69, no. 15, Oct. 13, 1921, pp. 935–942 and 950, 14 figs. Details of new foundry of American Chain Co., New York, located at York, Pa., showing radical departures from general practice in all three stages of conveying, melting and annealing.

Manufacturing System. Manufacturing System Applied to the Foundry. Machinery (Lond.), vol. 18, no. 466, Sept. 1, 1921, pp. 664–671, 20 figs. Review of system developed by Derwent Foundry Co. (1920), Ltd., Derby.

Mixtures. Figuring the Charges for Foundry Irons, Y. A. Dyer. Iron Age, vol. 108, no. 15, Oct. 13, 1921, pp. 931–933. Iron mixtures and how to figure them chemically. Classification of castings and suggested analyses.

additions to equipment to modernize plant.

Steel Foundry Makes Sugar Mill Machinery—I, James J. Zimmerman. Blast Furnace & Steel Plant, vol. 9, no. 9, Sept. 1921, pp. 536–540, 3 figs. Discusses milling or rolling equipment and its proper selection.

FREIGHT HANDLING

Automatic Unloading Devices. The Economy of Modern Automatic Unloading Devices in Railroad Transportation (Ueber die Wirtschaftlichkeit moderner Selbstentladevorrichtungen im Eisenbahntransportwesen), Hartwig Orenstein. Fördertechnik u. Frachtverkehr, vol. 14, nos. 15, 16, 17 and 18, July 22, Aug. 5, 19 and Sept. 2, 1921, pp. 171–174, 186–189, 205–208 and 221–224, 27 figs. Technical part: Development of types of automatic unloaders and wagon-tipping devices; operating conditions; loading and unloading plants. Economical part: Calculation of an example; costs and their variability; formula is developed and its application under different conditions explained.

Slow Traffic. On the Question of Slow-Freight Traffic, W. H. Williams. Bul. International Ry. Assn., vol. 3, no. 8, August 1921, pp. 1087–1101, 2 figs. Discusses loading and unloading, yard and train operation, freight car movement, freight rates, etc.

FUELS

Coke Breeze as Boiler Fuel. Value of Mixture of Coke Breeze and Bituminous Coal as Fuel for a Hand-Fired Boiler, John Blizard and James Neil. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 6, Sept. 1921, pp. 645–655, 2 figs. Tests carried out by Bur. of Mines show that mixtures of coarser coke breeze with Pittsburgh coal gave less than one-half the smoke given out by Pittsburgh coal alone, about 20 per cent less steam, and require stronger draft to burn them; steaming value is about 70 per cent that of Pittsburgh run-of-mine coal, and its price should be less than 70 per cent that of Pittsburgh coal. Finer coke breeze can be recommended only for use at low rates of combustion.

Influence on Engine Performance. The Influence of Various Fuels on Engine Performance—V, H. R. Ricardo. Automotive Industries, vol. 45, no. 5, August 4, 1921, pp. 211–216, 11 figs. Relation between mixture strength and indicated mean pressure for various fuels, compression ratios and spark timing is shown and influence of jacket water temperature and heating of charge determined. From preliminary report conducted for Asiatic Petroleum Co.

Mixed Culm and Pitch. Mix Culm and Pitch in New Fuel, Donald Markle. Iron Trade Rev., vol. 69, no. 12, Sept. 22, 1921, pp. 753–755. New heating material prepared by mixing anthracite coal and pitch; designed for use in blast furnace and metallurgical operations and for domestic heating. By-products are limited. (Abstract.) Paper presented before Am. Inst. Min. & Metallurgical Engrs.

Smokeless. The Present Position of Smokeless Fuels, F. S. Sinnatt. Iron & Coal Trades Rev. vol. 103, no. 2790, August 19, 1921, p. 233. Concludes that manufacture of some type of smokeless fuel would solve the problems of fuel conservation, air pollution and efficient house heating; coal should be worked at pithead or in conjunction with coal gas. (Abstract.) Paper read before Royal Sanitary Inst.

[See also OIL FUEL; PULVERIZED COAL.]

FURNACES

Preheated-Air vs. Direct-Fired. Experimental Comparison of a Preheated Air Furnace With a Direct Fired Furnace, L. Lellep. Am. Gas Jl., vol. 115, no. 12, Sept. 17, 1921, pp. 247–252 and 260–263, 4 figs. Discusses results of experiments and gives table of theoretical computation of fuel saving due to preheated air compared with fuel consumption in a direct-fired furnace.

FURNACES, BOILER

Improvements. The Reconstruction of Steam-Boiler Furnaces and Their Auxiliary Equipment for Obtaining a Maximum Conservation of Fuel (Die Umstellung der Dampfkesselfeuerung und ihrer Nebeneinrichtungen zur Erzielung grösster Brennstoff-Ökonomie), H. Briem. Fördertechnik u. Frachtverkehr, vol. 14, no. 14, July 8, 1921, pp. 156–161, 9 figs. Deals with ash-removal installations; forced-draft furnaces; and electric boiler protection.

Recovery of Unburned Fuel from Refuse. The Recovery of Unburned Fuel from Boiler Furnace Refuse, Thomas Fraser and H. F. Yancey. U. S. Bur. Mines Reports of Investigations serial no. 2281, Sept. 1921, 3 pp. Washing tests made in laboratory of mining department of University of Illinois show possibility of recovering unburned fuel by crushing refuse to ¾-in. ring size, washing on coal-washing tables, and removing slime from washed product by a dewatering conveyor-elevator or screen.

FURNACES, HEATING

Regenerative. Employ Regenerative Furnaces, E. C. Kreutzberg. Iron Trade Rev., vol. 69, no. 11, Sept. 15, 1921, pp. 680–683, 7 figs. Installation at Harrison, N. J., comprises 24 units, to burn either oil or gas. Operation is explained and results of tests are given.

FURNACES, HEAT-TREATING

Automatic Semi-Cylindrical. New Heat-Treating Furnace. Iron Age, vol. 108, no. 11, Sept. 15, 1921, p. 665, 1 fig. Automatic furnace, known as A. D. Dauch. Iron Age, vol. 108, no. 11, Sept. 15, 1921, pp. 666–667, 4 figs. Moving hearth is an annular ring; heated electrically and controlled automatically; suitable for large variety of parts. Installed at plant of Nash Motors Co., Kenosha, Wis.

FURNACES, HOT-AIR

Small Blowers for. Small Blowers in Combination with Furnaces for Domestic Heating Plants, F. R. Still. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 6, Sept. 1921, pp. 659–663, 2 figs. Describes type of air-blast inductor and its application to hot-air furnaces.

G

GAGES

Snap. Tools Used in the Manufacture of P & W Adjustable Limit Snap-Gage, Ellsworth Sheldon. Am. Mach., vol. 55, nos. 11 and 12, Sept. 15 and 22, 1921, pp. 428–431 and 456–460, 24 figs. Sept. 15: Accurate alignment a prime requisite. Tool that drills a "cut-out" or crescent-shaped hole. Sept. 22: Making measuring anvils; accurate grinding operations; an ingenious lapping device.

Thread. New Type of Thread Gages, B. M. W. Hanson. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 110–111, 3 figs. Describes accurate method of determining correctness of screw threads by vision as well as by touch.

GALVANIZING

Metal-Spray Process. The Metal Spray Process and Its Use in Shipbuilding and Other Industries (Das Metallspritzverfahren und seine Anwendung in Schiffbau und anderen Industrien). Schiffbau, vol. 22, no. 48, Aug. 31, 1921, pp. 1238–1241, 4 figs. Discusses process, and its advantages in shipbuilding technique.

Processes. Metal Coatings as Protection Against Rust (Metallüberzüge als Rostschutzmittel), Werner Lange. Zeit. für Metallkunde, vol. 13, no. 7, Apr. 1921, pp. 161–170, 26 figs. Evaluation of different galvanizing processes, based on corrosion tests carried out by German military authorities during war.

GAS TURBINES

Aeronautical. Turbines and Kindred Problems in Aeronautics (Turbinen und verwandte Probleme in der Flugtechnik), W. G. Noack. Zeitschrift für Flugtechnik u. Motorluftschiffahrt, vol. 11, no. 14, July 31, 1920, pp. 201–207, 8 figs. Investigation of extent to which turbine can be considered as a motor for aircraft, and what prospects exist of applying the driving principle of the turbine, namely, the conversion of the energy of flow into mechanical work, in a more direct manner than is the case with the turbine for forward drive. (To be concluded.)

Holzwarth. The Internal-Combustion Turbine, Mark Meredith. Oil Field Eng., vol. 23, no. 9, Sept. 1921, p. 130. Describes "Holzwarth" oil turbine now being tested at works of Thyssen & Co., Germany; develops 500 hp. at 3,000 r.p.m.

Oil and Gas Turbines. Gas and Oil Turbines (Die Gas- und Oelturbine), W. Schüle. Elektrotechnische Zeit., vol. 42, nos. 29 and 30, July 21 and 28, 1921, pp. 777–784 and 821–824, 12 figs. Some of greatest difficulties in design of gas turbines are enumerated, and author proves by actual tests and operating results that all these problems have been solved and that gas or oil turbines represent serious competitor with steam turbine for either stationary, railway or ship-propulsion purposes. Test data of 500-kw. oil turbine are given.

GASOLINE

Absorption from Casinghead Gas. The Absorption of Gasoline From Casinghead Gas by Activated Charcoal, H. R. Auerswald. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 601–602 and 606, 2 figs. Particulars regarding series of tests undertaken to evaluate process when applied to rich gas, with conclusions drawn therefrom as to its limitations.

Natural-Gas. Natural Gas-Gasoline Blends, D. B. Dow. U. S. Bur. Mines Reports of Investigations, serial no. 2279, Sept. 1921, 2 pp. Notes on how it is made. Includes table showing distillations of raw natural gas-gasoline, blending naphthas, and resulting blends.

GASOLINE ENGINES

Mixture Ratio and Temperature. The Effect of Mixture Ratio and Temperature on Power and Economy, C. S. Kegerreis. Automotive Industries, vol. 45, no. 13, Sept. 29, 1921, pp. 610–612, 5 figs. Tests conducted at Purdue Univ. show that marked gains in economy with but trifling loss in power result from proper heating of charge and correct mixture proportions.

GEARS

Compressive Stress. Gearing Calculations by the Compressive Stress Method—I, Joseph Jandasek. Automotive Industries, vol. 45, no. 11, Sept. 15, 1921, pp. 512–515, 15 figs. Maximum surface pressure, or compressive stress, must be considered if rate of wear of tooth is to be kept within proper limits.

Elliptical Wheels. The Design of Elliptical Wheels for a Constant Speed Reciprocating Motion—II, Osbert H. Nichols. Machinery (Lond.), vol. 18, no. 469, Sept. 22, 1921, pp. 754–756, 3 figs. Discusses proportions and effect of elliptical wheels, as used for modifying simple harmonic motion.

Helical. Cutting Rolling Mill Driving Gears. Machinery (Lond.), vol. 18, no. 470, Sept. 29, 1921,

pp. 787–790, 5 figs. Discusses production of large double helical gears by end-milling process.

Involute, Testing. Inspection of Involute Gear Hobs—II, Carl G. Olson. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 138–140, 6 figs. Methods used in examining test gears.

GRINDING

Automobile Parts. Grinding in the Automotive Industry—IV, P. M. Heldt. Automotive Ind., vol. 45, no. 9, Sept. 1, 1921, pp. 421–426, 12 figs. Discusses methods used in grinding crankshafts, flat faces, camshafts, gear teeth, splines and other parts. (Concluded.)

GRINDING MACHINES

Internal. Grinding Irregular-Shaped Holes on the Bryant Internal Grinding Machine. Am. Mach., vol. 55, no. 13, Sept. 29, 1921, pp. 499–500, 7 figs. Handling combinations of straight, tapered and curved internal surfaces. Grinding done in one operation. Laying out special control plates.

GUN MOUNTS

16-In. Disappearing Carriage. Design and Construction of the 16-in. Disappearing Carriage from an Engineer's Standpoint, G. M. Barnes. Mech. Eng., vol. 43, no. 10, Oct. 1921, pp. 659–660 and 674, 5 figs. Describes 16-in. high-power gun mounted on disappearing carriage, especially designed for seacoast-defense purposes; gun weighs 170 tons and carriage an additional 670 tons. Details of principal parts and forces acting on members of carriage, and recoil mechanism.

H

HANGARS

Concrete. The Hangar Near Tondern (Luftskibshallen ved Tönder), I. W. Unmack. Teknisk Tidsskrift (Elektroteknisk), vol. 45, no. 31, August 3, 1921, pp. 113–115, 5 figs. Reinforced concrete structure capable of housing two zeppelins. Details of construction and equipment.

Strauss Type. Airplane Shed with Special Roof and Door Construction. Eng. News-Rec., vol. 87, no. 14, Oct. 6, 1921, pp. 565–566, 2 figs. Quick-erection form of steel-roof-truss framing was adopted by designer, J. B. Strauss, and an adaptation of his well-known form of bascule bridge counterweighting was applied to pivoted door which forms one entire end of shed and is 21 ft. high and 100 ft. long.

HARDNESS

Testing. The Hardness Testing of Metals. Mech. Eng., vol. 43, no. 7, July 1921, pp. 445–449, 11 figs. Report of Committee of Engineering Division of Nat. Research Council on various methods of testing hardness of metals.

The Use of the Scleroscope on Light Specimens o Metals, Fred S. Tritton. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 8, 10 pp., 4 figs.; also Engineering, vol. 112, no. 2909, Sept. 30, 1921, pp. 492–493, 4 figs. Results of experiments show that usual methods of supporting light specimens of metal for scleroscope test do not give results with accuracy which can be obtained when specimens are supported by methods described.

HEALTH

Plant Medical Department. Practices and Functions of the Medical Department, Robert E. Andrews. Indus. Management, vol. 62, no. 4, Oct. 1921, pp. 206–211, 6 figs. Experiences and procedure in medical department of large textile industry.

HEAT

Dissipation Coefficients of Iron and Copper. Determination of Heat-Dissipation Coefficients (Verfahren zur Bestimmung von Wärmeabgabekoeffizienten), K. Luhowsky. Elektrotechnische Zeit. vol. 42, no. 4, Jan. 27, 1921, pp. 79–81, 4 figs. Heat-dissipation coefficients of iron and copper bodies, in air and in oil, stationary and in motion, influenced by different paints and insulating materials, are determined in watts per sq. cm. for 1 deg. cent. temperature rise. Account of test. Curves and tables, giving test data obtained, are included.

HEAT TRANSMISSION

Buildings. Heat Loss Through Various Types of Building Construction, L. A. Scipio. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 6, Sept. 1921, pp. 637–643, 2 figs. Results of series of experiments carried out to determine heat losses from different wall constructions for residence buildings, for which five houses exactly similar with exception of wall material and construction were built and heated by electric stoves for observation.

Furnaces, Losses in. Principles of Heat Loss in Furnaces, P. Rosin. Forging & Heat Treating, vol. 7, no. 8, August 1921, pp. 425–428, 1 fig. Study of heat losses through a furnace wall consisting of at least two different parts, a refractory material and an insulating material. Extract of article from "Metall und Erz."

Liquids. Numerical Laws of Heat Transmission Between Liquids in Industrial Heat Exchangers (Lois numériques de la transmission de la chaleur entre les fluides dans les echangeurs industriels), H. Dieterlen. Chaleur et Industrie, vol. 2, no. 16, August 1921, pp. 494–500, 4 figs. Discusses various formulas in use and finds them contradictory. (Continuation of serial.)

Problems. Solution of Heat Transfer Problems, H. G. Nevitt. Power Plant Eng., vol. 25, no. 17, Sept. 1, 1921, pp. 849–850, 1 fig. Discusses chart for determining mean temperature difference in a heat-transfer problem when initial and final temperature differences are known.

HEAT TREATING

Oil-Burning System. Screw Stock Heat Treated With Oil, F. J. Ryan. Iron Age, vol. 108, no. 11, Sept. 15, 1921, pp. 660–661, 3 figs. Application of Mircs system to ferrous and non-ferrous material by Bridgeport Screw Co. Operating data.

HEATING, STEAM

Boiler Improvements. Fuel Economy in Heating Service, A. Bement. Heat. & Vent. Mag., vol. 18, no. 9, Sept. 1921, pp. 36–38. Comments on present practice in down-draft boiler design with suggestions for improvements.

Vacuum. Vacuum Steam Heating (Vakuumdampfheizung), L. Silberberg. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 34, Aug. 20, 1921, pp. 898–901, 15 figs. Comparison of different methods of exhaust-steam heating. Description of vacuum heating, and its efficiency in practice. Experimental results.

HELICOPTERS

Types. Helicopters (Les Hélicoptères), L. Guguet. L'Aerophile, vol. 29, no. 13–14, July 1–15, 1921, pp. 209–213, 6 figs. Discusses Austrian army captive type, Oehmichen, Pateras, Pescara, and other types.

HYDRAULIC TURBINES

Installation. The Hydraulic Plant—II, N. L. Devendorf. Power, vol. 54, no. 14, Oct. 4, 1921, pp. 513–516, 6 figs. Types of turbine setting, forms of draft tube, effect of air leakage, vertical vs. horizontal turbines, thrust bearings, maintenance and repairs.

Pelton Wheels. An Experimental Study of the Effect of Roughness of Bucket Surface on the Efficiency of Pelton Wheel, Junzo Nakahara. Jl. Soc. Mech. Engrs. & Soc. Nav. Architects, Sept. 1921. (In Japanese.)

Reaction. Contribution to the Knowledge of Hydraulic Reaction Turbines (Contributo Allo Studio Delle Turbine Idrauliche A Reazione), R. Leonardi. L'Industria, vol. 35, nos. 13 and 14, July 15 and 31, 1921, pp. 296–298, 5 figs. and pp. 314–319, 5 figs. Discusses theory of turbines, especially performance curves. Discussion and calculation of efficiency.

Types. The Hydraulic Plant—I, N. L. Devendorf. Power, vol. 54, no. 13, Sept. 27, 1921, pp. 484–486, 4 figs. Methods of removing débris from water in high- and low-head plants, types of hydraulic turbine employed, their limitations and means for effecting regulation.

HYDROELECTRIC DEVELOPMENTS

Great Britain. Hydro-Electric Developments—I, F. Rowlinson. Beama, vol. 9, no. 3, Sept. 1921, pp. 224–230, 1 fig. Summarizes developments in North Wales, Scotland and Ireland.

HYDROELECTRIC PLANTS

Brazil. Sorocaba Hydro-Electric Plant in Brazil, H. P. Quick. Power, vol. 54, no. 15, Oct. 11, 1921, pp. 548–551, 6 figs. Development planned for 75,000 hp. in five 15,000-hp. turbines operating under a 600-ft. net effective head. Designed and put into successful operation by American engineers.

Kern River, Cal. Automatic Features of New Kern River Power Plant. Eng. News-Rec., vol. 87, no. 11, Sept. 15, 1921, p. 453. Reaction turbines for 810-ft. head have quickly changeable runners. Extensive automatic control equipment.

Manitoba, Canada. New Plant on Winnipeg River. Can. Engr., vol. 41, no. 10, Sept. 8, 1921, pp. 1, 6 and 8 Great Falls development to have capacity of 168,000 hp., with six 28,000-hp. units. Details of head gates, screens, hydraulic turbines, generators, transformers, switching apparatus and transmission lines.

Switzerland. Constructional Details of the Oberhasli Hydroelectric Works (Les dispositions constructives des usines hydro électriques de l'Oberhasli). Bulletin Technique de la Suisse Romande, vol. 47, no. 17, August 20, 1921, pp. 193–198, 7 figs. Discusses hydrographic conditions, construction of dams, reservoirs, etc. (To be continued.)

I

IMPACT

Stress Recorder. Fereday & Palmer's Patent Stress Recorder. Ry. Gaz., vol. 35, no. 7, August 12, 1921, pp. 283–285, 27 figs., partly on supp. pl. Describes an instrument for recording impact stresses on railway bridges by a train passing at high speed.

INDICATORS

Diagrams. Taking Indicator Diagrams, P. A. Baumeister. Power, vol. 54, no. 15, Oct. 11, 1921, pp. 551–552, 4 figs. Points out requirements and necessary steps for getting good indicator diagrams.

Steam-Engine, High-Speed. A New Design of High Speed Engine Indicator, Benno R. Dierfeld. Automotive Ind., vol. 45, no. 10, Sept. 8, 1921, pp. 471–473, 15 figs. German instrument employs steel pencil to trace extremely small diagram on soot-covered glass plate which is enlarged by use of microscope.

INDUSTRIAL MANAGEMENT

Factory Investigations. Economic Value of Factory Investigations, Albert A. Dowd. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 121–122. Gives examples of cost reductions resulting from investigations. Improved method of manufacturing a long rod. Notes on handling materials, inspection and salvage, time studies and assembling.

Gantt Charts. The Gantt Chart—III, Wallace Clark. Management Eng., vol. 1, no. 4, Oct. 1921, pp. 225–229, 4 figs. Its application to progress of work.

Intra-Plant Communication. A Development in Intro-Plant Communication, Donald McNicol. Management Eng., vol. 1, no. 4, Oct. 1921, pp. 235–237, 3 figs. Describes how printing telegraph may be employed to supplement telephone in solving problem of plant communication.

Objections Made to. Scientific Management—XXXI, Henry Atkinson. Eng. & Indus. Management, vol. 6, no. 11, Sept. 15, 1921, pp. 286–289. Examination of objections made against scientific management.

Production, Economics of. The Economics of Production—IV, V and VI, D. A. McCabe. Am. Mach., vol. 55, nos. 11, 12, 13 and 14, Sept. 15, 22, 29, and Oct. 6, 1921, pp. 419–420, 455–456, 497–498 and 539–540. Sept. 15: Causes of changes in demand. Sept. 22: Production and reduced demand. Sept. 29: Producer's job and profits. Oct. 6: Production and wages.

Production Methods. Modern Production Methods—XXI, XXII and XXIII, W. R. Basset. Am. Mach., vol. 55, nos. 11, 13 and 15, Sept. 15, 29 and Oct. 13, 1921, pp. 421–423, 501–505 and 604–608, 13 figs. Sept. 15: Graphic methods of control; when to use graphic charts and when not to; master charts. Sept. 29: Various uses of time studies; attitude of workman; some general rules for time-study observer. Oct. 13: Records of actual time studies of machine operations; fallacy of taking over-all times for standards.

Protection Control by Graphics, Fred R. Daniels. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 112–120, 14 figs. System employing graphic charts for controlling shop operations, in use in plant of Hopedale Mfg. Co., Milford, Mass.

Production Planning. Quality and Costs as Standards of Production (Güte und Kosten als Grundmassstäbe der Produktion), H. Basson. Betrieb, vol. 3, no. 22, Aug. 13, 1921, pp. 695–703, 12 figs. States that quality and cost of product are influenced by fitness of design and quality of materials used, as well as by accuracy of production, etc. Based on practical examples, errors in design, possibilities for economizing in material, and accuracy of production are discussed.

Works Organization, R. Waring-Brown. Eng. & Indus. Management, vol. 6, no. 14, Oct. 6, 1921, pp. 377–382, 9 figs. Production engineer's planning department in automobile factory.

Purchasing Organization. Purchasing Organization in Machine Works (Beitrag zur Frage der Einkaufsorganisation in Maschinenfabriken), E. Springorum. Betrieb, vol. 3, no. 21, July 25, 1921, pp. 682–687, 13 figs. Purchasing system is described according to which departments making use of purchased material share responsibility.

Routing. Routing Work in Factories for Series Production with Numerous Separate Parts and Erection Groups (Die Abwicklung der Werkaufträge in Fabriken für Serienfabrikation mit sehr vielen Einzelteilen und Montagegruppen), H. Fürstenau. Betrieb, vol. 3, no. 21, July 25, 1921, pp. 665–674, 10 figs. Describes system for smooth flow of production and gives examples of its application in manufacture of railway cars. It can be applied to manufacture of locomotives, motor plows, automobiles, ships, etc.

Charting Routing Losses. Factory, vol. 27, no. 3, Sept. 1921, pp. 328–329, 2 figs. Graphic method of locating source of trouble. Experience of Am. Optical Co.

Simplification. Simplification in Industry—VII, Howard Coonley. Factory, vol. 27, no. 3, Sept. 1921, pp. 317–319, 4 figs. How line was reduced from 17,000 to 610 items. Describes how simplification facilitated development of suitable budget of business and opened way to other advantages.

Small Shop. Organization and Management of the Small Shop—V, VI and VII, E. W. Leach. Am. Mach., vol. 55, nos. 11, 13 and 15, Sept. 15, 29 and Oct. 13, 1921, pp. 438–441, 513–516, and 592–595, 7 figs. Sept. 15: Production planning and control. Necessity and uses of system. Figuring shop capacity. Simple method of cost-keeping. Sept. 29: Value of cost records; what profit should be based upon. Classification of material and labor accounts; overhead and what it consists of. Oct. 13: Filling customer's order; necessity of keeping records; efficiency in shipping room.

Stock-Record Keeping. Worth While Considerations in Stock Record Keeping, F. E. Merriam. Indus. Management, vol. 62, no. 4, Oct. 1921, pp. 199–205, 9 figs. Defines duties and scope of stock-record department, and its relation to management.

Tracing Materials. Making It Easy to Trace Materials, L. E. Dodd. Factory, vol. 27, no. 3, Sept. 1921, pp. 330–332, 5 figs. Plan for recording material in factory that readily permits tracing it back to its source or ahead to its ultimate destination. Developed in Optical Glass Plant of Nat. Bur. of Standards, Pittsburgh and Washington.

[See also MOTION STUDY.]

INDUSTRIAL ORGANIZATION

Knitting Mills. The Organization of Knitting Mills, Carle M. Bigelow. Management Eng., vol. 1, no. 4, Oct. 1921, pp. 193–198, 4 figs. Notes on solving problems of specialized industry.

INDUSTRIAL RELATIONS

Human Factor. The Human Factor in Industry—I,

grew above the machine.

INDUSTRIAL TRUCKS

Hydraulic. The L.A.C. Hydraulic Truck, George F. Zimmer. Eng. & Indus. Management, vol. 6, no. 14, Oct. 6, 1921, pp. 385–387, 3 figs. Describes truck consisting of a main and sub-frame, former supported by four wheels 9 in. in diam. and 3 in. wide. Hydraulic lifting device consists of two cylinders and operating valves, formed together in gun-metal casting.

INSPECTION

Delco System. The Delco Inspection System. Machinery (Lond.), vol. 18, no. 460, July 21, 1921, pp. 468–471, 8 figs. Description of methods used in tool and gage-designing department of Dayton Eng. Laboratories Co. and standards of gaging adopted.

INTERNAL-COMBUSTION ENGINES

Frictional Losses. Distribution of Frictional Losses in Internal Combustion Engines, E. P. Taylor. Gas & Oil Power, vol. 16, no. 192, Sept. 1, 1921, pp. 190–192. Describes a number of tests and concludes that the retardation method offers the advantages of accuracy and complete speed range with the disadvantage that values of friction are obtained under special conditions. (From Jl. Proc. Roy. Soc. of New South Wales.)

Fuel, Valves and Ignition. The Internal-Combustion Engine: Fuel, Valves, and Ignition, A. W. Bradbury. Mech. Wld., vol. 70, no. 1809, Sept. 2, 1921, p. 193. Discusses chemical and mechanical work done in combustion chamber. (To be continued.) From paper read before Inst. Mar. Engrs.

Fuels, Influence of. The Influence of Various Fuels on Engine Performance—VI, H. R. Ricardo. Automotive Industries, vol. 45, no. 10, Sept. 8, 1921, pp. 465–470, 6 figs. Outlines tests intended to determine conditions which govern ease of starting with various fuels and effect of fuel upon volumetric efficiency. (To be continued.) From preliminary report conducted for Asiatic Petroleum Co.

The Influence of Various Fuels on the Performance of Internal Combustion Engines—VII, H. R. Ricardo. Automobile Engr., vol. 11, no. 153, August 1921, pp. 279–284, 5 figs. Gives tables of fuel characteristics and experimental results for variable compression engines.

Two- and Four-Cycle. The Internal Combustion Engine Discussed, A. W. Bradbury. Power House, vol. 14, no. 17, Sept. 5, 1921, pp. 32–36, 14 figs. Discusses two-cycle and four-cycle types, their advantages and disadvantages. Read before Inst. Mar. Engrs.

[See also AEROPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GASOLINE ENGINES; OIL ENGINES.]

IRON

Stainless. Stainless Iron. Times Eng. Supp., no. 563, Sept. 1921, p. 257. A variant of stainless steel, mechanical properties, corrosion and errosion.

IRON AND STEEL

Microscopic Examination. Microscopic Examination of Iron and Steel. Chem. & Met. Eng., vol. 25, no. 10, Sept. 7, 1921, pp. 471–472. Report of committee appointed by Am. Soc. for Testing Materials on methods for testing iron and steel.

L

LABOR TURNOVER

Causes. Why Men Quit, H. L. Keely. Indus. Management, vol. 62, no. 4, Oct. 1921, pp. 223–227, 3 figs. Simple method of recording caused, classifying them, and making record of practical use to management.

LATHES

Bench. Bench Lathes and Millers as Production Tools. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 130–134, 9 figs. Examples of work regularly manufactured on bench machines by B. C. Ames Co., Waltham, Mass.

Large. A Very Large Lathe. Engineer, vol. 132, no. 3430, Sept. 23, 1921, pp. 325–326, 3 figs., two on supp. plate. Describes sliding, surfacing and screw-cutting lathe built by Thomas Shanks & Co., Johnstone. Principal dimensions are: Height of centers without packing, 111 in.; and with packing, 123 in.; admit between centers, 40 ft.; width of slide bed, 18 ft. 6 in.; overall length of bed, 60 ft.; diam. of face-plate, 15 ft.; main motor, 120 hp.

Motor-Driven Heavy. Recent Machine Tool Developments—XXI, Joseph Horner. Engineering, vol. 112, no. 2906, Sept. 9, 1921, pp. 364–367, 12 figs. Motor-driven heavy lathe of 20-in. centers, constructed by Francis Berry & Sons, Sowerby Bridge, England.

Turret. Improving Tool Equipments, Hubert Bentley. Eng. & Indus. Management, vol. 6, no. 10, Sept. 8, 1921, pp. 265–266, 3 figs. Describes hexagon turret toolholder, use of which, it is claimed, increases productivity of machine and prolongs life of tool.

Production Work in the Locomotive Shop—I. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 102–105, 10 figs. Application of Bullard vertical turret lathe to locomotive-shop practice, with typical examples and description of tooling for each job.

44 figs. partly on supp plate. Details of automatic turret lathe constructed by Gisholt Machine Co., Madison, Wis. Swing of lathe is 20 in., maximum distance between chuck and turret is 45 in. and maximum length of work which can be handled 14 in.; overall length, 11 ft. 10⅝ in.; weight, 10,100 lb. It can be driven by electric motor or belt.

Vertical. An Original Type of Lathe. Eng. Production, vol. 3, no. 49, Sept. 8, 1921, pp. 219–220, 1 fig. Details of vertical lathe made by Cadillac Tool Co., Detroit, which can be used for turning, facing and grooving operations.

LIQUIDS

Viscosity. Effect of Temperature on the Viscosity of Liquids (Influence de la température sur la viscosité des liquides normaux), Edm. van Aubel. Comptes Rendus des Séances de L'Académie des Sciences, vol. 173, no. 7, August 16, 1921, pp. 384–387. Gives new formula and shows that it is accurate with normal liquids.

LOCOMOTIVES

Booster Tests. Booster Tests on Temiskaming & Northern Ontario. Ry. Age, vol. 71, no. 10, Sept. 3, 1921, pp. 447–448, 4 figs. Results of tests of locomotive boosters show 20 per cent increased freight tonnage and rapid acceleration of passenger trains.

British. The Comparison of Dimensions and Proportions of British Locomotives, E. C. Poultney. Ry. Mech. Engr., vol. 95, no. 9, Sept. 1921, pp. 539–542, 1 fig. Discusses factor of adhesion, rated tractive effort, boiler factor, factors of combustion, firebox volume, efficiency, etc. (To be continued.)

Coaling Stations. Concrete Coaling Station. Engineer, vol. 132, no. 3428, Sept. 9, 1921, pp. 271–273, 3 figs. Plant of moderate size built at engine yard and running sheds of Phila. & Reading R. R., Philadelphia. Conveyor is intermittent vertical hoist, with single bucket of 3 tons capacity; both coal and sand for engines are handled by same apparatus. Reinforced-concrete structure consists of tower with hoisting shaft and a 600-ton storage bin which span two lines of rails.

New Coaling Stations on the Santa Fe. Ry. Elec. Engr., vol. 12, no. 9, Sept. 1921, pp. 334–337, 5 figs. Description of 400-ton reinforced-concrete automatic electric coaling and sanding plant permitting continuous operation of buckets.

Design and Operation. The Necessity for Improvement in the Design and Operation of Present-Day Locomotives, H. W. Snyder. Mech. Eng., vol. 43, no. 7, July 1921, pp. 455–458, 1 fig. Brief discussion of engine problems, followed by consideration of design of main and side rods and crankpins to withstand tremendous piston thrust to which they are subjected in large engines; problem of counterbalancing; frame design and cross-bracing; driving-box brasses; ashpan design, lubrication, etc.

4-6-0 Express Goods. Four-Cylinder Express Goods Locomotives on the Great Central Railway. Ry. Gaz., vol. 35, no. 10, Sept. 2, 1921, pp. 368–369, 2 figs. Type 4–6–0, tractive effort 29,507 lb. at 85 per cent boiler pressure.

4-6-0 Three-Cylinder. New Three-Cylinder 4–6–0 Type Locomotives, Caledonian Railway. Ry. Gaz., vol. 35, no. 13, Sept. 23, 1921, pp. 463, 2 figs. on page 464. Three 8½-in. single-expansion cylinders, six coupled wheels of medium diameter, and 60 tons of adhesion.

Freight. Advantages of Large Freight Locomotives. Particularly the 2–10–2 Type, Albert F. Stuebing. Mech. Eng. vol. 43, no. 7, July 1921, pp. 459–460. Points out more important considerations involved in study of economic value of various types of motive power and demonstrates complexity of problem.

Liquid Fuel. On the Utility of Studying the Question of the Use of Liquid Fuel in Locomotives, Henry Fowler. Bul. International Ry. Assn., vol. 3, no. 8, August 1921, pp. 923–976, 11 figs. Discusses a number of questions sent to R. R. administrations on their using liquid fuel and gives tabulated statement of replies received.

Mikado. New Locomotives for the Missouri Pacific. Ry. Age, vol. 71, no. 11, Sept. 10, 1921, pp. 495–498, 4 figs. Data on Mikado type equipped with booster, switcher, Pacific and mountain types.

Oil Firing. Oil-Firing on English Railways, E. C. Bowden-Smith. Petroleum Times, vol. 6, no. 139, Sept. 3, 1921, pp. 617–618, 1 fig. Describes working of a Great Central tank locomotive burning oil.

Superheater. Three-Cylinder Superheated Steam Goods Train Locomotive. Type 2–10–0, G. Heise. Eng. Progress, vol. 1, no. 5, May 1920, pp. 191–195, 25 figs. Describes types built by Lokomotiv-Bauanstalt Henschel & Sohn.

2-8-0 Belgian State Railways. Powerful New 2–8–0 Type Locomotives For the Belgian State Railways. Ry. Gaz., vol. 35, no. 7, August 12, 1921, pp. 286–287, 5 figs. Built by Armstrong, Whitworth & Co., for mixed traffic; develops tractive force of 45,820 lb.

Weighing Plant. A Large Capacity Locomotive Weighing Plant, Carl C. Bailey. Ry. Age, vol. 71, no. 10, Sept. 3, 1921, pp. 453–455, 5 figs. Heavy scale is housed in special building with equipment for determining wheel loads.

LUBRICATION

Car Journals. Lubrication of Car Journals Without the Use of Waste. Ry. Rev., vol. 69, no. 9, August 27, 1921, pp. 267–271, 6 figs. Particulars of tests conducted to determine relative advantages of splash-oil lubrication vs. waste-packed method.

MACHINE SHOPS

Design and Construction. The Design and Construction of Engineering Workshops—XXII, Ernest G. Beck. Mech. Wld., vol. 70, no. 1810, Sept. 9, 1921, pp. 202–203, 2 figs. Continuation of discussion on construction of roofs.

Haarlem, Holland. A Visit to the Haarlem Machine Works, Formerly Figee Bros. (Bezoek aan de fabrieksterreinen Noorder Buiten Spaarne van de Haarlemsche Machine-fabriek, voorheen Gebrs. Figee), P. J. Van Zwieten. De Ingenieur, vol. 36, no. 35, August 27, 1921, pp. 664–677, 23 figs. Describes development of works and some of its principal construction work carried out.

MACHINE-TOOL INDUSTRY

Influence of Automobile on. The Influence Exerted by the Automobile on the Machine-Tool Industry. Mech. Eng., vol. 43, no. 8, Aug. 1921, pp. 529–534, 1 fig. Group of papers by F. K. Hendrickson, Henry J. Eberhardt, Henry J. Hinde, Ralph E. Flanders and Chester B. Lord, dealing with changes brought about by automobile in machine-tool design, construction and operation, together with discussion of fundamentals of interchangeable manufacture.

MACHINE TOOLS

Special vs. Standard. Manufacturing with Special Machines vs. Standard Equipment—V, G. F. Jenks and M. H. Christopherson. Am. Mach., vol. 55, no. 12, Sept. 22, 1921, pp. 475–479, 12 figs. Lapping cylinders; testing and assembling. Comparison of machining times at Otis Works and Water town Arsenal.

MAGNESIUM ALLOYS

Electron Metal. The Magnesium Alloy "Electron," S. Beckinsale. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 12, 2 pp. Note on results of examination of samples, of German origin, of magnesium alloy known as electron.

MALLEABLE IRON

American. American Malleable Cast Iron—XIX, H. A. Schwartz. Iron Trade Rev., vol. 69, no. 13, Sept. 29, 1921, pp. 813–816, 1 fig. Inspection and testing.

MANGANESE STEEL

Carbonizing. Carbonizing Manganese Steel, A. A. Blue. Forging & Heat Treating, vol. 7, no. 8, August 1921, pp. 413–415, 4 figs. States that increased manganese content produces greater sensitiveness to carbonizing.

MARINE ENGINES

Broken Propeller Blades. Examples of Broken Propeller Blades of Marine Engines, S. Sasaki. Jl. Soc. Mech. Engrs. & Soc. Nav. Architects, Sept. 1921. (In Japanese.)

MARINE STEAM TURBINES

Diaphragms. Turbine Diaphragms, H. M. David. Mech. Wld., vol. 70, no. 1809, Sept. 2, 1921, pp. 181–183, 7 figs. Examines question from mechanical and constructional point of view; discusses type applying more particularly to marine turbines of impulse type having double reduction gear.

Geared. Double-Reduction Gearing of the Three-Case Type for Steamships. Engineering, vol. 112, no. 2906, Sept. 9, 1921, p. 376, 2 figs. on supp. plate. Constructed by Scotts Shipbuilding & Eng. Co., Ltd., Greenock, England, for single-screw vessel; transmits 6000 shaft hp.; high-pressure and low-pressure turbines have speed of 3,000 and 18,000 r.p.m., respectively.

Angular Vibrations in Marine Propelling Machinery, Richard Gardner. Engineering, vol. 112, no. 2906, Sept. 9, 1921, pp. 363–364, 3 figs. Investigation of vibration effect in relation to geared steam-turbine installations. Proposes method for obtaining comparative estimates of outside limits to amplitude of vibration in gearing.

METAL SPRAYING

Schoop Process. The Schoop Process of Metal Spraying. Am. Mach., vol. 55, no. 16, Oct. 20, 1921, pp. 647–648, 6 figs. Protective coating of metal sprayed by compressed air. Impalpable particles discharged at high velocities penetrate pores. Variety of metals can be used.

METALLOGRAPHY

Etching. A New Etching Medium for Chrome and Tungsten Steels (Ein neues Aetzmittel für Chrom- und Wolframstähle), Karl Daeves. Stahl u. Eisen, vol. 41, no. 36, Sept. 8, 1921, pp. 1262–1264, 3 figs. Describes composition of new etching medium containing yellow prussiate of potassium, adapted to etching of high-speed tool steel, and other purposes.

The Electrolytic Etching of Metals, Frank Adcock. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 11, 9 pp., 18 figs. Notes on citric acid solution; ammonium molybdate solution; method of etching cupro-nickel (80:20) so as to show both cores and grain boundaries. Notes on gold. Heat etching of platinum.

METALS

Alkaline. Experiences with the Alkaline and Alkaline Earth Metals in Connection with Non-Ferrous Alloys, Charles Vickers. Am. Electrochemical Soc. advance paper no. 14, for Meeting, Sept. 29–Oct. 1, 1921, pp. 191–198. Sodium, of the alkaline metals, is said to serve as suitable deoxidizing agent in producing copper castings of superior torsional

strength; calcium, of alkaline earth metals, when in combination with an acid element, as silicon, produces castings of good electrical conductivity.

Fatigue. The Fatigue of Metals, Clifford W. Nash. Commonwealth Engr., vol. 8, no. 12, July 1, 1921, pp. 250–353. Discusses fatigue and elastic limit, endurance limit, mechanism of fatigue failure, and conditions favoring resistance to fatigue.

Rigidity and Viscosity. The Effect of Temperature on the Modulus of Rigidity, and on the Viscosity of Solid Metals, Kei Iokibe and Sukeaki Sakai. Lond., Edinburgh, and Dublin Philosophical Mag. & Jl. Sci., vol. 42, no. 249, Sept. 1921, pp. 397–418, 17 figs. Gives results of experiments carried out with 13 different metals to measure rigidity and logarithmic decrement at ordinary and high temperatures.

MICROMETERS

Accuracy. Checking the Accuracy of Micrometer Measurements, Ellsworth Sheldon. Am. Mach., vol. 55, no. 14, Oct. 6, 1921, pp. 562–564. Notes on close measurements with micrometer; possibilities of error due to mechanical defects.

Recording Ultra-. The Recording Ultra-Micrometer, John J. Dowling. Engineering, vol. 112, no. 2906, Sept. 9, 1921, p. 395, 1 fig. States that both in physical laboratory and engineering, measurement of minute strains, displacements, expansions and the like, can be carried out with a degree of refinement altogether out of proportion with simplicity and reliability of apparatus. All measurements can be made from a distance and can be recorded by a recording galvanometer if desired. Paper read before British Assn. at Edinburgh.

MILLING CUTTERS

Forged High-Speed. Characteristics of the Forged Milling Cutter, William G. Galkins. Am. Mach., vol. 55, no. 11, Sept. 15, 1921, pp. 424–427, 10 figs. Methods of manufacture. Results of casting and forging high-speed steel. Structure of metal. Comparison of bar stock and forged steel.

MOLYBDENUM STEEL

Constituents. On Constituents Found in Tungsten and Molybdenum Steels, Albert M. Portevin. Iron & Steel Inst. advance proof for meeting Sept. 5–6, 1921, no. 5, 4 pp., 6 figs.; also Engineering, vol. 112, no. 2906, Sept. 9, 1921, pp. 372–373, 6 figs. As results of systematic investigation of special steels author has been able to effect disappearance of obviously hard states (martensitic or austenitic), and to establish fact that certain structures which might have been regarded as being in equilibrium, are superseded by others which represent an even more advanced state of equilibrium.

MOTION STUDY

Photographic Apparatus for. Photographic Apparatus for Motion Study (Hilfsmittel für Bewegungsuntersuchungen), R. Thun. Betrieb, vol. 3, no. 24, Sept. 5, 1921, pp. 771–779, 10 figs. Discusses motion pictures and photographic bases for time-motion studies. Describes apparatus for the taking and evaluation of motion pictures and compares two different kinds of motion photographs.

MOTOR PLOWS

German Ergomobil. The Ergomobil Motor Plow (Der Ergomobil-Motorseilpflug), A. Schilling. Oel- u. Gasmaschine, vol. 18, nos. 6, 7 and 8, June, July and Aug., 1921, pp. 96–97, 115–117 and 123–126, 15 figs. Details of rope-transmission plow with single-cylinder internal-combustion-engine drive, constructed by A. Borsig, Ltd., Berlin-Tegel.

Types. Motor-Driven Ploughs, Dr. Martiny. Eng. Progress, vol. 2, no. 8, August 1921, pp. 169–174, 21 figs. Discusses application of motor-driven plows; describes Stock, Wede, Hansa-Lloyd types.

MOTOR TRUCKS

Advantages. Trucks Pass the Tests of the Times, F. W. Fenn. Power Wagon, no. 202, September 1921, pp. 15–17 and 37. Gives figures showing decrease of horse traffic and increase of motor trucks, and gives examples of advantages of latter.

Dump Bodies. Making Dump Bodies for Motor Trucks. Iron Age, vol. 108, no. 15, Oct. 13, 1921, pp. 937–938, 2 figs. Specialized factory unit of Van Dorn Iron Works Co. arranged for convenience and economy in handling materials. Shipping room is abolished.

MOTORCYCLES

Engines. Machining Motor Cycle Engines. Eng. Production, vol. 3, no. 48, Sept. 1, 1921, pp. 205–210, 15 figs. Methods of J. A. Prestwich & Co., Ltd., Tottenham, London.

N

NICKEL ALLOYS

Nickel-Aluminum-Copper. The Properties of Some Nickel-Aluminium-Copper Alloys, A. A. Read. Inst. Metals advance paper for meeting Sept. 21–22, 1921, no. 1, 24 pp., 23 figs.; also Engineering, vol. 112, no. 2908, Sept. 23, 1921, pp. 453–456, 22 figs. Continuation of work described in Jl. Inst. Metals (vol. 11, no. 1, 1914, p. 169) in course of which a type of alloy was observed which, while extremely soft and ductile on quenching from 900 deg. cent., was considerably hardened by cooling. In present work the properties of alloys of this type are investigated more fully.

NOZZLES

Diffuser, Tests of. Tests with Diffusers ([Ueber Versuche mit Verdichtungsdüsen (Diffusoren)], August Riffart. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 35, Aug. 27, 1921, pp. 918–922, 44 figs. A diffuser is a wedge-shaped pipe section for conversion of flow velocity into pressure. Whereas in conversion of pressure into velocity efficiency of 96 to 98 per cent has been obtained, the reverse is possible only with great loss. Writer seeks to determine causes therefor based on phenomena of flow.

O

OIL ENGINES

Injection Type. The Rising Importance of Oil-Injection Type of Internal-Combustion Engine, Charles E. Lucke. Mech. Eng., vol. 43, no. 10, Oct. 1921, pp. 653–658 and 686, 24 figs. Review of development of internal-combustion engine from early gas-burning type to present-day injection engine capable of operating on any form of liquid fuel without explosive shock.

Marine. Some Observations on Marine Oil Engines, D. M. Shannon. Mech. Wld., vol. 70, no. 1808, August 26, 1921, pp. 163–164, 3 figs. Discusses systems of oil injection and states that for large marine engines the favorite mechanical injection system consists in having a common pressure main in which oil is kept at 3000 to 4000 lb. and to which all fuel valves are connected. (Continued.) Paper read before Inst. Mar. Engrs.

Piston Temperature Measurements. Temperature Measurements of Oil-Engine Pistons (Temperaturmessungen an Kolben von Oelmaschinen), W. Riehm. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 35, Aug. 27, 1921, pp. 923–925, 7 figs. Direct measurement of temperatures of uncooled pistons in Diesel engines under different operating conditions. Temperature distribution in piston heads of different shapes.

Still. Still Oil Engine for Marine Propulsion. Engineering, vol. 112, no. 2905, Sept. 2, 1921, pp. 344–345, 2 figs. Brief description of engine followed by extracts of report by deputation of French engineers of tests on experimental engine designed and built by Scotts' Shipbuilding & Eng. Co., Ltd., Greenock, England.

Vegetable-Oil Fuel. Using Vegetable Oils in Hot-Bulb Engines (Essais sur l'utilisation des huiles végétales dans les moteurs a boule chaude), M. Mathot. Bulletin Technique du Bureau Veritas, vol. 3, no. 7, July 1921, pp. 167–169. Results of tests show that with palm and cotton oil a hp-hour requires 265 grams in a 4-stroke 25-hp. engine, 320 grams in a 2-stroke 16-hp. engine, 285 grams in a 2-stroke 33-hp. engine, etc. Paper read before Association pour le perfectionnement du materiel colonial, at Brussels.

OIL FUEL

Chemical Research. The Role of the Chemist in Relation to the Future Supply of Liquid Fuel, Harold Hibbert. Jl. Industrial & Eng. Chem., vol. 13, no. 9, Sept. 1921, pp. 841–843. Discusses alcohol, saccharifying organisms, and sources other than alcohol. Read before Am. Chem. Soc.

Installations. The Installation of Oil as Fuel, Allen F. Brewer. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 361–364, 1 fig. Suggestions for selection of suitable equipment.

Mexican. The Production and Combustion of Mexican Fuel Oil—V and VI, J. M. Pettingell and J. R. Carlson. Combustion, vol. 5, nos. 3 and 4, Sept. and Oct. 1921, pp. 110–114, 6 figs. and 168–175, 6 figs. Describes features common to oil-burning plants and successful practice; various types of burners and furnaces.

Production and Use. Fuel Oil: Its Production and Use, W. A. Whyte. Petroleum Times, vol. 6, no. 133, July 23, 1921, pp. 133–135. Discusses Mexican oils, physical tests, etc. (Concluded.)

Vegetation. Motor Fuel from Vegetation, T. A. Boyd. Jl. Industrial & Eng. Chem., vol. 13, no. 9, Sept. 1921, pp. 836–841, 6 figs. Discusses shale, benzene, alcohol and cellulose as sources of motor fuel. Read before Am. Chem. Soc.

OILS

Linseed. A Study on the Oil Bromide Test of Linseed Oil, Thomas A. Davidson. Jl. Industrial & Eng. Chem., vol. 13, no. 9, Sept. 1921, pp. 801–806. Finds that the centrifuge is most satisfactory for separating oil bromides from reaction mixture, and volatility of either proved no drawback.

Viscosity. Viscosity-Temperature Curves of Fractions of Typical American Crude Oils, E. W. Dean and F. W. Lane. Jl. Industrial & Eng. Chem., vol. 13, no. 9, Sept. 1921, pp. 779–786, 7 figs. Determines curves for products derived from Pennsylvania, California and Wyoming crude oils.

Viscosity of Engine Oils, O. W. Franke. Power Plant Eng., vol. 25, no. 17, Sept. 1, 1921, pp. 847–848. Greasy friction is essential for reciprocating engines.

OPEN-HEARTH FURNACES

Acid. Acid Open-Hearth Practice (Der saure Martinofenbetrieb). Stahl u. Eisen, vol. 40, nos. 34 and 35, Aug. 26 and Sept. 2, 1920, pp. 1129–1135 and 1165–1170, 15 figs. on supp. plate. Refers to two works by B. Yaneske, and J. H. Whiteley and A. F. Hallimond, respectively, in Jl. Iron & Steel Inst. (vol. 99, no. 1, 1919), both based on the physical-chemical phase rules. Notes on presence of ferric oxide in furnace; regulation of degree of acid in slag; addition of lime; physical conditions during smelting; removal of carbon due to oxidation through gas; reaction between metal and slag; etc. (To be concluded.)

Design. Open-Hearth Furnace Design, A. D. Williams. Iron Age, vol. 108, no. 12, Sept. 22, 1921, pp. 719–721, 6 figs. Reversing valves and their effect on efficiency. Chimney areas and heights.

P

PAINTS

White Lead. Paints, Painting and Painters, With Reference to Technical Problems, Public Interests and Health, Henry E. Armstrong. Jl. Roy. Soc. Arts, vol. 69, no. 3588, August 26, 1921, pp. 655–682 and (discussion) 682–685, 4 figs. Discusses suggested prohibition of white lead; volatilization of lead and turpentine; volatile constituents of paint removers; risks and dangers due to mechanical operation; etc. Is against government interference.

PATTERNS

Storage. The Organization of Pattern Stores, H. Varley. Eng. & Indus. Management, vol. 6, no. 14, Oct. 6, 1921, pp. 374–376, 3 figs. Account of organization of stores shows how economy in time, money and labor may easily be effected by introduction of suitable system.

PISTON RINGS

Design. Important Factors in Piston-Ring Design, H. H. Platt. Jl. Soc. Automotive Engrs., vol. 9, no. 3, Sept. 1921, pp. 195–197 and (discussion) 197–199, 1 fig. Discusses diagonal and lap joints, design for gas tightness, oil leakage.

POWER GENERATION

Steam, Fuel Economy in. Fuel Economy by the Adoption of Scientific Management in Steam Generation and Utilisation, David Brownlie. Eng. & Indus. Management, vol. 6, no. 14, Oct. 6, 1921, pp. 393–394 and 396. Discusses cause of losses in steam generation, low-temperature carbonization, and flue-gas analysis.

POWER PLANTS

Design. Developments in Power Station Design—VI–XI. Engineer, vol. 132, nos. 3426, 3427, 3428, 3429, 3430, 3431, Aug. 26, Sept. 2, 9, 16, 23 and 30, 1921, pp. 214–216, 8 figs., pp. 234–235, 7 figs., pp. 258–260, 8 figs., pp. 282–284, 9 figs., pp. 324–325, 5 figs. and pp. 336–338, 6 figs. Aug. 26: The Scarab and Babcock oil burners. Sept. 2: The Thornycroft oil fuel burners; the White low-pressure system; the Lawton steam jet burner. Sept. 9: The Alldays & Onions, and White oil burners, and the Wilton burner for burning of all classes of liquid fuel. Sept. 16: Electrical distance thermometers and CO_2 recorders. Sept. 23: Describes Tozer retort for low-temperature carbonization of bituminous coal. Sept. 30: Tozer low-temperature carbonization power plant for South African Carbide & By-Products Co., Natal, with retorts, steam turbine and electric plant.

Economic Operation. The Economic Operation of Small Power Plants, Malcolm C. W. Tomlinson. Management Eng., vol. 1, no. 4, Oct. 1921, pp. 199–204, 4 figs. How to reduce wastage of coal, steam, water, electric power, and compressed air.

Evolution. Power-Plant Evolution, C. F. Hirshfeld. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 575–578. Discusses decrease brought about in cost of producing electric power, and of possibilities of further increasing plant efficiencies by use of higher steam pressures, air preheating, improved methods of feedwater heating, etc.

Ford Plant, River Rouge. New Ford Power Plant at River Rouge, Thomas Wilson. Power, vol. 54, no. 9, Sept. 6, 1921, pp. 348–353, 9 figs. Plant featured by large double-ended boilers having 26,470 sq. ft. of steam-making surface and burning simultaneously blast-furnace gas and powdered coal; complete electrical system and unique substation layout.

Toledo, Ohio. Acme Power Plant at Toledo. Power, vol. 54, no. 12, Sept. 20, 1921, pp. 434–442, 13 figs. A 200,000-kw. ultimate-capacity generating station, of which 40,000 kw. in two units has been installed. Prominent features of station are said to be coal handling, water supply, boiler room with unusual facilities for metering and control, and switchhouse.

PRESSES

Spring-Clip, Manufacture. Press Tools for the Manufacture of Spring Clips, J. J. Holloway. Machinery (Lond.), vol. 18, no. 469, Sept. 22, 1921, pp. 765–766, 6 figs. Describes operation of each tool.

Uses. Cutting Costs with the Power Press, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 96–101, 9 figs. How material and labor are saved by use of power presses.

PROFIT SHARING

Disadvantages. Thrift Encouragement by Employers—IV, Leonhard Felix Fuld. Indus. Management, vol. 62, no. 4, Oct. 1921, pp. 214–215. Writer explains his objections to profit-sharing dividends.

PULVERIZED COAL

Advantages and Disadvantages. Commission on Fuel Utilization (Commission d'Utilisation du Combustible). Revue de L'Industrie Minérale, no. 15, August 1, 1921, pp. 514–519. Third report Minister of Public Works. Discusses firing with pulverized coal and summarizes advantages and disadvantages.

Application. Application of Pulverized Coal (Renseignements sur l'emploi du charbon pulvérisé), Pierre Appell. Chaleur et Industrie, vol. 2, no. 16, August 1921, pp. 510–512. Gives results of tests made in boiler burning 200 kg. per hour.

Boilers. Powdered Coal Under Steam Boilers—III, H. D. Savage. Coal Trade Jl., vol. 52, no. 38,

of pulverized-fuel combustion.

Colloidal Mixtures. Pulverised Coal and Colloidal Mixtures, L. C. Harvey. Eng. & Indus. Management, vol. 6, no. 11, Sept. 15, 1921, pp. 310–312. Discusses merits and general features of pulverized coal and its admixture with liquid fuel.

Furnaces for Electrical Works. Pulverized-Coal Furnaces for Electrical Works (Kohlenstaubfeuerungen für Elektrizitätswerke), Friedrich Münzinger. Elektrotechnische Zeit., vol. 42, no. 5, Feb. 3, 1921, pp. 97–103, 10 figs. Systematic review and critical investigation of prospects of different construction types of pulverized-coal furnaces, especially from operative and economic viewpoint. Notes on preparation plant; combustion of pulverized coal; and adaptability of pulverized-coal furnaces for stationary steam boilers. Abstract of book entitled Pulverized-Coal Furnaces for Stationary Steam Boilers, published by J. Springer, Berlin.

Plant. Development of a Powdered Coal Plant, Charles Longenecker. Blast Furnace & Steel Plant, vol. 9, no. 9, Sept. 1921, pp. 567–569. Discusses grade of coal, powdered-coal equipment and furnace changes.

PUMPS

Air-Lift. Experiments on Air Lift Pumping, John S. Owen. Engineering, vol. 112, no. 2908, Sept. 23, 1921, pp. 458–461, 9 figs. Describes experiments made with view to ascertaining most efficient design for air-lift pump, for lifting acid mine liquors in mine in San Domingos, Portugal. Describes installation finally adopted, and gives lists of tests showing that it is quite possible to get pump efficiencies with air lifts of between 60 and 70 per cent. Paper read before British Assn.

PUMPS, CENTRIFUGAL

Flood-Proof Pump House. Novel Condenser Pump House. Elec. Ry. Jl., vol. 58, no. 11, Sept. 10, 1921, pp. 387–391, 9 figs. American Railways power plant at Kenova, W. Va., recently enlarged in capacity, now derives circulating water from new electrically driven centrifugal pumps, housed in a structure which is designed to be floodproof.

R

RAILS

Fissures. Causes of Fissures in Street-Railway Rails (Ursachen der Riffelbildung auf Strassenbahnschienen), P. Oberhoffer. Stahl u. Eisen, vol. 41, no. 33, Aug. 18, 1921, pp. 1137–1141, 14 figs. on supp. plate. Discusses results of tests (shown in tables) carried out on different makes of rails of the Berlin street railway, from which it is concluded that the character of section has a greater influence than quality of material used.

Grooved, Wear of. The Alternating Contact Action Between Car-Wheel Flanges and Grooved Rails on Curves (Die Wechselwirkung zwischen den Berührungskreisen des Räderpaares und des Bogengleises beim Rillenschienenoberbau), F. Hartmann. Verkehrstechnik, vol. 38, no. 19, July 5, 1921, pp. 294–295, 13 figs. Shows that where both flanges are in contact with groove sides, the layout is such that the wear and tear is only half as great as usual.

RAILWAY ELECTRIFICATION

Austria. Electrification of the Austrian Federal Railway (Einführung der elektrischen Zugförderung auf den österreichischen Bundesbahnen), C. Wlach. Elektrotechnische Zeit., vol. 42, no. 20, May 19, 1921, pp. 505–511, 8 figs. Abstract of officially accepted electrification program of Austrian Republic. It is expected to finish four main branches before end of 1925. Description of Austrian main roads which are to be electrified, together with description and sketches of four types of locomotives, all of which are 15,000-volt, 16²/₃-cycle a.c. machines.

France. French Railways Electrification—V and VI. Elec. Ry. & Tramway Jl., vol. 44, nos. 1072 and 1077, April 8 and May 13, 1921, pp. 164–165. April 8: Classification of locomotives according to axle arrangement. May 13: Three-phase system as applied to Simplon line, single-phase system as applied to Swiss Railways, and continuous current at high tension.

Holland. Railways Electrification in Holland. Elec. Ry. & Tramway Jl., vol. 45, no. 1095, Sept. 9, 1921, pp. 171–173. Concludes that electrification must be on the direct-current system and a 1500-volt working tension. Report of special commission.

Italy. Electrification Progress on Italian Railways, Giovanni B. Santi. Ry. Age, vol. 71, no. 10, Sept. 3, 1921, pp. 439–442, 6 figs. A number of hydroelectric plants are under construction, as fuel is expensive and hard to obtain.

Switzerland. Electrification Program of the Swiss Federal Railroads (Programme d'électrification des chemins de fer Fédéraux et consequences financières du remplacement de la traction a vapeur par la traction électrique). Bulletin Téchnique de la Suisse Romande, vol. 47, no. 18, Sept. 3, 1921, pp. 208–211, 5 figs. Compares cost of traction of trains at various prices of coal. (Concluded.)

The Electrification of the Swiss Federal Railways—I and II. Engineer, vol. 132, nos. 3431 and 3432, Sept. 30 and Oct. 7, 1921, p. 335 and 376–377, 1 fig. Abstract of paper by L. Thorman dealing with technical side of electric traction for main lines in so far as it affects electrification of Swiss Federal Railway. Points out successful use of 15,000-volt single-phase current in Switzerland.

RAILWAY OPERATION

Cost of Stopping Trains. The Cost of Stopping train resistance and analyzes cost of stopping.

Freight Traffic, Unit Cost Data for. Unit Cost Data For Freight Traffic. Ry. Gaz., vol. 35, no. 13, Sept. 23, 1921, pp. 458 and 462. Discusses simple method of recording work of freight and mixed trains in order to get ton-mile costs quickly.

Train Control. Train Control Problems Discussed in England. Ry. Signal Engr., vol. 14, no. 9, Sept. 1921, pp. 336–342. Problems of Automatic Train Control by W. J. Thorrowgood; Automatic Train Control by J. Beaumont; Elimination of Frost Trouble by E. W. Kolb; Stop or Proceed vs. Stop and Proceed by A. H. Rudd.

RAILWAY SIGNALING

Electric. Maintenance of A. C. Signal Apparatus, L. F. Viellard. Ry. Signal Engr., vol. 14, no. 9, Sept. 1921, pp. 347–350. Describes experience with a.c. signals and interlockers on Long Island R. R.

Principles of Alternating Current Signaling—VI, J. S. Holliday. Ry. Signal Engr., vol. 14, no. 9, Sept. 1921, pp. 350–352, 2 figs. Vector solutions of correct transformer voltage and distribution of energy between signal motor, slot-coil and lamps.

Position-Light Signal. New Design of Position Light Signal. Ry. Age, vol. 71, no. 12, Sept. 17, 1921, pp. 538–539, 3 figs. Discusses new Pennsylvania R. R. signaling system worked day and night by uncolored electric lights.

RAILWAY TIES

Machine for Cutting and Boring. Cross-Cutting, Adzing and Boring Machine for Railway Sleepers. Engineer, vol. 132, no. 3431, Sept. 30, 1921, pp. 353–354, 4 figs. partly on p. 348. Built by Indian State Railways by Thos. Robinson & Son, Ltd., Rochdale.

RAILWAY TRACK

Construction. On the Question of the Construction of the Road Bed and of the Track, E. F. C. Trench. Bul. International Ry. Assn., vol. 3, no. 8, August 1921, pp. 991–1086, 15 figs. Report deals with Great Britain, India, South Africa, Australia and New Zealand. Gives a large appendix containing answers to question from railways. Concludes that present conditions are satisfactory.

Maintenance. On the Question of the Maintenance and the Supervision of the Track, Earl Stimson. Bul. International Ry. Assn., vol. 3, no. 8, August 1921, pp. 977–990. Concludes that high costs are due to causes beyond the control of supervisory organizations; advises most direct contact between maintenance-of-way engineer and division engineer.

RAILWAYS

France. The Great French Railroad Lines in 1920 (Les résultats de l'exploitation des grands réseaux français de chemins de fer en 1920). Révue Générale des Chemins de Fer, vol. 40, no. 9, Sept. 1921, pp. 141–167. Discusses income and expenditure, rolling stock, traffic, fuel, wages, of the Nord, Est, P.L.M., P.O., Midi and Etat lines, giving numerous tables.

REDUCTION GEARS

Machining. Machining Turbine Reduction Gears. Machinery (Lond.), vol. 18, no. 460, July 21, 1921, pp. 481–483, 6 figs. Discusses methods adopted by W. Beardmore & Co. Dalmuir, Scotland.

REFRACTORIES

Physical Characteristics. Physical Characteristics of Specialized Refractories, M. L. Hartmann and W. A. Koehler. Am. Electrochemical Soc., advance paper no. 9, for Meeting, Sept. 29–Oct. 1, 1921, pp. 129–136, 1 fig. Series of tests to determine transverse breaking strength of each of ten refractories, at 20 and 1350 deg. cent. Chrome brick showed most decided drop in modulus of rupture, followed in order by bauxite, magnesia, fireclay and silica.

REFRIGERATING PLANTS

Fulton Market, Chicago. Fulton Market Cold Storage Plant, Chicago. Power, vol. 54, no. 13, Sept. 27, 1921, pp. 470–473, 4 figs. Describes economical synchronous-motor-driven refrigerating plant to have eventually 10,500,000 cu. ft. of storage space and 888 tons of refrigerating capacity. Compressors are two-stage machines with injection of liquid between stages and pipe coil in intermediate drum to precool ammonia liquor on its way to brine coolers.

Pipe for. Pipe for Refrigeration Systems. Southern Engr., vol. 36, no. 1, Sept. 1921, pp. 50–54, 8 figs. Discusses dependability, bursting pressure, threading principle of pipe, etc.

Reconstruction. Reconstruction of Ice and Cold Storage Plant. Ice & Refrigeration, vol. 61, no. 2, August 1921, pp. 91–93, 7 figs. Sherman Ice Co. Sherman, Texas.

Turbo-Compressor. Calculation of Turbo-Compressor Refrigerating Plant (Intorno al calcolo degli impianti frigoriferi a vapore d'acqua azionati da turbo-compressori), Luigi M. Brunelli. L'Industria, vol. 35, no. 15, August 15, 1921, pp. 334–337, 2 figs. Discusses Leblanc turbo-compressors and its application to refrigeration.

ROLLING MILLS

Matching and Doubling Machine. Mechanical Matcher Lowers Cost. Iron Trade Rev., vol. 69, no. 15, Oct. 13, 1921, pp. 948–950, 5 figs. Manual work involved in aligning and doubling hot rolled sheets is performed by motor-driven machine. Device designed by Lawrence C. Steele, Pittsburgh, is said to offer increased production.

108, no. 14, Oct. 6, 1921, pp. 859–864, 7 figs. Prominent features of new rolling mill in Chicago is pack cooling bed, said to be first installation of its kind in industry, and hot runout table, all rollers having individual motor drive, those next to bed being of swiveled cone type. See also article on same subject by George H. Manlove in Iron Trade Rev., vol. 69, no. 14, Oct. 6, 1921, pp. 869–873 and 880, 10 figs.

Plate Mills. A Plate Mill in Norway, Wilh. Krämer. Eng. Progress, vol. 1, no. 7–8, July–August 1920, pp. 267–270, 2 figs. Describes equipment and working processes of A. S. Norsk Valseverk's installation.

Roll Design. The Logic of Roll Design—V, W. H. Melaney. Blast Furnace & Steel Plant, vol. 9, no. 9, Sept. 1921, pp. 543–545, 3 figs. Proportion of wabbler to size of neck for various type mills is considered.

Rotary Piercing Machines. The Rotary Piercing Machine for Steel and Copper Billets, C. E. Davies. Engineering, vol. 112, nos. 2907, 2908, 2910 and 2911, Sept. 16, 23, Oct 7 and 14, 1921, pp. 397–399, 429–430, 495–496 and 527–528, 25 figs. Writer seeks to outline satisfactory theory for rotary piercer. Description and theory is obtained from translation of article published in Stahl u. Eisen (Sept. 1919), to which a short summary with remarks on design and use of rotary piercer in England are added.

Sheet Mills. The Possibility of Improved Methods of Rolling Sheet Steel, Sumner B. Ely. Mech. Eng., vol. 43, no. 10, Oct. 1921, pp. 670–671. Points out importance of proper heating in sheet-steel rolling and discusses possibility of a continuous sheet mill. Describes a successful Austrian continuous sheet mill.

RUBBER

Aging Tests. Ten Years' Experience With Aging Tests, William C. Geer. India Rubber Wld., vol. 64, no. 10, Sept. 1, 1921, pp. 887–892, 15 figs. Describes test that can be used for predicting probable effect of natural aging upon vulcanized rubber. Paper read at International Rubber Conference, Lond.

Substitutes. Rubber Substitutes and the Role They Play in Vulcanisation, D. H. Priestley and H. Skellon. Rubber Age, vol. 2, no. 7, Sept. 1921, pp. 351–352. Discusses unsaturated oils and oxydized oils, dark substitutes and white substitutes.

Vulcanization. Influence of Certain Organic Accelerators on Vulcanization of Rubber, George Stafford Whitby and Osman James Walker. Jl. Industrial & Eng. Chem., vol. 13, no. 9, Sept. 1921, pp. 816–819, 4 figs. Influence of 1 per cent of (a) piperidine piperidyl-dithocarbamate (b) hexamethylenetetramine, and (c) thiocarbanilide on the rate of vulcanization of a 90:10 rubber-surface mix etc. Presented before Am. Chem. Soc.

S

SAFETY ENGINEERING

Education in. Education in Safety Engineering as Given at the Lynn General Electric Engineering and Apprentice School, N. M. DuChemin. Safety Eng., vol 42, no. 3, Sept. 1921, pp. 106–112. Outline of lessons presented in ten lectures.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT

SHAPERS

Production Work, Use in. Production Shaping—I. Machy. (N. Y.), vol. 28, no. 2, Oct. 1921, pp. 89–93, 5 figs. Use of shapers in production work for planing column and table castings for Avey drilling machine.

SPECIFIC HEAT

Apparatus. New Specific Heat Apparatus, Ezer Griffiths. Physical Soc. of Lond. Proc., vol. 33, no. 190, August 15, 1921, pp. 355–361, 3 figs. Describes apparatus for determination of specific heat of cork, charcoal, etc., difficult to deal with by ordinary methods.

Lead. The Behaviour of Substances Near The Absolute Zero, William R. Fielding. Chemical News, vol. 123, no. 3201, August 19. 1921, pp. 97–99, 1 fig. Discusses specific heats of lead and gives tables for lead, water and copper.

STANDARDIZATION

German N.D.I. Report. Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 21, July 25, 1921, pp. 319–330, 14 figs. Accepted standards: Blank castel nuts, standard screw heads and points. Proposals of Board of Directors for cotter and taper-pin nut locking devices; sizes for technical photographic prints; proposed standards for steel window sash; concrete sewer pipes.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 22, Aug. 13, 1921, pp. 339–348, 16 figs. Proposals of Board of Directors for relative temperature of measuring tools and workpieces; drive and sunk keys, flat keys, saddle keys, fitted and sliding feather keys, gibhead keys, gibhead flat and saddle keys. Proposed standards for belt-pulley diameters; speeds for transmission gears; graphic representation by means of curves.

Report of the German Industry Committee on Standards (Mitteilungen des Normenausschusses der Deutschen Industrie). Betrieb, vol. 3, no. 23, Aug. 27, 1921, pp. 355–360, 7 figs. Proposals of

ENGINEERING INDEX (Continued)

Board of Directors for pressure stages for pipe lines; wires and cables for high-voltage overhead lines. Proposed standards for drawings.

STEAM

Flow Measurement. Steam Flow Measurements from a Boiler, C. T. Mitchell. Power, vol. 54, no. 9, Aug. 30, 1921, p. 318. Points out importance of constant pressure as regards accuracy of steam-flow records, and develops simple formula for calculating amount of steam given off by boiler for given pressure drop, independently of fuel consumption.

High-Pressure. High Pressure Steam in Small Power Plants—III, Charles L. Hubbard. Sanitary & Heating Eng., vol. 96, no. 7, Sept. 23, 1921, pp. 199–201, 9 figs. Disclosing functions and principles of steam specialties used in conjunction with power plants, and explaining their mechanical operations (To be continued.)

Specific Heat. The Various Determinations of the Specific Heat of Steam and Their Technical Significance, H. Schmolke. Mech. Eng., vol. 43, no. 10, Oct. 1921, pp. 675–677. Account of experiments carried out over pressure range of 2 to 8 atmos. and with temperatures ranging from around saturation to 350 deg. cent., and other investigations. Translated from Zeit. für Dampfkessel u. Maschinenbetrieb, vol. 44, nos. 1 and 2, Jan. 7 and 14, 1921.

STEAM ENGINES

Throttle Valves. Throttle Valves for Steam Engines, W. H. Wakeman. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 372–373, 7 figs. Various types.

Uniflow. Straight-Flow High-Lift Poppet-Valve Steam Engine, J. Stumpf. Mech. Eng., vol. 43, no. 8, Aug. 1921, pp. 541–542, 6 figs. Describes engine in which, it is claimed, losses due to cylinder condensation, clearance space, throttling, friction, leakage, heat radiation, heat conduction and imperfect expansion are reduced. Its most characteristic element is said to be the very small high-lift nozzle-disk valve employed therein. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 19, May 7, 1921.

200 Hp. Uniflow Steam Engine. Engineer, vol. 132, no. 3426, Aug. 26, 1921, pp. 222–224, 5 figs. Describes engine constructed by Galloways, Ltd., Manchester, England, most novel features of which are said to be shockless high-speed valve gear and a compression release device designed by Henry Piling.

STEAM GENERATION

Waste-Heat Utilization. Waste Heat Utilization For Steam Generation, G. R. McDermott. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 9, Sept. 1921, pp. 293–319, 7 figs. Gives particulars of tests with waste heat boilers and discusses sources of waste gases, including those from large gas engines.

STEAM GENERATORS

Electric. An Electric Steam-Generator For Low Voltage, F. A. Lidbury and F. A. Stamps. Am. Electrochemical Soc., advance copy, no. 4, pp. 77–86, 2 figs. Describes an inexpensive form of apparatus for the generation of steam by means of alternating current of voltages from 100 to 500. (Abstract.)

STEAM PIPES

Resistance Reduction. Savings Effected by Reducing the Resistance in Steam Pipe Lines (Ersparnisse durch Verminderung der Widerstände in Dampfleitungen), O. Denecke. Zeit für Dampfkessel u. Maschinenbetrieb, vol. 44, no. 26, July 1, 1921, pp. 201–204, 2 figs. Total pressure reduction through friction and various resistances. Determination of diameter of pipe with given pressure reduction for any given resistances. Curve is given with which it is possible to read pipe diameter for any steam volume, pipe length, variation of pressure and of the various resistances.

STEAM POWER PLANTS

Condensation in Turbine Room. Condensation in Turbine Rooms of Steam Power Stations, L. J. Towne. Stone & Webster Jl., vol. 29, no. 3, Sept. 1921, pp. 119 225. Condensation on walls and ceilings especially inconvenient during winter months. How condensation occurs and fundamental principles which will prevent or minimize this trouble.

Buick Motor Co. The New Buick Plant. Power Plant Eng., vol. 25, no. 17, Sept. 1, 1921, pp. 835–845, 14 figs. Describes coal-handling equipment, engine and boiler room, wood-burning equipment and electric equipment of Buick Motor Co., a subsidiary of General Motors Corp.

Hydraulic-Relay. Requirements in the Design of Steam Power Stations for Hydraulic Relay, E. B. Powell. Mech. Eng., vol. 43, no. 10, Oct. 1921, pp. 650–652 and 674, 6 figs. Flow or head deficiency type of relay; effect of growth of load, seasonal variation of flow and pondage; relay stations for minimum flow development and for higher-load-factor conditions. Emergency reserve type of relay.

Oil-Burning. Efficient Operation of Oil-Burning Steam Plants, C. H. Delany. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 603–605, 4 figs. Discussion of plant characteristic diagram, with particulars regarding its use in establishment of standard of performance and in increasing plant efficiency.

STEAM TRAPS

Types. Steam Traps—Types, Principles of Operation, Selection, Installation, Troubles, Remedies, L. A. H. Merrihew. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 378–381, 4 figs. Savings by proper use of traps; advantages and disadvantages of each type.

STEAM TURBINES

Bleeder. Estimating Steam Consumption of Bleeder Turbines, Joseph Gershberg. Power, vol. 54, no. 15, Oct. 11, 1921, pp. 556–557, 1 fig. Explains convenient method of estimating steam consumption at given load and with given amount of steam being bled.

Curtis Impulse. Efficiency Tests of a 30,000 kw. Turbine, Herbert B. Reynolds. Power House, vol. 14, no. 16, August 20, 1921, pp. 21–25 and 27, 8 figs. Turbines are of Curtis impulse type having twenty pressure stages. Gives tables of turbine, condenser and dry-vacuum-pump tests.

Design. Recent Developments in Steam Turbine Design, C. J. Everett. Trans. S. African Inst. Elec. Engrs., vol. 12, part 7, July 1921, pp. 131–142, 10 figs. Discusses impulse type; Curtis impulse; reaction type; radial-flow type; steam, shaft, and disk packings; blading; etc.

Developments. Some Recent Developments in Large Steam Turbine Practice, K. Baumann. Jl. Instn. Elec. Engrs., vol. 59, no. 302, June 1921, pp. 565–623 and (discussion) 623–663, 49 figs. Part I—Discusses general trend of development, reaction turbines, impulse turbines, turbines for special purposes. Part II—Discusses reliability, working conditions, thermodynamic efficiency, overall dimensions, weights and costs in connection with turbine design. Part III—Economic rating of a given turbine frame. Part IV—Maximum output of turbines at a given speed. Part V—Governing of steam turbines. Part VI—Steam consumption guarantees and test results of large turbines. Part VII—Operation experience with large turbines.

Efficiency Tests. Efficiency Tests of a 30,000-Kw. Steam Turbine, Herbert B. Reynolds. Mech. Eng., vol. 43, no. 7, July 1921, pp. 450–454 and 460, 8 figs. Account and results of tests carried out during 1920 on General Electric turbines at 59th St. power station of Interborough Rapid Transit Co., New York City. These turbines are of straight Curtis impulse type, having 20 pressure stages, each pressure stage consisting of one velocity stage; speed is 1500 r.p.m.

Foundations. Steam Turbine Foundations of Reinforced Concrete (Dampfturbinen-Fundamente aus Eisenbeton), Paul Müller. Bauingenieur, vol. 2, nos. 16 and 17, Aug. 31 and Sept. 15, 1921, pp. 436–439 and 474–478, 14 figs. Writer seeks to determine influence of dynamic action of turbo-compressors and generators on their foundations, and recommends basic form for such foundations which, with minimum use of material, is qualified to withstand all such unfavorable influences.

Heat Balance. Heat Balance with House Turbine. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 382–383, 2 figs. Layout of system for obtaining heat balance with house turbine.

High-Capacity. Steam Turbines for Maximum Loads, A. Loschge. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 607–608, 2 figs. Discusses magnitudes which determine value of maximum output of turbine, technical difficulties which have to be overcome in order to make a higher output possible, and ways and means adopted by various concerns to overcome these difficulties. Translated from Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 28, July 9, 1921.

Safe Operation. Safety Precautions in the Operation of Large Turbines. Power, vol. 54, no. 10, Sept. 6, 1921, pp. 354–357, 5 figs. Practical pointers on avoiding turbine injury due to spindle deflection, blade rub, dummy rub and other causes, together with rules for starting and stopping large turbines.

[See also MARINE STEAM TURBINES.]

STEEL

Bars, Specification for. British Standard Specification for Steel Bars for the Production of Machined Parts. British Eng Standards Assn., no. 32, May 1921, 13 pp., 4 figs. Specification of bars for production of machined parts suitable for automatic, semi-automatic and turret lathes. Tables of round, square and hexagon bars; Appendix giving forms of British standard tensile test pieces.

Coalescence in. Contributions to the Study of Coalescence in Steels and Its Commercial Results, Albert Portevin and Victor Bernard. Iron & Steel Inst. advance proof for meeting Sept. 5–6, 1921, no. 6, 35 figs., 10 figs. Experiments are said to afford abundant evidence of influence of initial structural state on solution of cementite during heating, on its precipitation on cooling, and therefore on general result of quenching.

Corrosion. Rust Prevention by Slushing, Haakon Styri. Am. Electrochemical Soc. advance paper no. 8, for Meeting, Sept. 29–Oct. 1, 1921, pp. 113–128. It is shown that a prerequisite for protection against rust by greases is a thorough cleaning of steel parts by an aqueous solution, preferably by oil emulsion which leaves a thin oil film for short time protection.

Damascene. Damascene Steel, N. T. Belaiew. Iron & Steel Inst. advance proof for meeting Sept. 5–6, 1921, no. 1, 4 pp., 1 fig.; also Engineering, vol. 112, no. 2906, Sept. 9, p. 395, 1 fig. In author's opinion a marked analogy exists in structure and in some of properties of high-speed and damascene steels, and a comparative study of both is presented.

Elasticity. On the Temperature Coefficient of the Modulus of Longitudinal Elasticity of Steel, H. M. Dadourian. Lond., Edinburgh, and Dublin. Phil. Mag. & Jl. Sci., vol. 42, no. 249, Sept. 1921, pp. 442–448. Reviews work done on the subject and describes additional experiments.

Fatigue Resistance. Fatigue Resistance of Steel under Repeated Combined Stresses, Akimasa Ono. Jl. Soc. Mech. Engrs. & Soc. Nav. Architects, Sept. 1921. (In Japanese.)

Fracture. Woody Fracture in Steel (Ein Beitrag zur Frage des Holzfaserbruches im Stahl), J. Hanny. Stahl u. Eisen, vol. 41, no. 37, Sept. 15, 1921, pp. 1298–1300. Shows how in production of gun steel, it was possible to prevent formation of woody fracture, through measures based on assumption that inclusions of carbon-monoxide bubbles originating in oxides are the cause of such formations.

Mechanical Properties. An Experimental Investigation of the Mechanical Properties of Steels at High Temperatures, E. L. Dupuy. Engineering, vol. 112, nos. 2906 and 2907, Sept. 9 and 16, 1921, pp. 391–394 and 427–428, 33 figs.; also Iron & Steel Inst. advance proof, Sept. 1921, no. 2, 22 pp., 33 figs. Determination of mechanical properties of steels in respect of their carbon percentages, at all temperatures between normal and incipient fusion. Experiments were carried out on both cast and rolled material.

Physics in. New Discussion on the Physics of Steel, Wm. R. Webster. Blast Furnace & Steel Plant, vol. 9, no. 9, Sept. 1921, pp. 555–563. Application in rolling of effects of carbon, phosphorus and manganese on mechanical properties of steel.

Special. On the Question of Special Steels, M. Sand. Bul. International Ry. Assn., vol. 3, no. 8, August 1921, pp. 1103–1107. Discusses trials with cast manganese steel and Edelstahl cast-steel crossings, also Sandberg process applied to rails of basic open-hearth high-silicon steel.

Tensile Tests. Elongation and Gauge Length in Tensile Tests, J. H. G. Monypenny. Engineer, vol. 132, no. 3426, Aug. 26, 1921, pp. 220–221, 2 figs. Results of series of comparative tests on a large series of steels to see if it were possible to fix some approximate relationship for commercial use between values obtained on British standard test piece on one hand and French and German types on the other.

Testing. Test for Shock Strength of Hardened Steel, C. E. Margerum. Forging & Heat Treating, vol. 7, no. 9, Sept. 1921, pp. 488–490, 3 figs. Describes apparatus to determine ability to resist impact and gives curves of various impact strength tests. Paper presented before Am. Soc. for Testing Materials.

The Influence of the Width of the Specimen Upon the Results of Tensile Tests of Mild Steel and Rolled Copper, T. Hudson Beare and William Gordon. Engineering, vol. 112, no. 2906, Sept. 9, 1921, pp. 389–391, 6 figs. Results of experiments show that, as final thickness is shown to be practically constant for all widths of specimen, decline in percentage of reduction of area is due to gradual diminution in proportional reduction of width. Paper read before British Assn. in Edinburgh.

The Influence of the Width of the Specimen Upon the Results of Tensile Tests of Mild Steel and Rolled Copper, T. Hudson Beare and William Gordon. Metal Industry (Lond.), vol. 19, no. 12, Sept. 16, 1921, pp. 209–212, 6 figs. Details of experiments carried out. Paper read before British Assn.

Worked, Structure of. Structure of Worked Steel as Shown by Etched Sections (Kraftwirkungsfiguren in Flusseisen, dargestellt durch ein neues Aetzverfahren), Ad. Fry. Stahl u. Eisen, vol. 41, no. 32, Aug. 11, 1921, pp. 1093–1097, 19 figs. Describes new etching process which, under certain conditions, reveals peculiar, heretofore unobserved figures; and the brittleness of iron at blue heat is traced to these phenomena.

[See also ALLOY STEEL; CHROME-NICKEL STEEL; MANGANESE STEEL; MOLYBDENUM STEEL; STEEL, HIGH-SPEED.]

STEEL, HEAT TREATMENT OF

Annealing. A Metallographic Characteristic for the Determination of the Pre-Heating of Soft Low-Carbon Steel (Ueber ein metallographisches Kennzeichen für die Ermittlung der vorangegangenen Glühbehandlung von weichem Flusseisen), P. Oberhoffer. Stahl u. Eisen, vol. 41, no. 35, Sept. 1, 1921, pp. 1215–1217, 8 figs. Describes characteristic in structure which makes it possible to determine whether annealing has taken place between Ac_1 and Ac_3.

Cast Steel. The Thermal Treatment of Cast Steel, Alvin N. Conarroe. Trans. Am. Soc. for Steel Treating, vol. 1, no. 12, Sept. 1921, pp. 746–757, 35 figs. Concludes that steel castings can be refined by heat treatment to possess physical characteristics comparable to forgings; also considers inclusions, segregation, shrinkage, etc.

Characteristic Curves. The "Characteristic Curves" of the Heat Treatment of Steels, Albert M. Portevin and Pierre Chevenard. Iron & Steel Inst., advance proof for meeting Sept. 5–6, 1921, no. 7, 19 pp., 11 figs. So-called characteristic curves combine, within a single diagram, fundamental data of every possible heat treatment, and also afford a means of defining accurately the annealed and hardened states of the particular steel.

Drop Forgings. Effect of Heat-Treatment on Steel Castings and Drop Forgings, A. A. Blue. Am. Mach., vol. 55, no. 11, Sept. 15, 1921, pp. 413–418, 26 figs. Results of tests at different stages in heat treatment. Chemical analyses and their results.

Hardened Carbon Steel. Thermal and Physical Changes Accompanying the Heating of Hardened Carbon Steels, Howard Scott and H. Gretchen Movius. Trans. Am. Soc. for Steel Treating, vol. 1, no. 12, Sept. 1921, pp. 758–774, 12 figs. Discusses in detail the transformations in steel below the A_1 change.

Overheating, Effect of. Effect of Overheating High Carbon Steel, Lancelot W. Wild. Blast Furnace & Steel Plant, vol. 9, no. 9, Sept. 1921, pp. 541–542. Heating to the completion of the magnetic change before quenching gives strongest, toughest, best wearing and best cutting steel.

Quenching. Cooling Oil for Quenching Tanks, S. E. Derby. Iron Trade Rev., vol. 69, no. 11, Sept. 15, 1921, pp. 674–676, 5 figs. Proper speed of

ENGINEERING INDEX (Continued)

cooling steel is said to be determining factor in attaining degree of hardness; after determining best temperature of medium, it should be maintained by suitable cooling system.

Steel Castings. Heat Treating Improves Castings, Martin M. Rock. Iron Trade Rev., vol. 69, no. 11, Sept. 15, 1921, pp. 677–679. Tensile tests of unannealed, annealed, air-cooled and water-quenched steel castings do not disclose marked difference in strength, but impact tests show water-quenched product excels other three.

Stresses. Stresses Resulting from Heat Treatment (Das Entstehen von Spannungen bei der Wärmebehandlung), W. Tafel. Stahl u. Eisen, vol. 41, no. 38, Sept. 22, 1921, pp. 1321–1328, 13 figs. It is shown that every heat treatment of a spherical, prismatic or cylindrical body changes its state of stress, based on which the principal deformations in connection with hardening are derived and conclusions arrived at relative to annealing and hardening of steel.

Tempering. Changes Taking Place in Steels During Tempering (Sur la nature des transformations qui se produisent pendant la trempe des aciers), M. P. Dejean. Revue de Métallurgie, vol. 18, no. 7, July 1921, pp. 419–427, 7 figs. Discusses critical points in cooling of nickel steel, carbon steel, manganese steel, etc.

On the Tempering Phenomena of Steels (Remarque et observations concernant les phénomènes de trempe des aciers), Portevin and P. Chevenard. Revue de Metallurgie, vol. 18, no. 7, July 1921, pp. 428–444, 16 figs. Discusses cooling and elongation curves, cementite formation, etc. in ferro-nickel system.

Volume Changes. Volume Changes in the Heat Treatment of Steel, Leslie Aitchison. Trans. Am. Soc. for Steel Treating, vol. 1, no. 12, Sept. 1921, pp. 734–737, 2 figs. Gives curves showing alterations in volume during heating and cooling.

STEEL, HIGH-SPEED

Heat Treatment. Heat Treatment of High Speed Steel, J. L. Thorne. Trans. Am. Soc. for Steel Treating, vol. 1, no. 12, Sept. 1921, pp. 727–732 and (discussion) 732–733. Discusses composition, influence of principal elements, and various stages of heat treating.

Metallurgy of. The Metallurgy of High Speed Steel, D. M. Giltinan. Trans. Am. Soc. for Steel Treating, vol. 1, no. 12, Sept. 1921, pp. 716–726, 10 figs. Discusses present requirements of high-speed steels to meet demand for increased production without increased cost; theories of self-hardening.

STEEL WORKS

Anti-Friction Bearings. Anti-Friction Bearings in the Steel Mill, A. M. MacCutcheon. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 9, Sept. 1921, pp. 321–350, 16 figs. Discusses advantages and disadvantages of anti-friction and oil ring type of bearings, development of ball and roller bearings, mounting of anti-friction bearings and experiences in various mills.

Fuel Requirements. Fuel Requirements of Steel Mills, F. E. Leahy. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 9, Sept. 1921, pp. 427–435. Discusses application of solid, gaseous and liquid fuels, also pulverized coal.

Railway Electrification. Electrification of the Steel Plant Railroad, R. B. Gerhardt. Assn. Iron & Steel Elec. Engrs., vol. 3, no. 9, Sept. 1921, pp. 277–291. Concludes that electric motor will displace steam engine just as happened in rolling mills.

STOKERS

Capacity and Limitations. Capacity and Efficiency Limitations of Stokers Using Mid-West Coals, John E. Wilson. Mech. Eng., vol. 43, no. 8, Aug. 1921, pp. 536–537 and 561. In case of natural-draft chain-grate stokers, greatest losses are said to be those due to dry chimney gases and carbon in ash. Capacity is governed principally by available draft and ratio of total boiler heating surface to grate area. Notes on use of underfeed and overfeed forced-draft stokers in Mid-West.

Limitations. Limitations of Mechanical Stokers Utilizing Mid-West Coals, Edward H. Tenney. Mech. Eng., vol. 43, no. 8, Aug. 1921, pp. 535–536. Points out that Mid-West coals are characterized by higher moisture, volatile and ash contents as compared with Eastern coals. Discusses limitations imposed by air supply and by design of furnace; and effect of these various limitations on stoker operation. (Abstract.)

Low-Grade Fuel. Stoking Inferior Fuels, A. Wirth. Eng. Progress, vol. 2, no. 8, August 1921, pp. 185–189, 27 figs. Discusses grates, traveling stokers, removal of slag and ashes.

Traveling Grate Regulators. Speed Regulators for Traveling Grates (Geschwindigkeitsregler für Wanderroste), H. Generlich. Zeit. des Vereines deutscher Ingenieure, vol. 65, no. 36, Sept. 3, 1921, pp. 943–944, 5 figs. Describes device for automatic regulation of speed of grate.

SUPERHEATED STEAM

Use in Sugar Factories. The Employment of Superheated Steam in Sugar Factories, E. de Bernard. La. Planter & Sugar Mfr., vol. 47, no. 13, Sept. 24, 1921, p. 202, 1 fig. Points out that in order to employ superheated steam, it is necessary to have separate boilers for supplying machine developing motive power and for supplying steam to evaporators, as then different pressures in both cases may be developed.

SUPERHEATERS

Design and Calculation. Steam Superheaters: Their Design, Construction, Application and Use, H. B. Oatley. Mech. Eng., vol. 43, no. 10, Oct. 1921, pp. 663–669, 15 figs. Fundamentals of design and materials used. Characteristics and details of locomotive, marine and stationary superheaters. Operating conditions where reciprocating or rotating prime movers used superheated steam. Results obtained by using superheated steam.

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TEMPERATURE MEASUREMENT

Radiation of Energy. The Measurement of Temperature—XIV, P. Field Foster. Mech. World, vol. 70, no. 1811, Sept. 16, 1921, pp. 225–226, 3 figs. Discusses radiation, or transmission, of energy without the aid of intervening matter. (To be continued.)

TERMINALS, LOCOMOTIVE

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Air Conditioning. Air Conditioning in Textile Mill (in Japanese), Masanosuke Yanagimachi. Jl. Soc. Mech. Engrs., Tokyo, Japan, vol. 24, no. 69, June 1921, pp. 11–23, 3 figs.

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Utilization. The Utilisation of Tidal Power, with Special Reference to the Severn Estuary, F. C. Lea. Engineering, vol. 112, no. 2907, Sept. 16, 1921, pp. 424–426, 8 figs. Writer summarizes preliminary work and investigations necessary before decisions are come to, relative to use of tidal estuaries for power purposes. Paper read before British Assn.

Transmission of Electrical Energy and Tidal Power, T. F. Wall. Engineer, vol. 132, no. 3431, Sept. 30, 1921, p. 345. Brief preliminary outline of system obviating difficulty of varying speeds of turbines, and permitting use of a.c. generators driven directly from turbines. (Abstract.)

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Foundries. Time Studies in the Foundry, A. G. Peter. Indus. Management, vol. 62, no. 4, Oct. 1921, pp. 244–250, 3 figs. Describes method of graphic analysis of molding work, and its successful operation at Chain Belt Co., Milwaukee, Wis.

Stop-Watches. More Jobs for the Factory Stop-Watch—I. Factory, vol. 27, no. 4, Oct. 1921, pp. 473–475, 1 fig. Describes development of stop-watches and different types which are available for different industrial uses.

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Analysis of Production. Analysing Tool Production Problems. Eng. & Indus. Management, vol. 6, no. 14, Oct. 6, 1921, pp. 370–373, 9 figs. Describes method of analysis and gives results of alternative methods of machining and set-up.

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Cletrac. Smaller Tractor Added to Cleveland Line, J. Edward Schipper. Automotive Industries, vol. 45, no. 10, Sept. 8, 1921, pp. 454–457, 6 figs. Describes the "Cletrac" built by Cleveland Tractor Co.; weighs 1820 lbs. and can plow 6 to 8 acres a day; can perform other farm tasks.

TRADE UNIONS

Influence on Production. Some Thoughts on Modern Trade Unionism—II, Edward Brown. Eng. & Indus. Management, vol. 6, no. 9, Sept. 1, 1921, pp. 237–239. Its influence on production.

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Steel. Investigation of the Effect of the Ratio of Diameter to Gage Thickness Upon the Torsional Strength of Steel Tubing. Air Service Information Circular, vol. 3, no. 263, July 20, 1921, 11 pp., 6 figs. Research of investigation showing that modulus of rupture of thin wall steel tubing varies with relation to diam./thickness.

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Air Filtration in Buildings. A Study of the Infiltration of Air in Buildings, F. Paul. Jl. Am. Soc. Heating & Ventilating Engrs., vol. 27, no. 6, Sept. 1921, pp. 671–676, 5 figs. Supplementary to report by O. W. Armspach in same journal (Jan. 1921), explaining fundamental principles of experiments being conducted, methods followed, etc. Present report contains explanation of several changes and refinements introduced and report of 25 tests conducted in seven different rooms in five different buildings.

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Piecework Payment System. Piecework and Production, H. Varley. Eng. & Indus. Management, vol. 6, no. 11, Sept. 15, 1921, pp. 291–292. Advantages and disadvantages of piecework payment system. Elements of a successful system of payment.

Premium System. The 100 Per Cent Time Premium Plan, L. V. Estes. Management Eng., vol. 1, no. 4, Oct. 1921, pp. 231–234. How it is applied to payment of wages for both individual and gang effort.

System. The Wages System and Possible Developments. Eng. & Indus. Management, vol. 6, no. 13, Sept. 29, 1921, pp. 346–349. Abstract of paper entitled Principals of Wages Determination by W. L. Hichens, and one entitled Grading of Labour, by A. W. Kirkaldy, read before British Assn.

WASTE ELIMINATION

Industrial. Federated American Engineering Societies Reports on Elimination of Waste in Industry. Ry. & Locomotive Eng., vol. 34, no. 9, Sept. 1921, pp. 245–246. Review of report.

Report on Elimination of Waste in Industry. Mech. Eng., vol. 43, no. 9, Sept. 1921, pp. 579–583. Committee authorized by Am. Eng. Council and appointed by Herbert Hoover points out wastes and recommends steps for elimination.

Save and Have, Harold D. Winney. Indus. Management, vol. 62, no. 4, Oct. 1921, pp. 216–220 3 figs. How war on waste at Gen. Elec. Co.'s largest plant (Schenectady) is conducted.

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Recovery and Application. The Utilization of Exhaust and Intermediate Pressure Steam, H. Dubbel. Eng. Progress, vol. 1, no. 5, May 1920, pp. 173–179, 17 figs. Discusses waste-heat recovery and its various applications.

WATER HAMMER

Elimination. Water Hammer in Pipes and Its Elimination [Stosserscheinungen in hydraulischen Systemen (Rohrleitungen) und ihre Bekämpfung], H. Schneider. Betrieb, vol. 3, no. 23, Aug. 27, 1921, pp. 738–743, 7 figs. Simple ratios for impact pressure increases in hydraulic systems are derived, and means for combating them described.

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Development. Notes on Water-Power Development, A. H. Gibson. Engineering, vol. 112, no. 2907, Sept. 16, 1921, pp. 420–422; also Engineer, vol. 132, nos. 3428 and 3429, Sept. 9 and 16, 1921, pp. 273–274 and 301–302. Notes on world's available water power; power available in Great Britain and British Empire; uses of hydroelectric energy; conservation; scope for future development and modern tendencies in hydroelectric development. Among questions still requiring investigation are mentioned: turbines, dams, run-off data, tidal power, etc.

Main and Danube Rivers. Hydroelectric Power Resources Along the Main-Danube Waterway in Bavaria (Die Grosswasserkräfte an der Main-Donau-Wasserstrasse in Bayern). Elektrotechnische Zeit., vol. 42, no. 20, May 19, 1921, pp. 511–514, 5 figs. Review of book by J. Hallinger, Munich, giving results of investigation of possibilities of large water powers. Waterway in its present form would yield 100,000 hp., but with some additions and connections with other watersheds, 1,000,000 may be obtained. Sketches of proposed sites are included.

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Hammer. Welding; Particularly Hammer Welding, Ernest Edgar Thum. Chem. & Met. Eng., vol. 25, no. 12, Sept. 21, 1921, pp. 553–561, 18 figs. Brief discussion of various modern methods of welding, indicating advantages and limitations of each, and field for hammer-welding heavy pressure vessels; operations necessary for hammer-welding steel sheets.

Hyde Process. The Hyde Welding Process. Engineering, vol. 112, no. 2905, Sept. 2, 1921, pp. 338–339, 15 figs. partly on supp. plate. Method of uniting iron and steel which partakes of nature of both welding and brazing; consists of uniting surfaces by means of molten copper, the copper impregnating masses of metal to be joined and uniting them in such a way that they cannot again be separated by heat.

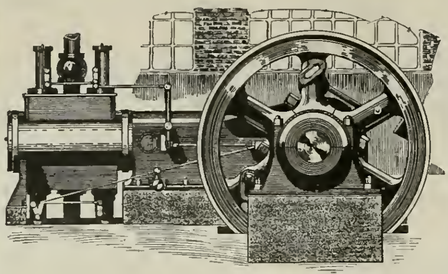
Rail Joints. Welding Rail Joints. Welding Engr., vol. 6, no. 8, August 1921, pp. 23–25, 11 figs. Discussion of work done on street railways by Lincoln process.

Thermit and Electric Rail. The Thermit and the Electric Welding Processes with Special Regard to Welding of Rails (Das Thermit-Schweissverfahren und das elektrische Schweissverfahren unter besonderer Berücksichtigung der Schienenschweissung), H. Lange. Elektrotechnische Zeit., vol. 42, no. 27, July 7, 1921, pp. 722–724, 4 figs. Discussion of most important systems.

[See also AUTOGENOUS WELDING, ELECTRIC WELDING; ELECTRIC WELDING, ARC.]

WIND TUNNELS

Balances for. The Bifilar Windbalance, A. F. Zahm. Jl. Franklin Inst., vol. 192, no. 2, Aug. 1921, pp. 233–237, 3 figs. For delicate measurement of air resistance along stream, in a wind tunnel. Practical usefulness.



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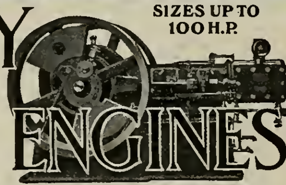

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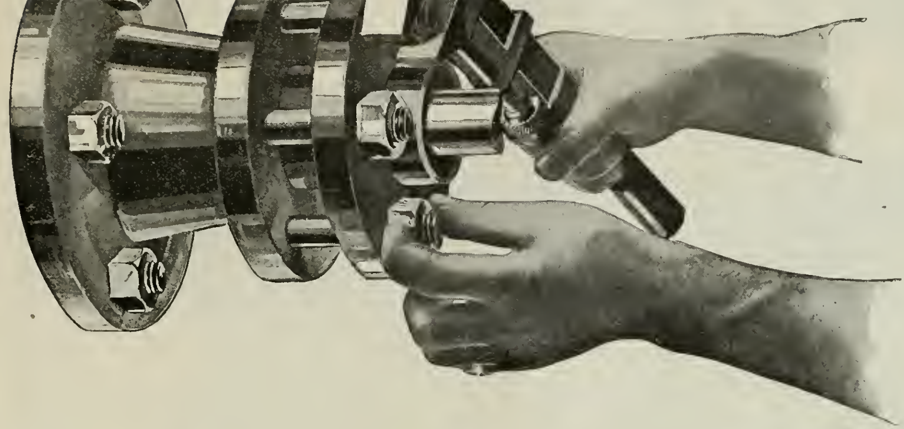
gland nuts than forcing them with a wrench—a way that makes both rod and packing last longer. Read about it.



How do you pull up gland nuts?

With a wrench?

WHEN you pull up gland nuts tight with a wrench, you may stop leakage. But when you've stopped the leak, the packing grips the rod tighter than before—the only reason why inert packing packs at all. But the power required to force the rod through tightly jammed packing and the resulting destructive wear are often more expensive than the leak.

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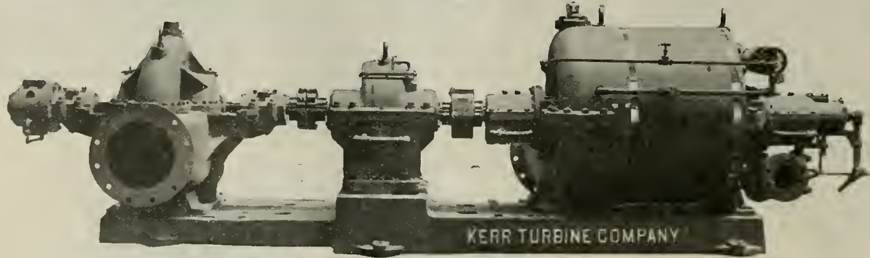

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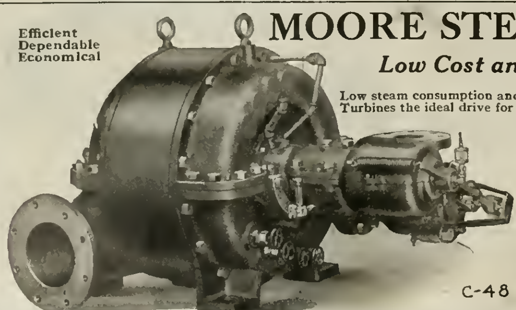

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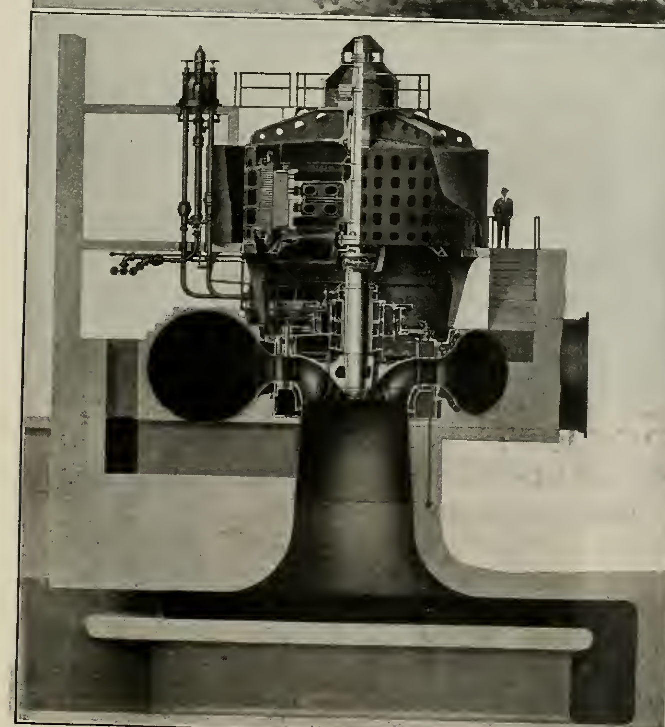

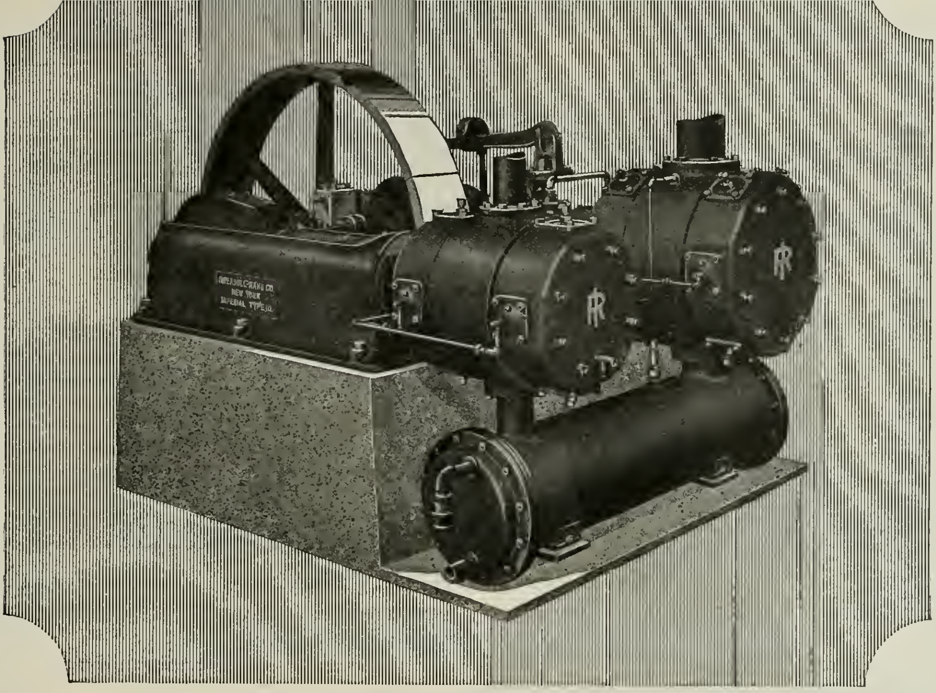

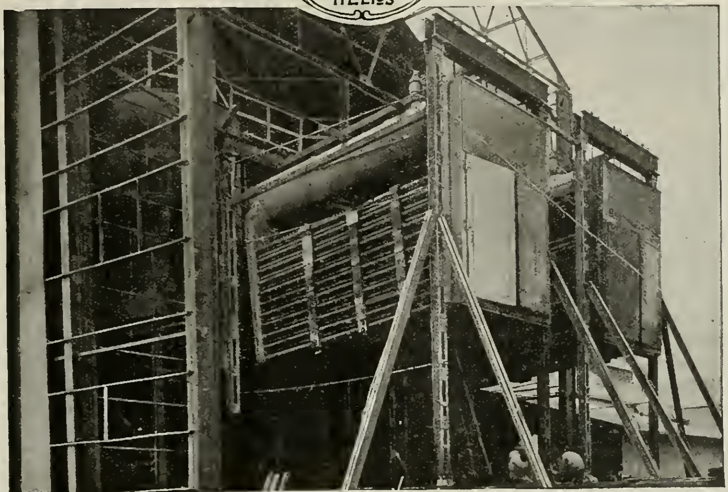

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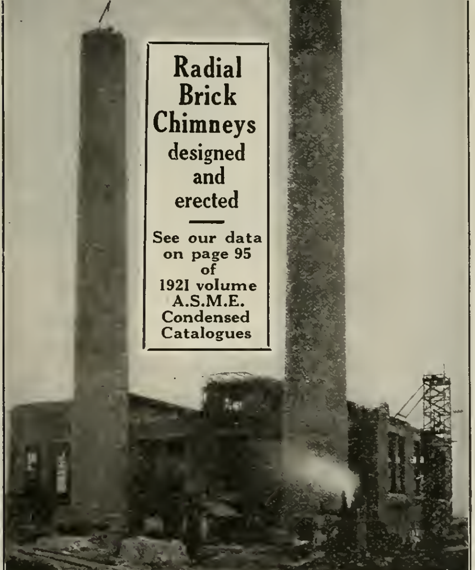

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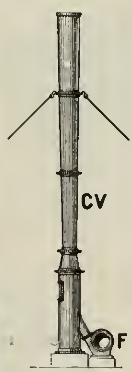

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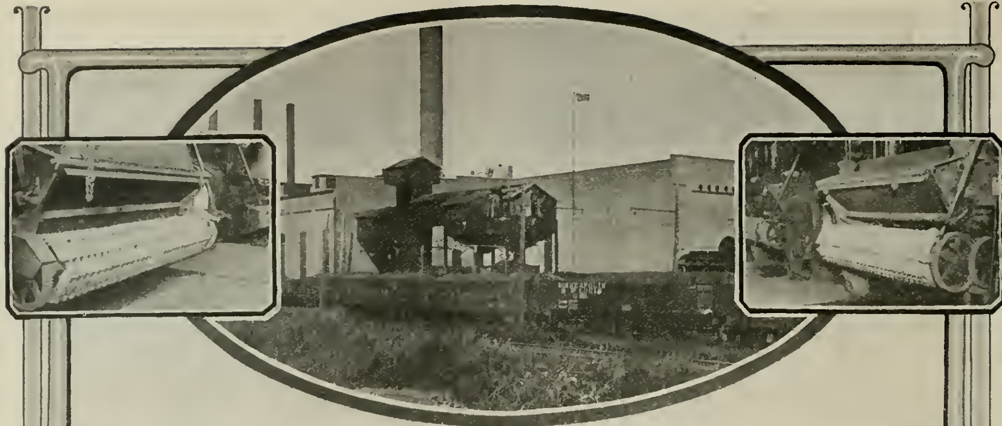

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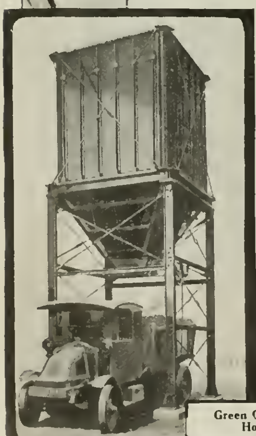

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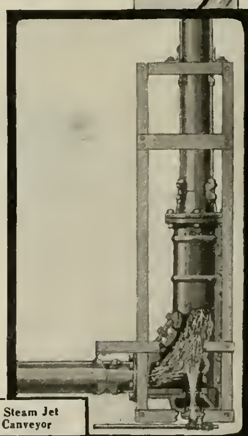

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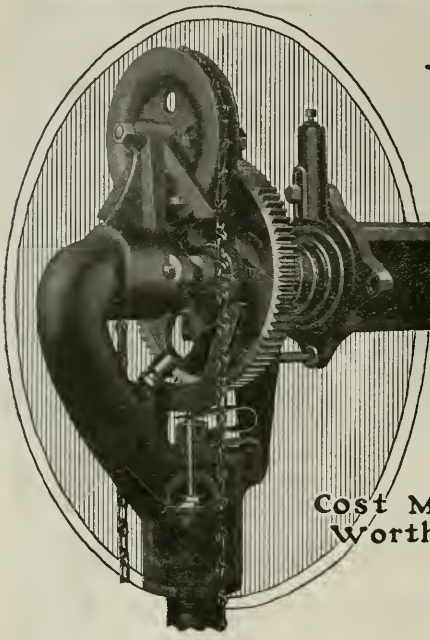

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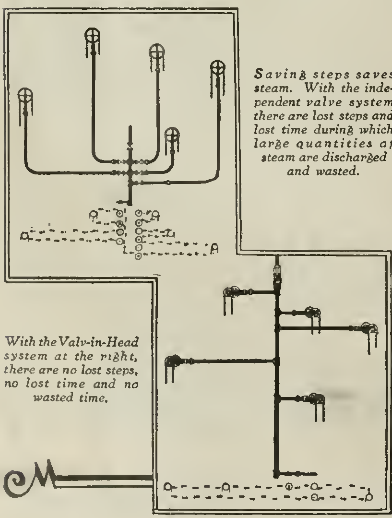

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Built in capacities from 5 G.P.M. to 80,000 G.P.M.

Large stock of fabricated parts ready for immediate shipment.

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Billions of gallons of condensing water per year which were formerly wasted to the sewer are today saved and recooled by means of

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which allows the water to be used over and over again with only a small fractional loss.

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excels in cooling and minimizes plugging.

THE COOLING TOWER CO., INC.
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SPRAY NOZZLE SYSTEMS

Write for Catalogue 9B

1

1044 SPRACO Cooling Pond Systems, with a total capacity of *2,403,843 gallons per minute*, are now in successful operation in 44 states and 20 foreign countries. If you wish highest efficiency and best vacuum you should install a SPRACO system.

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(See Our Data in 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

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Lowest in pumping head and maintenance are characteristic of all

Burhorn Cooling Towers

EDWIN BURHORN CO.

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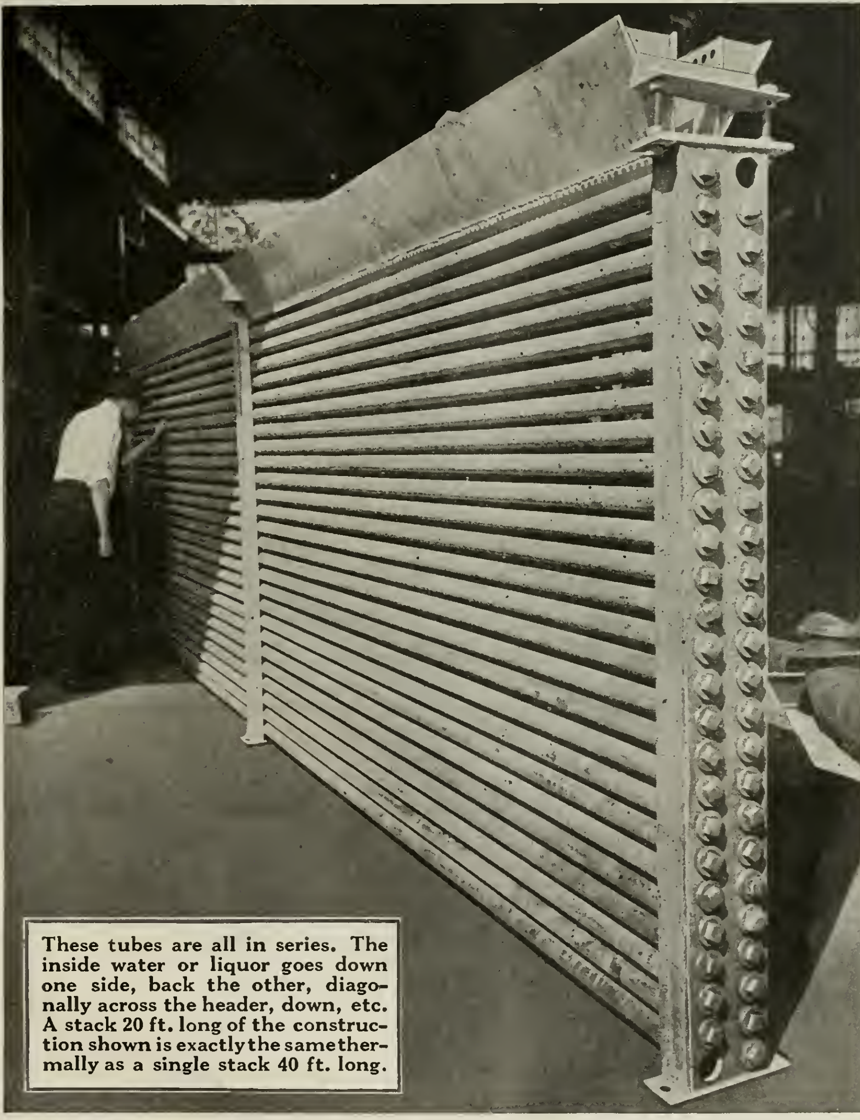
These tubes are all in series. The inside water or liquor goes down one side, back the other, diagonally across the header, down, etc. A stack 20 ft. long of the construction shown is exactly the same thermally as a single stack 40 ft. long.

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in ALL BRANCHES of the ENGINEERING FIELD

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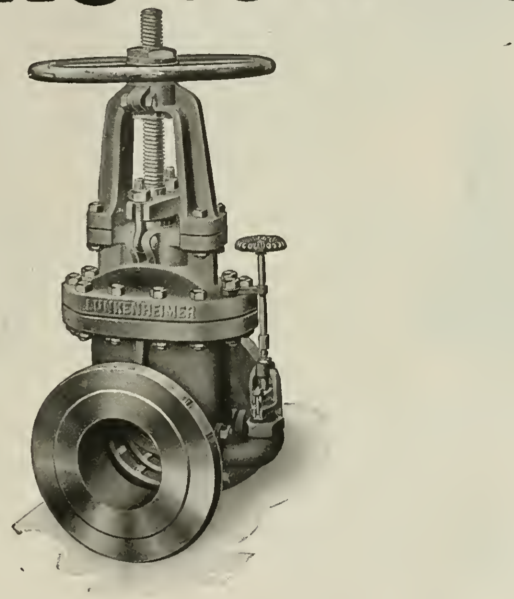
LUNKENHEIMER
"Victor" Gate Valves



Dependable performance is the service record of LUNKENHEIMER "VICTOR" Gate Valves. The "VICTOR" solid wedge disc, double-faced and guided in its travel, is the most practical design of Gate Valve construction. It eliminates "dragging" across the seatring faces and the consequent wear prevalent in valves employing loose parts.

Highest quality materials, coupled with the LUNKENHEIMER method of manufacture; bearings bronze bushed to minimize wear; the indestructible gasket between the bonnet and body flanges and all parts, including the seatrings renewable, all tend to enhance their value and insure longevity.

Made of Iron, bronze mounted, in both Inside Screw Stationary Stem and Outside Screw Rising Stem types, in four weights for pressures ranging from 100 to 250 pounds. Also in Quick-opening Sliding Stem type for pressures from 125 to 50 Pounds, depending on the size.

"VICTOR" Gate Valves are also made in Bronze for pressures up to 250 pounds, and in Cast Steel for pressures up to 350 pounds and temperatures to 800 deg. F.

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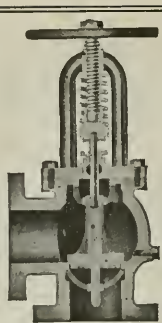

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You can have full protection for your boiler plant and even make your "lazy boiler" work with FORD Automatic Stop & Check Valves.

Note the adjustable light auxiliary spring with which it is possible to secure flow of steam from boiler into the main at variable differences of pressure.

The FORD Valve is the *only* valve on the market having this feature.

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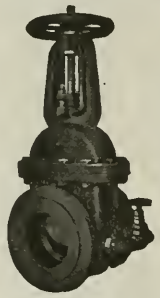

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have stood the test of time. Their superior features have been proven by efficient service from year to year. There is no necessity for experimenting when buying valves.

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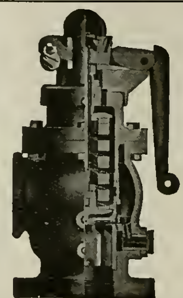

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Pop Valves and Gages.

A QUALITY PRODUCT with a record of over 50 years of dependable service on high-pressure power plant installations.

The Ashton Valve Co.

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Unless a valve is positively dependable and will remain tight for long periods without attention it represents a poor investment.

Pratt & Cady Renewable Valves are a worthwhile economy in times where every effort is made to reduce the cost of doing business. When after long hard service or because of scale, or other similar substances in the line, leaks develop, the worn parts can be repaired without removing the valves from the line and in minimum time.

Gate valve wedges are reversible and the discs of globe, angle and check valves, as well as seat rings in all types of valves, are renewable. No tool more complicated than a spanner wrench is needed to make the replacement.

Pratt & Cady Valves are economical in both first and final cost. You cannot afford to install any other kind.

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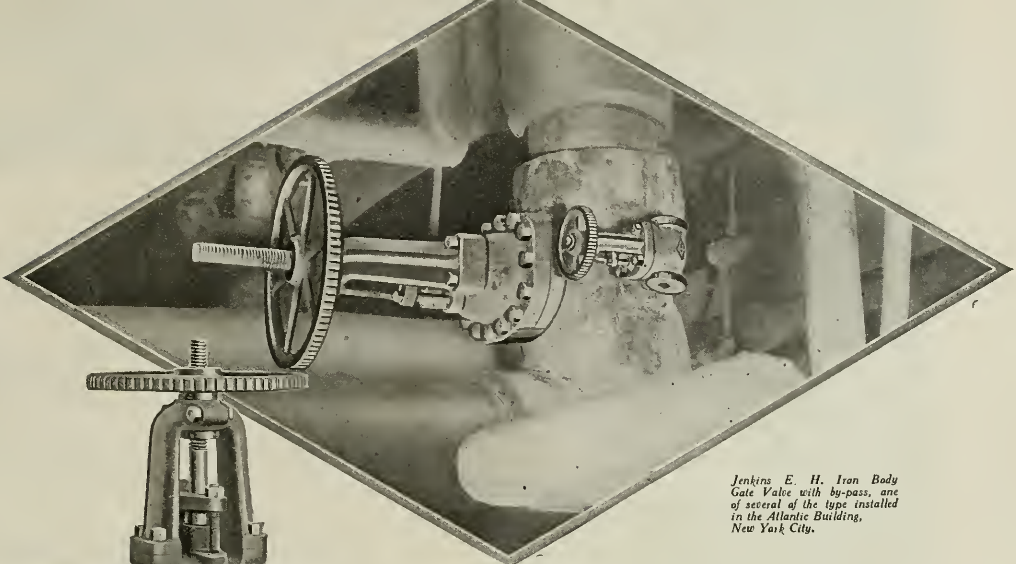
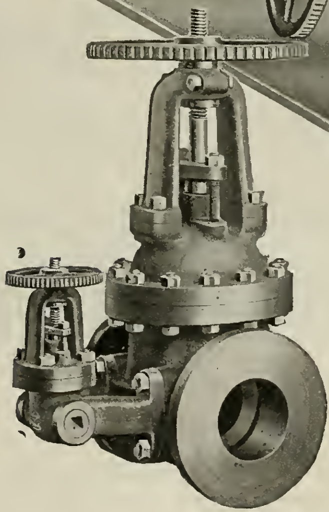


Jenkins E. H. Iron Body Gate Valve with by-pass, one of several of the type installed in the Atlantic Building, New York City.



Flanged, 204-B

Jenkins Extra Heavy Iron Body Gate Valves

Built throughout for heavy pressures and high temperatures and especially adapted to meet the requirements of modern high pressure power plants.

The valves are of the double face, solid wedge type and are made either with inside screw, stationary spindle, or outside screw, rising spindle.

Shape and the distribution of metal are such as to not only insure castings entirely free from internal and shrinkage strains, but also to secure perfect rigidity and resistance to the severe stresses incident to the service for which they are recommended.

Suitable for working pressures of 250 pounds steam or 400 pounds water. Made with screwed or flanged ends, and with or without by-pass, as ordered.

Genuine Jenkins Valves are known by the name and Jenkins "Diamond Mark"—and are obtainable through supply houses everywhere.

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Jenkins Valves

SINCE 1864

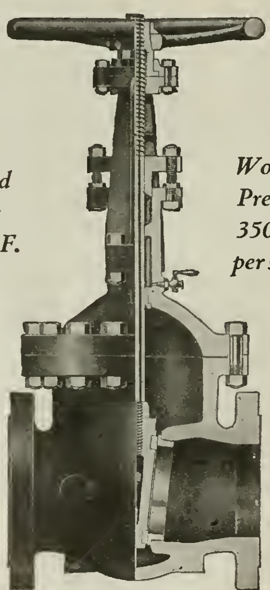
NELSON

Steel Gate Valve

Solid Wedge Construction

Good for 800°F.

Working Pressure, 350 lbs. per sq. in.



No. 1510

CYLINDRICAL body and bonnet. Full monel mountings. For high superheat and high-pressure steam. Can be furnished with by-pass. Sizes 2 to 18 inches.

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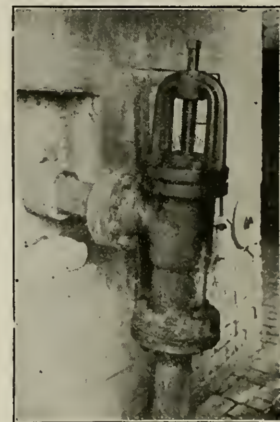
10 Years' Daily Blow-Off Service Without Repacking



The illustration—made from an unretouched photograph—shows a 3-inch angle flanged YARWAY SEATLESS BLOW-OFF VALVE in the plant of the Consumers Power Company, Cadillac, Mich.

This valve was installed in 1911, has been in continuous daily service ever since, and has never been repacked.

The engineer says it looks good for ten more years.

Do you experiment—or do you buy blow-off valves of proved worth?

Many power plants now use Yarway Seatless and Yarway Double Tightening Valves in tandem, where two valves are required on each blow-off line.

YARWAY

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SEATLESS BLOW-OFF VALVE

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7614-20 Queen St.

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Representatives in all Principal Cities

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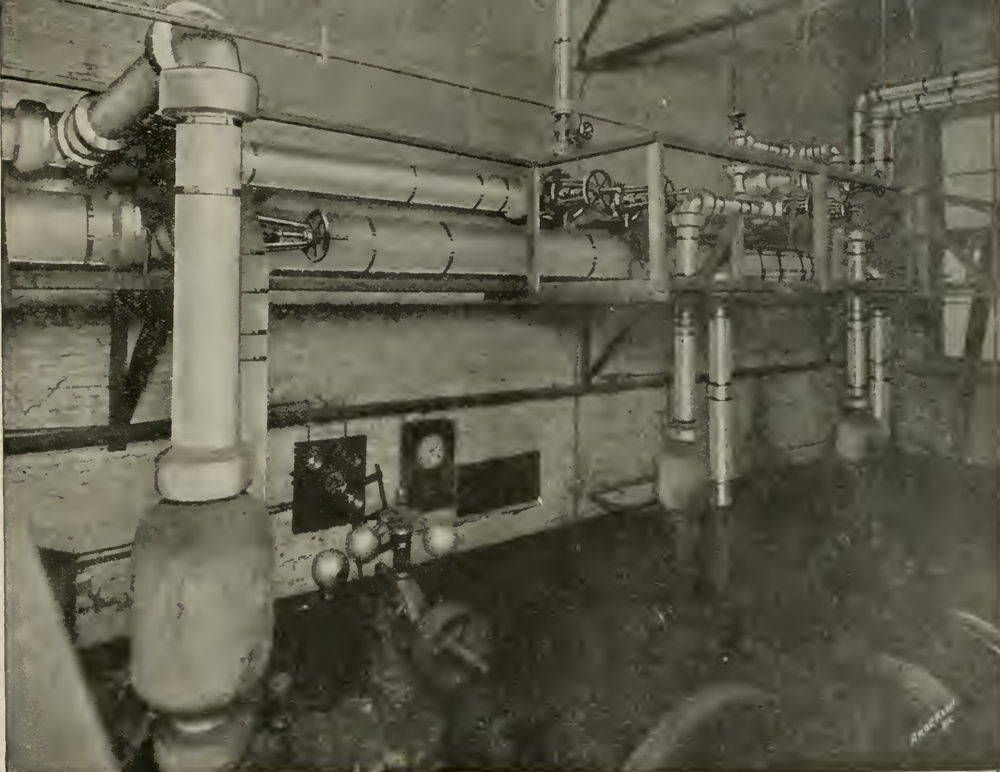
YARWAY POWER PLANT DEVICES



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Sizes 1½" to 8" incl.

Bent to any required circle.

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Conveying Abrasive Material

Cast Iron Pipe

The greatest copper reclaiming plant in the world is that of the Calumet & Hecla Mining Co., on the shores of Torch Lake, an arm of Lake Superior. Fifty million tons of mill tailings, which have accumulated here during the past 50 years, and now being dredged and pumped out through the two lines of cast iron pipe shown here, at the rate of thousands of tons, daily, to the tanks in their ammonia leaching plant. No other pipe has been found to withstand this severe service so well.

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United States Cast Iron Pipe and Foundry Co.

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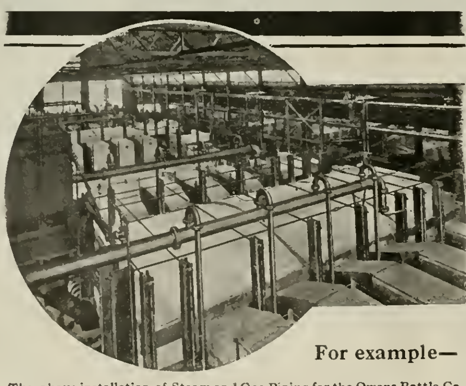
INDUSTRIAL PIPING



For example—

The above installatioo of Steam aod Gas Piping for the Owens Bottle Co. of Toledo at their Whitney Glass Works at Glassboro, N. J.

Let us tell you more about the importance of Industrial Piping. Refer to our data on Page 234 of the 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment or write for Bulletin M-11.

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PIPING

For

Steam Power and Industrial Plants
Of Every Description

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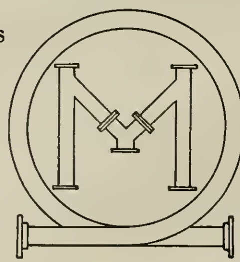

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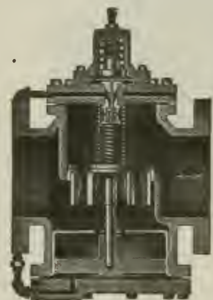
Beginning at the boiler with the **Non-return Pilot Valve** that closes in case of rupture to either power piping or boiler.

High and Low Water Alarm indicating when not enough water or too much is in the boiler.

Feed Water Controlling Device to maintain constant water level in high pressure boilers.

Damper Regulator to control draft dampers.

Pressure Reducing Valves from high to medium or above vacuum. Also for water, gas or air.



Kieley High Pressure Pilot Regulating Valve

Combination for controlling engine and draft for mechanical stoker fired boilers.

Steam Separators and Traps.

Oil Separators and Grease Traps.

Back Pressure Valves, enabling the use of exhaust steam for heating purposes.

Pump Governor to return condensation from high and low pressure returns direct to boilers.

Exhaust Heads, Blow-off and Drip Tank Controllers.

Temperature Controller for hot water tank.

Combination Pump Governor and Lever Float Valve for keeping water supply tank filled.

Low Pressure Boiler Water Feeders and Damper Regulators.

Lifting and Return Traps to return condensation back to boiler where radiators or coils are set below same.

Our catalogue and further information regarding your requirements are at your service.

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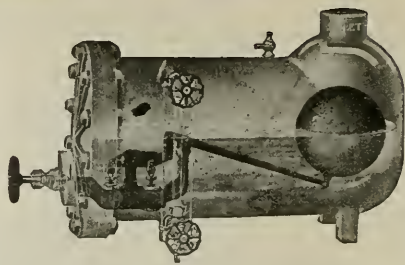

Its family name is "Davis"—

You might guess that from the history of the operation of this Davis Steam Trap. For by giving unusually dependable service and long life it exhibits the Davis family traits.

The Davis Steam Trap operates under any pressure without loss of steam. Valves are cone shaped and well balanced. They are isolated from the inlet, so that they cannot be clogged or damaged by incoming foreign matter. Valves and seats are made of durable Tobin bronze—and are renewable. All parts are easily accessible without breaking steam line by removing trap cover.

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STEAM SAVERS SINCE 1875
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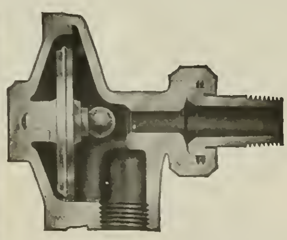
Have been successfully installed in thousands of buildings

A RECORD OF 20 YEARS OF SUCCESS



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The Original Vertical Seat Trap. Dirt proof. Closes against the steam. Positive operation and long life. As good as it Looks.

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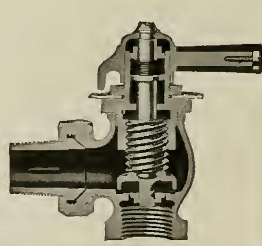
Write for new Vapor Catalog—real data.



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Time is the best test for durability. Goetze Gaskets do last and we want you to know it. The best proof is to try them in your plant on your most troublesome joints. In order to demonstrate their merit to you—we want you to—

TRY GOETZE No. 2 GASKETS for 90 days at our expense

Send in a trial order—your trial order today means reorders tomorrow

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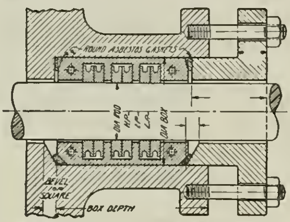

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The positive displacement, oscillating piston EMPIRE oil meter is commended to the attention of all Oil Engineers because of its extreme simplicity, ease of installation and operation and great reliability. We offer every facility for its complete investigation, in factory or actual service.

EMPIRE meters have proved their worth by the test of thirty years of service under a wide range of conditions in every part of the country.

(See Our Data in 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

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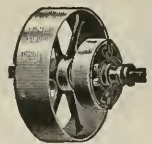

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THE JOHNSON FRICTION CLUTCH

Single clutch with pulley mounted.

Friction Control Means Better Machinery.

Any friction drive can be handled most successfully by a Johnson Clutch.

Complete Engineering Service.

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(See Our Data in 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

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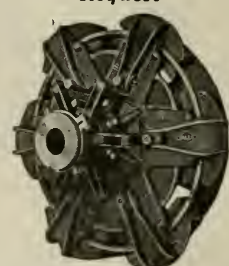
Power Transmission Machinery

Belt or Rope Distribution

Complete Engineers Catalogue on Request



Six-Arm Friction Clutch Coupling

FALLS CLUTCH & MACHINERY COMPANY

Engineers, Founders and Machinists

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BRANCHES

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(See Our Data in 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

3

Jones Spur Gear Speed Reducer, with slow speed shaft connected directly to driven shaft by all-metal flexible coupling. Motor speed, 365 r.p.m. Final speed, 30.25 r.p.m. Reduction ratio, 28 1/2 to 1.

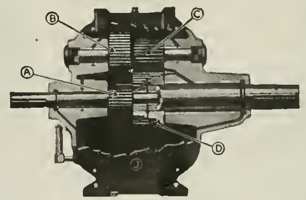
Compact—Simple—Durable

—the Jones Spur Gear Speed Reducer

Although it occupies very little installation space, the Jones Speed Reducer accomplishes reductions up to 200 to one, and over. A typical installation is shown above.

Its simplicity and durability are due to its mechanical correctness—demonstrated in the small illustration on the right. Three countershafts are evenly spaced about the drive and driven shafts, so that transverse loads due to tooth thrust are exactly balanced.

Just plain spur gear drive, with no internal gears or overhanging shafts.



A—Pinion meshes with and drives three gears B. B—Gears are mounted integral with the three pinions C. C—Pinions mesh with and drive slow speed gear D.

Our Engineers are at Your Service

W. A. Jones Foundry & Machine Company

4416 West Roosevelt Rd., Chicago

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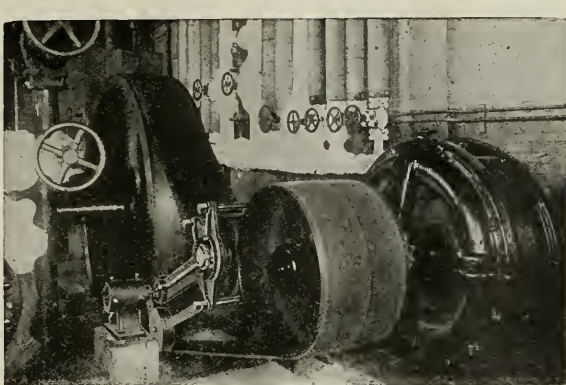
Jones

MEMBER OF AGMA

SPUR GEAR SPEED REDUCERS

J-158

THE LENIX DRIVE



200 H.P. Motor Driving Ice Machine
2 Bearings—10′ Centers. Pulleys—Driving 31″, Driven 96″, Belt 17″

will
minimize
your belt
troubles
and save
space
power
cost of belts
belt wear
cost of motors

Booklet "Saving Slippage and Space" will explain—Ask us for it.

See our data in 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment

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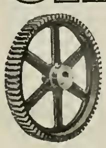
50 CHURCH STREET, NEW YORK

CALDWELL



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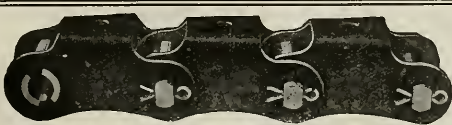

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For standard cast tooth sprockets No. 35 to 6 in. pitch.
For cut tooth sprockets 1 in. to 2 in. pitch.

UNION STEEL RIVETLESS CHAINS

The Chains with the Substantial Links and Large Case-Hardened Bearings.

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Special Transmission Chains up to 1,000,000 Pounds Ultimate Strength

The Union Chain & Mfg. Co., Seville, Ohio

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QUALITY CHAINS

Get Our Prices on the Chains You Need

You will find real satisfaction and economy in dealing with DIAMOND. Satisfaction, because your chain requirements will be handled expertly and shipped promptly. Economy, because the best chain on your product, or plant equipment, means greater value, better service and longer life.

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Diamond Chain & Mfg. Co.
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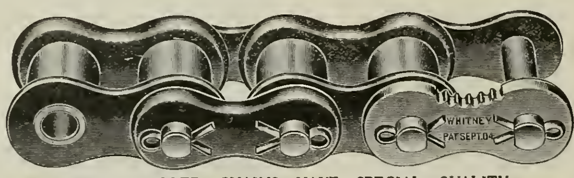
"WHITNEY"

HIGH EFFICIENCY

ROLLER AND SILENT TYPE

CHAINS

also ***Low*** Cost per ***Thousand Miles*** of Service



LATEST ROLLER CHAINS HAVE SPECIAL QUALITY
SOLID ROLLS AND OTHER IMPORTANT IMPROVEMENTS

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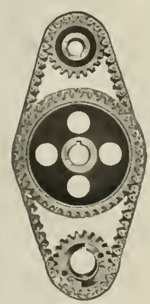


EXCEPTIONAL MILEAGE
AND NEVER KNOWN
TO SKIP THE
SPROCKET TEETH

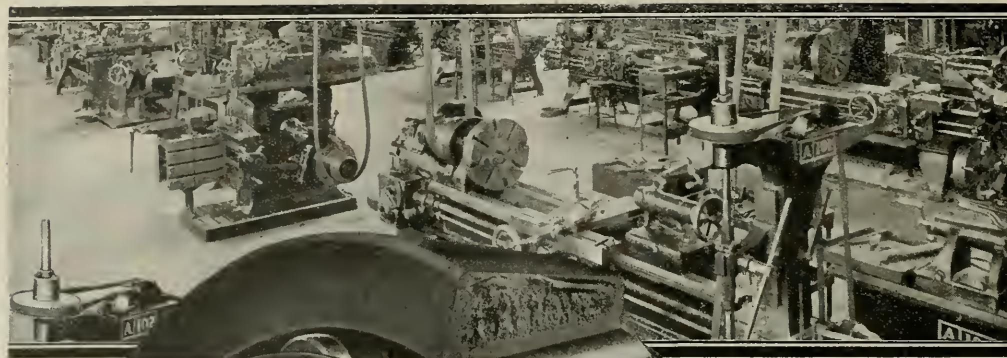
THE WHITNEY MFG. CO.

HARTFORD, CONNECTICUT, U. S. A.

(*See Our Data in* 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

MECHANICAL ENGINEERING

November, 1921 **CARD INDEX** **Vol. 43, No. 11**



Better Machine Tools

Timken performance charts are laid out in years; and the service element in terms of hundreds of millions of revolutions at speeds of more than 3,000 r p m.

No one of the more than 60,000,000 Timken Tapered Roller Bearings now in service has been recommended for its service except on the basis of tried and known performance. Timken Tapered Roller Bearings are applicable in every industry

—because Timken Tapered Roller Bearings perform most satisfactorily where demands both of high speed and heavy load are excessive.

Timken performance is quite readily accounted for because Timken Tapered Roller Bearings

—carry radial loads, thrust loads, and resultant loads continuously and simultaneously

—function uniformly satisfactorily throughout the entire speed and load range

—carry more load per unit space required

—are adjustable for the wear which *must* follow motion.

The Timken Engineering Journal, containing authoritative data on better machine tools of all descriptions, mine equipment, road machinery, electrical equipment, printing presses, pumps, and hundreds of other industrial and machinery appliances, is available upon request

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Timken Tapered Roller Bearings for Machinery, Industrial Appliances Passenger Cars, Trucks, Tractors, Trailers, and Farm Implements

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ROLLER·BEARINGS

Handle It Mechanically

and save time and money

YOUR material handling problems may seem unusual and difficult, yet they can be solved by installing G. W. Equipment. Every unnecessary step is a loss and adds to the cost of production. G-W. Elevators and Conveyors carry things anywhere, thus increasing capacity and lowering costs.

Consult us on your requirements — our engineers can solve your problems.

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Mechanical Handling in all lines of Industry

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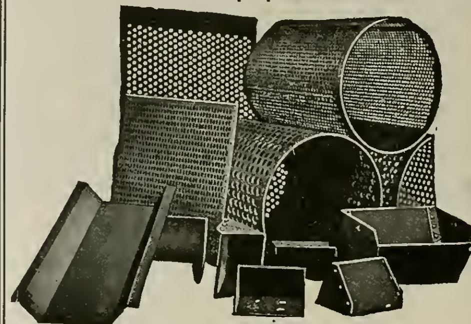

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PLAIN AND PERFORATED

General Sheet and Light Structural Work

Light and Heavy Steel Plate Construction

HENDRICK MFG. CO., Carbondale, Pa.

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(*See Our Data in* 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

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with Power Scrapers and Dragline Cableways

The use of space now going to waste, for the storage of coal can be made a very profitable undertaking.

With adequate layout and equipment, coal can be bought whenever the market is favorable, and stored for future use.

Sauerman equipped storage yards can be operated at the minimum of expense, and provide adequate facilities for the coal supply for the power plant.

Equipment suited to individual needs can be laid out by our engineers in sizes and types for all requirements.

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BLOW SHAVINGS SAWDUST OR PULP CHIPS 4000 FT. WITH A

POSITIVE PNEUMATIC CONVEYOR.

WE INSTALL AND GUARANTEE OPERATION.

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Move Materials Without Power

Every dollar counts double in factory operating costs today. Every pound of material you can efficiently move by gravity *saves money* on power costs.

SEDGWICK GRAVITY DROPS

are paying dividends in *saved power and time* in hundreds of plants. Our 30 years of experience in applying hand power elevators and gravity drops to the needs of industrial plants is at your service. *Write for data.*

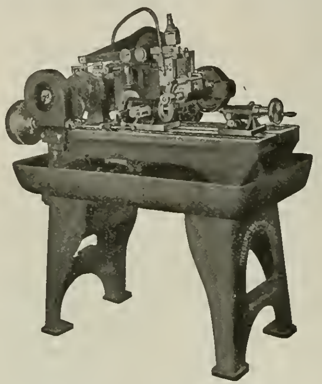
SEDGWICK MACHINE WORKS, 162 West 15th St., New York

Specialists in Dumbwaiters and Hand Power Elevators for more than a Quarter of a Century

(*See Our Data in* 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

Gear Milling Machines
Gear Hobbing Machines

We specialize in machines for automatically cutting gears up to 10-inch diameter and as course as 8 pitch in steel. For Spur, Bevel, Spirals, Worm Gears, Worms, Special Shapes and Form Milling.

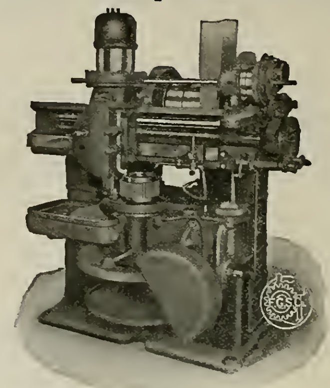


AUTOMATIC MILLING MACHINES
PLAIN MILLING MACHINES
PLAIN AND BALL BEARING DRILL PRESSES

Send for Catalog No. 15

THE BILTON MACHINE TOOL CO.
BRIDGEPORT, CONN.

The Fellows Spur Gear Shaper



This machine works on the generating principle, using a generating cutter that is ground all over after hardening, including the involute curves on the teeth which are generated with a precision that is beyond question.

The Fellows Spur Gear Shaper is designed for the economic and accurate production of spur, external and internal gears, shoulder gears, cluster gears, cams and a large variety of work.

A complete description of this machine and a list of examples illustrating its many possibilities is given in our general catalog "Commercial Gear Cutting," a copy of which will be gladly sent to those interested.

THE FELLOWS GEAR SHAPER COMPANY
Springfield, Vermont, U. S. A.

1 (See Our Data in 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

MACKINTOSH-HEMPHILL CO.
PITTSBURGH, PA.

ROLLING MILLS

ENGINES
HYDRAULIC PRESSES
STEEL and *MANGANITE* ROLLS
CAST & MACHINE CUT GEARS
SHEARS PUNCHES SAWS

LANDIS MACHINE COMPANY, Inc.
WAYNESBORO, PA.

Manufacturers of

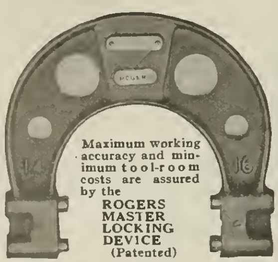
Bolt and Pipe Threading Machinery

Let our Engineering Department solve your threading problems. Send your specifications today.

Catalogues upon request.

A complete discussion of the Landis chaser, die head, and machine will be found on pages 496 and 497 of the 1921 volume of A.S.M.E. Condensed Catalogues of Mechanical Equipment.

ROGERS ADJUSTABLE LIMIT GAUGES



Maximum working accuracy and minimum tool-room costs are assured by the ROGERS MASTER LOCKING DEVICE (Patented)

Adjusting and locking screws are set in sockets for sealing with wax in the tool room, and cannot be touched in the shop without the seal becoming broken. Anvils are of tool steel hardened, ground and lapped, with ample measuring surfaces. Marking plates are screwed to frame; and may readily be replaced when anvils are re-set to different measurements. Range of sizes 0" to 8". Write for prices.

Manufacturers also of Gauges and other Measuring Appliances. Solid Adjustable-Blade Reamers. Adjustable-Blade Hollow Mills.

Established 1865

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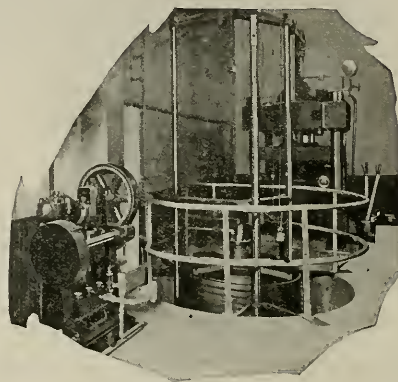
The R. K. LeBlond Machine Tool Co.
CINCINNATI, OHIO

We manufacture a complete line of Heavy Duty Lathes and Milling Machines. They are scientifically designed, so the power is limited only by the strength of the cutting tool. It will pay you to investigate our machines.

Catalog upon request

HYDRAULIC EQUIPMENT
For Every High Pressure Purpose

A Difficult Pressing Problem.



The illustration shows a complete H-P-M hydraulic installation,—press, pump, accumulator, valves and fittings, in operation in one of the largest industrial laboratories in the country.

The press shown in background is used for making a special form of metallic briquette. The metal which is in powdered form is placed in a mould. The mould is in two pieces and is not bolted. The base of the press is so designed that a side ram operated hydraulically clamps the mould together and holds it in place while the upper ram exerts a pressure of 500 tons on the material. Both upper and side rams have hydraulic pull back cylinders.

These and similar pressing problems which we have solved, guarantee our ability to meet your "pressing needs," no matter how out-of-the-ordinary they may be. Tell us what you wish to press. We will submit catalogs, drawings and estimates.

Partial List of H-P-M Users

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Hudson Motor Car Co.
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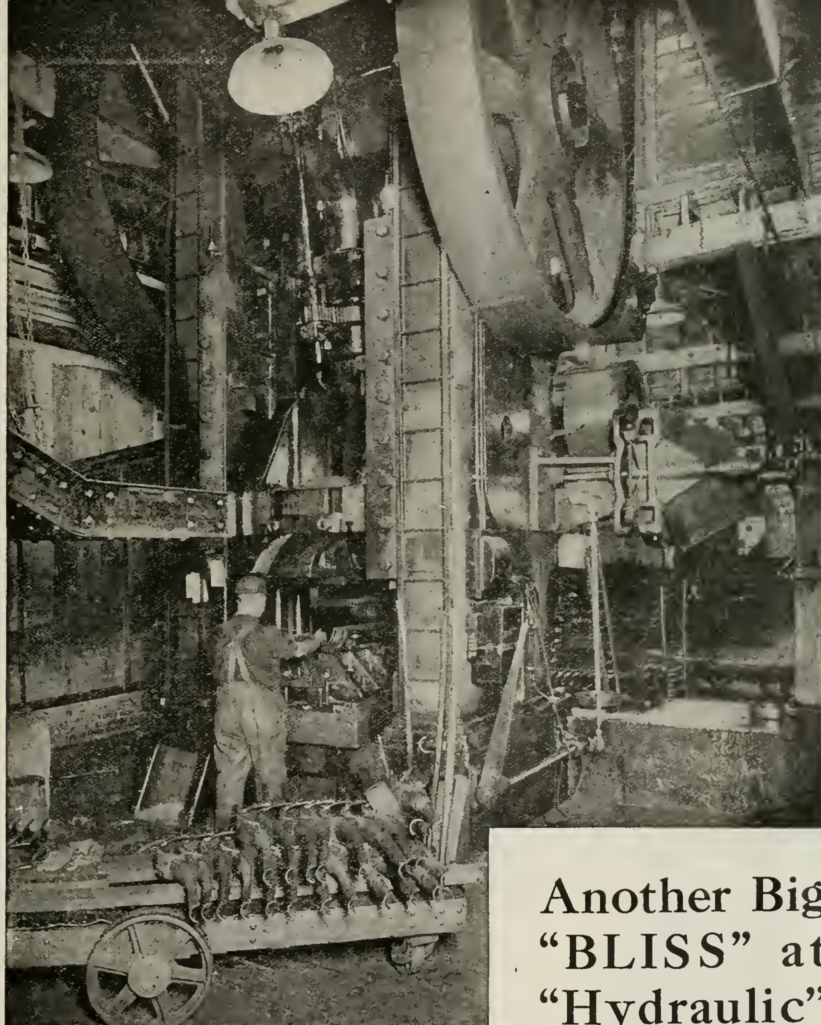
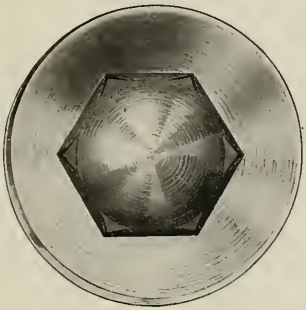
"FOR - YOUR - PRESSING - NEEDS"



The corner triangles in the bottom

Identify—



The 30% Stronger Hollow Set Screw

Look in the bottom of the socket-hole: At the corners are little triangular "pits," left by the hexagon punch in the Allen process of cold-drawing.

First the socket-hole is drilled; you'll see the drill marks on the bottom. Then a solid hex. punch (of the same diameter) fits down into the hole and drives the "blank" through a die, compressing the metal around the hexagon shaft—*forming the socket.*

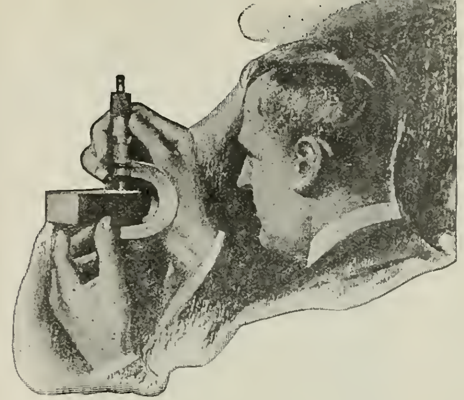
In the corner triangles the angular edges of the punch leave their mark. And that is the mark of an Allen screw; essential evidence of the Allen process; your guide in getting the right article.

This doesn't tell you much about the advantages of USING "Allens," but we'll gladly send you an interesting booklet that will (not forgetting the price list!).

THE ALLEN MFG. CO.

131 Sheldon Street, Hartford, Conn.

Pacific Coast Branch Office: The Charles A. Dowd Sales Co., 320 Market St., San Francisco, Calif.



Among men who work metal—

there's no question about the accuracy and quality of a Starrett precision tool. The experience of two generations of machinists with Starrett Tools has demonstrated that these tools are consistently dependable.

Write for Starrett Catalog No. 22 "LD." Sent free upon request.

THE L. S. STARRETT COMPANY

The World's Greatest Toolmakers

Manufacturers of Hack Saws Unexcelled

ATHOL, MASS.

(*See Our Data in* 1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment)

42-257

Starrett Tools

BUY IT FROM THE NAVY

Naval Vessels as Hulks for Salvage

By Sealed Proposals opening January 16, 1922
At Board of Survey, Appraisal and Sale,
Navy Yard, Washington, D. C.

Improvements in Naval construction have rendered these fine old warships obsolete, and the opportunity is now being given the metal trades to purchase for salvage the following vessels:—

Some of the Vessels Offered for Salvage

(Note.—Displacement given below is for full load.)

U. S. S. MAINE (Battleship). Built in 1901.
Length, 393 feet; draft, 23 feet; beam, 72 feet.
Displacement, 13,500 tons. Now at Philadelphia, Pa.

U. S. S. MISSOURI (Battleship). Built in 1901.
Length, 394 feet; draft, 24 feet; beam, 72 feet.
Displacement, 13,500 tons. Now at Philadelphia, Pa.

U. S. S. WISCONSIN (Battleship) Built in 1898.
Length, 374 feet; draft, 24 feet; beam, 72 feet.
Displacement, 12,150 tons. Now at Philadelphia, Pa.

*U. S. S. BROOKLYN (Cruiser). Built in 1895.
Length, 402 feet; breadth, 65 feet; draft, 24 feet.
Displacement, 10,068 tons. Now at Mare Island, Cal.

*U. S. S. COLUMBIA (Cruiser). Built in 1892.
Length, 413 feet; draft, 23 feet; beam, 58 feet.
Displacement, 7,387 tons. Now at Philadelphia, Pa.

U. S. S. MEMPHIS (Cruiser). Built in 1903.
Length, 504 feet; draft, 25 feet; beam, 73 feet.
Displacement, 15,712 tons.
Now a wreck at Santo Domingo, D. R.

TARGET (Ex-Monitor PURITAN). Built 1882.
Length, 299 feet; draft, 18 feet; beam, 60 feet.
Displacement, 6,060 tons. Now at Norfolk, Va.

U. S. S. OZARK (Monitor). Built in 1900.
Length, 225 feet; draft, 13 feet; beam, 50 feet.
Displacement, 3,356 tons. Now at Philadelphia, Pa.

TARGET (Ex-Monitor MIANTANOMOH). Built in 1876.
Length, 263 feet; draft, 14 feet; beam, 55 feet.
Displacement, 3,990 tons. Now at Norfolk, Va.

U. S. S. TONOPAH (Monitor). Built in 1900.
Length, 255 feet; draft, 13 feet; beam, 50 feet.
Displacement, 3,356 tons. Now at Philadelphia, Pa.

*U. S. S. SMITH (Destroyer). Built in 1909.
Length, 294 feet; draft, 8 feet; beam, 26 feet.
Displacement, 902 tons. Now at Philadelphia, Pa.

*U. S. S. ALBERT BROWN (Fish Boat). Built in 1897.
Length, 103 feet; draft, 10 feet; beam, 18 feet.
Gross tonnage, 108 tons. Now at Philadelphia, Pa.

U. S. S. ORIOLE (Ex-DALE); Wooden Sailing Vessel. Built in 1839.
Length, 117 feet; beam, 34 feet.
Now at Coast Guard Depot (S. Baltimore, Md.)

NOTE.—The vessels marked with an asterisk (*) will on December 15, 1921, be offered for sale for "Conversion to Commercial Uses." Such vessels as are not sold on that date will be offered on January 16, 1922, for sale as "Hulks for Salvage."

The offer of these vessels by the Navy Department for sale to commercial organizations should be considered from the standpoint of a nucleus to go into the ship breaking up field for some *"farsighted concern" looking for new business.*

Aside from the ferrous and non-ferrous metals entering into Naval ship construction, consider the electrical machinery, pumps, winches, boilers, engines, piping, etc., for which there is always a receptive market with an attractive recovery.

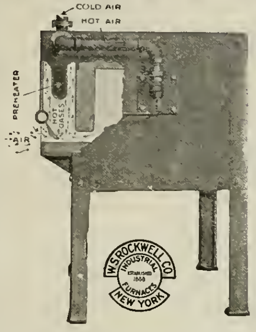
A careful investigation of the success recently achieved in foreign countries by *"ship breaking"* concerns will convince you of the advisability of promptly communicating with the Navy Department.

Write or wire for catalog No. 27-46b giving the terms of sale and describing the vessels offered.

Central Sales Office

NAVY DEPARTMENT WASHINGTON, D. C.

IDLE MEN IN FORGE SHOPS



(Patented)
Section showing deflection of hot gases, *with induced air toward the furnace, for protection of the operator*, and the preheating of air for combustion.

When men are idle, expensive equipment and buildings are also idle.

In past summers, the unbearable heat that caused prolonged shutdowns in many forge shops was **often due to faulty forges or improper application and utilization of the heat.**

To relieve these conditions, progressive forge shops are installing Rockwell Economizer Forges.

These forges enable the men to *work steadily and in comparative comfort*. They also afford other advantages in the way of *decreased operating cost, better quality of product*, and *decreased floor space*.

Bulletin 239-U, dealing with improved methods of heating and handling material, layout of equipment, and other factors influencing the cost of production, may be had by writing to our nearest branch.

W. S. ROCKWELL COMPANY

Furnace Engineers and Contractors
50 Church St. (Hudson Terminal Building) **New York**

WE MAKE INDUSTRIAL HEATING FURNACES
FOR EVERY REQUIREMENT.
COAL—OIL—GAS—ELECTRICITY
"FURNACES AND FUEL TO SUIT CONDITIONS"

BRANCHES:

Chicago	Cleveland	Detroit
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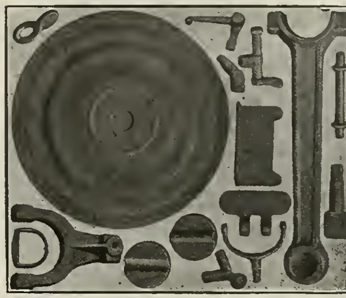
AMERICAN FORGINGS

Any Size, Any Analysis. Carbon or Alloy Steel.

Furnished Annealed or Heat Treated.

See data on pages 430 and 431 of the 1921 volume A.S.M.E. Condensed Catalogues of Mechanical Equipment.



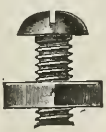
Send blue prints or write us requesting our Engineer to call. He can undoubtedly help you with suggestions regarding design, quality and cost.

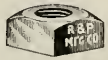
THE AMERICAN FORGE & MACHINE CO.

CANTON, OHIO

See
1921 A.S.M.E. Condensed Catalogues of Mechanical Equipment for data concerning our products

WOOD SCREWS, MACHINE SCREWS, CAP SCREWS, SET SCREWS, BOLTS, NUTS, RIVETS, BURRS, SPECIALTIES.





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MAIN OFFICE and Plant at WORCESTER, MASS.

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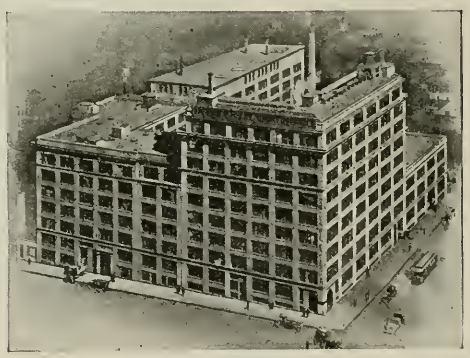
DIE-CASTING COMPANY

SMEAD & PROSPECT AVES.
TOLEDO O.



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BROOKLYN N.Y.

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DIE-CASTINGS

ANNEALING TWIST DRILLS IN NICHROME CONTAINERS

NICHROME CONTAINERS IN PLANT OF BEARING MFR

Higher than Price

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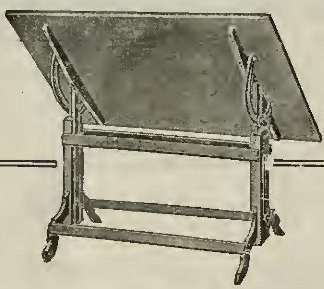

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Cards Continued on Next Page

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(See Compressors, Receivers, etc., Air)

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(See Condensers, Fittings, etc., Ammonia)

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(See Blowers, Pumps, etc., Centrifugal)

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Curtis Pneumatic Mchy. Co.
* General Electric Co.
* Goulds Mfg. Co.
* Ingersoll-Rand Co.
Mackintosh-Hemphill Co.
* Pangborn Corporation
* Titusville Iron Works Co.
* Union Steam Pump Co.
* Worthington Pump & Machinery Corp'n

Compressors, Air Centrifugal
* De Laval Steam Turbine Co.
* General Electric Co.

Compressors, Air, Compound
* Ingersoll-Rand Co.
* Worthington Pump & Machinery Corp'n

Compressors, Ammonia
* Vilter Mfg. Co.
* Worthington Pump & Machinery Corp'n

Compressors, Gas
* De Laval Steam Turbine Co.
* General Electric Co.
* Ingersoll-Rand Co.
* Worthington Pump & Machinery Corp'n

Concrete Hardener
Sonneborn, L. Sons (Inc.)

Condensers, Ammonia
* De La Vergne Machine Co.
* Vilter Mfg. Co.

Condensers, Barometric
* Allis-Chalmers Mfg. Co.
* Ingersoll-Rand Co.
* United States Cast Iron Pipe & Fdry. Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Condensers, Jet
* Allis-Chalmers Mfg. Co.
Elliott Co.
* Schutte & Koerting Co.
* Union Steam Pump Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Condensers, Surface
* Allis-Chalmers Mfg. Co.
* Braun, C. F. & Co.
Elliott Co.
* Union Steam Pump Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Conduits
* Johns-Manville (Inc.)

Controllers, Automatic, for Temperature or for Pressure
(See Regulators)

Controllers, Electric
* General Electric Co.

Converters, Synchronous
* Allis-Chalmers Mfg. Co.
* General Electric Co.

Conveying Machinery
* Beaumont, R. H. Co.
* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.
* Jones, W. A. Foundry & Mach. Co.

Conveyor Systems, Pneumatic
* Allington & Curtis Mfg. Co.

Conveyors, Belt
* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.

Conveyors, Bucket, Pan or Apron
* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.
* Jones, W. A. Fdry. & Mach. Co.

Conveyors, Ice
* Gifford-Wood Co.

Conveyors, Screw
* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.

Conveyors, Steam Jet
Girtanner Engineering Corp'n

Coolers, Oil
* Braun, C. F. & Co.

Cooling Ponds, Spray
* Badger, E. B. & Sons Co.
* Cooling Tower Co. (Inc.)
* Schutte & Koerting Co.
* Spray Engineering Co.
* Yarnall-Waring Co.

Cooling Towers
* Braun, C. F. & Co.
Burhorn, Edwin Co.
* Cooling Tower Co. (Inc.)
* Spray Engineering Co.
* Wheeler, C. H. Mfg. Co.
* Worthington Pump & Machinery Corp'n

Copper Converting Machinery
* Allis-Chalmers Mfg. Co.
* Worthington Pump & Machy. Corp'n

Copper, Drawn
* Roebling's, John A. Sons Co.

Copper Work
* Badger, E. B. & Sons Co.

Corliss Engines
(See Engines, Steam, Corliss)

Counters, Revolution
* Ashton Valve Co.
* Bristol Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.
Veeder Mfg. Co.

Countershafts
* Hill Clutch Co.
* Wood's, T. B. & Sons Co.

Counters
Veeder Mfg. Co.

Couplings, Pipe
* Central Foundry Co.
* Crane Co.
* Lunkenheimer Co.

Couplings, Shaft (Flexible)
* Allis-Chalmers Mfg. Co.
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Caldwell, W. E. Co. (Inc.)
* Fawcus Machine Co.
* Jones, W. A. Foundry & Machine Co.
* Medart Patent Pulley Co.
Smith & Serrell

Couplings, Shaft (Rigid)
* Allis-Chalmers Mfg. Co.
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Caldwell, W. E. Co. (Inc.)
* Falls Clutch & Machinery Co.
* General Electric Co.
* Hill Clutch Co.
* Jones, W. A. Foundry & Machine Co.
* Medart Patent Pulley Co.
* Royersford Foundry & Machine Co.
Smith & Serrell
* Wood's T. B. Sons Co.

Couplings, Union
(See Unions)

Couplings, Universal Joint
* Caldwell, W. E. Co. (Inc.)
* Wood's, T. B. Sons Co.

Coverings, Steam Pipe
* Johns-Manville (Inc.)
* Magnesia Assoc. of America

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1921 Volume*

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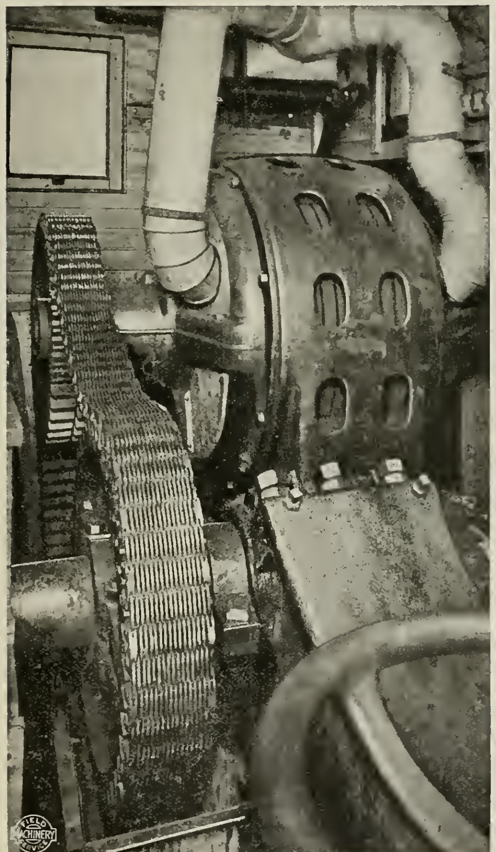
SILENT CHAIN

THE MORSE "ROCKER JOINT"



Let us tell you more about them

This 125 H. P. MORSE CHAIN Drives 20 Dry Dock Plunger Pumps

Photo and data come from a well-known Eastern shipyard. The twenty pumps are located on a 1200 ton dry-dock and connected to the 125 H.P. motor through Morse Drives. This installation has been in operation for over a year and the man in charge of it says "it's a very good chain and has saved us a lot of trouble."

Our inspector in making his last report recently said he found the chain practically as good as new.

Morse chains transmit 99% of power, are silent, durable and economical to maintain. They have eliminated driving troubles for many well-known concerns and our engineers will tell you exactly what they will do for you.

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"Morse" is the Guarantee Always Behind the Efficiency, Durability and Service

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued) FOR ALPHABETICAL INDEX, SEE PAGE 112

Cranes, Electric Traveling
* Niles-Bement-Pond Co.
* Northern Engineering Works
* Pawling & Harnischfeger Co.

Cranes, Floor (Portable)
* Lidgerwood Mfg. Co.

Cranes, Gantry
* Brown Hoisting Machinery Co.
* Niles-Bement-Pond Co.
* Northern Engineering Works
* Pawling & Harnischfeger Co.

Cranes, Hand Power
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.
Curtis Pneumatic Mchy. Co.
* Niles-Bement-Pond Co.
* Northern Engineering Works

Cranes, Jib
* Brown Hoisting Machinery Co.
Curtis Pneumatic Mchy. Co.
* Niles-Bement-Pond Co.
* Northern Engineering Works
* Pawling & Harnischfeger Co.

Cranes, Locomotive
* Brown Hoisting Machinery Co.
* Pawling & Harnischfeger Co.

Cranes, Pillar
* Brown Hoisting Machinery Co.
* Northern Engineering Works

Cranes, Portable
* Brown Hoisting Machinery Co.
Clyde Iron Works Sales Co.

Cranes, Pneumatic
Curtis Pneumatic Mchy. Co.

Crushers, Coal
* Allis-Chalmers Mfg. Co.
* Fuller-Lehigh Co.
* Smidth, F. L. & Co.
* Worthington Pump & Machinery Corp'n

Crushers, Jaw
* Worthington Pump & Machinery Corp'n

Crushers, Roll
Eastern Machinery Co.
* Worthington Pump & Machinery Corp'n

Crushing and Grinding Machinery
* Allis-Chalmers Mfg. Co.
* Fuller-Lehigh Co.
* Smidth, F. L. & Co.
* Worthington Pump & Machinery Corp'n

Cupolas
* Bigelow Co.
* Northern Engineering Works

Cutters, Bolt
* Landis Machine Co. (Inc.)
* Niles-Bement-Pond Co.

Cutters, Milling
Bilton Machine Tool Co.
* Whitney Mfg. Co.

Cutters, Pipe
* Niles-Bement-Pond Co.

Cutting-Off Machines, Metal
* Niles-Bement-Pond Co.

Damper Regulators
(See Regulators, Damper)

Dehumidifying Apparatus
* American Blower Co.
* Carrier Engineering Corp'n

Derricks and Derrick Fittings
Clyde Iron Works Sales Co.
* Lidgerwood Mfg. Co.

Destructors, Refuse
* Washburn & Granger (Inc.)

Die Castings
(See Castings, Die Moulded)

Dies, Blanking
* Bliss, E. W. Co.

Dies, Punching
* Bliss, E. W. Co.

Dies, Sheet Metal Working
* Bliss, E. W. Co.

Dies, Thread Cutting
* Jones & Lamson Machine Co.
* Landis Machine Co. (Inc.)
* Pratt & Whitney Co.

Die Heads, Thread Cutting (Self-opening)
* Jones & Lamson Machine Co.
* Landis Machine Co. (Inc.)

Diesel Engines
(See Engines, Oil, Diesel)

Digesters
* Bigelow Co.

Distilling Apparatus
* Braun, C. F. & Co.

Draft Control Systems
* Engineer Co.

Drawing Instruments
Dietzgen, Eugene Co.
Keuffel & Esser Co.
Kolesch & Co.

Drawing Materials
Dietzgen Eugene Co.
Keuffel & Esser Co.
Kolesch & Co.
New York Blue Print Paper Co.

Dredges, Hydraulic
* Morris Machine Works

Dredging Machinery
Sauerman Bros.

Drilling Machines
* Niles-Bement-Pond Co.
* Pawling & Harnischfeger Co.

Drilling Machines, Sensitive
Bilton Machine Tool Co.
* Pratt & Whitney Co.
* Royersford Fdry. & Mach. Co.

Drilling Machines, Vertical
Bilton Machine Tool Co.
* Niles-Bement-Pond Co.
* Royersford Fdry. & Mch. Co.

Drills, Coal and Slate
* General Electric Co.

Drills, Rock
* General Electric Co.
* Ingersoll-Rand Co.

Drop Forgings, Hammers, etc.
(See Forgings, Hammers, etc., Drop)

Dryers, Rotary
* Bigelow Co.
* Fuller-Lehigh Co.

Dryers, Sand
* Pangborn Corporation

Drying Apparatus
* American Blower Co.
* Carrier Engineering Corp'n
* Philadelphia Drying Machinery Co.

Dumb Waiters
* Sedgwick Machine Works

Dust Arresting Systems
* Pangborn Corporation

Dust Collecting Systems
* Allington & Curtis Mfg. Co.
* Allis-Chalmers Mfg. Co.
Hoevel Mfg. Corp'n

Dust Collectors
* Allington & Curtis Mfg. Co.
* Allis-Chalmers Mfg. Co.
Cleveland Blow Pipe & Mfg. Co.
* Pangborn Corporation

Dustproofing Materials
Sonneborn, L. Sons (Inc.)

Dyeing Machinery
* Philadelphia Drying Machinery Co.

Dynamic Balancing Machines
(See Balancing Machines, Dynamic)

Dynamometers
* General Electric Co.
* Schaeffer & Budenberg Mfg. Co.
* Wheeler, C. H. Mfg. Co.

Economizers, Fuel
* Green Fuel Economizer Co.

Ejectors
* Lunkenheimer Co.
Manning, Maxwell & Moore (Inc.)
* Schutte & Koerting Co.

Electric Generators, Hoists, Trucks, Welding, etc.
(See Generators, Hoists, Trucks, Welding, etc., Electric)

Electric Machinery
* Allis-Chalmers Mfg. Co.
* General Electric Co.

Electric Measuring Instruments
(See Instruments, Electrical Measuring)

Electric Supplies
* General Electric Co.
* Johns-Manville (Inc.)

Elevating and Conveying Machinery
* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.
* Hill Clutch Co.
* Jones, W. A. Fdry. & Mach. Co.

Elevators, Electric
Eastern Machinery Co.
* Northern Engineering Works
* Washburn & Granger (Inc.)

Elevators, Hand Power
* Sedgwick Machine Works
* Washburn & Granger (Inc.)

Elevators, Passenger and Freight
Eastern Machinery Co.
* Northern Engineering Works
* Washburn & Granger (Inc.)

Engine Stops
Golden-Anderson Valve Specialty Co.
* Schutte & Koerting Co.

Engineers, Consulting
(See Professional Engineering Service Section)

Engines, Blowing
* Allis-Chalmers Mfg. Co.
Mackintosh-Hemphill Co.
* Worthington Pump & Machinery Corp'n

Engines, Distillate
Western Machinery Co.

Engines, Gas
* Allis-Chalmers Mfg. Co.
* De La Vergne Machine Co.
* Titusville Iron Works Co.
Western Machinery Co.

Engines, Gasoline
* Titusville Iron Works Co.
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Hoisting
* Allis-Chalmers Mfg. Co.
Clyde Iron Works Sales Co.
Flory, S. Mfg. Co.
* Lidgerwood Mfg. Co.
* Morris Machine Works
Western Machinery Co.

Engines, Kerosene
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Marine
* Johnson, Carlyle Machine Co.
* Ward, Chas. Engineering Co.
* Worthington Pump & Machinery Corp'n

Engines, Oil
* Allis-Chalmers Mfg. Co.
* De La Vergne Machine Co.
* Titusville Iron Works Co.
Western Machinery Co.
* Worthington Pump & Machinery Corp'n

Engines, Oil, Diesel
* Allis-Chalmers Mfg. Co.
* Worthington Pump & Machinery Corp'n

Engines, Pumping
* Allis-Chalmers Mfg. Co.
* Morris Machine Works
* Worthington Pump & Machinery Corp'n

Engines, Steam
* Allis-Chalmers Mfg. Co.
* Brownell Co.
Clyde Iron Works Sales Co.
* Cole, R. D. Mfg. Co.
* Erie City Iron Works
* Leffel, James & Co.
* Lidgerwood Mfg. Co.
Mackintosh-Hemphill Co.
* Morris Machine Works
* Titusville Iron Works Co.
* Troy Engine & Machine Works
* Vilter Mfg. Co.
* Wheeler, C. H. Mfg. Co.

Engines, Steam, Automatic
* American Blower Co.
* Brownell Co.
* Erie City Iron Works
* Leffel, James & Co.
* Troy Engine & Machine Works

Engines, Steam, Corliss
* Allis-Chalmers Mfg. Co.
Mackintosh-Hemphill Co.
* Vilter Mfg. Co.

Engines, Steam, High Speed
* American Blower Co.
* Brownell Co.
* Erie City Iron Works

Engines, Steam, Poppet Valve
* Erie City Iron Works
* Vilter Mfg. Co.

Engines, Steam, Throttling
* Brownell Co.

Engines, Steam, Variable Speed
* Brownell Co.

Engines, Steering
* Lidgerwood Mfg. Co.

Evaporators
* Braun, C. F. & Co.

Excavating Machinery
Clyde Iron Works Sales Co.
Flory, S. Mfg. Co.
* Lidgerwood Mfg. Co.
* Pawling & Harnischfeger Co.
Sauerman Bros.

Exhaust Systems
* Allington & Curtis Mfg. Co.
* American Blower Co.
* Pangborn Corporation

Exhausters, Gas
* General Electric Co.
* Green Fuel Economizer Co.
* Schutte & Koerting Co.

Expansion Joints
(See Joints, Expansion)

Extractors, Centrifugal
* Tolhurst Machine Works

Extractors, Oil and Grease
* Braun, C. F. & Co.
* Kieley & Mueller (Inc.)

Fans, Exhaust
* American Blower Co.
Cleveland Blow Pipe & Mfg. Co.
* General Electric Co.
* Green Fuel Economizer Co.
Mechanical Appliance Co.
* Pangborn Corporation
* Philadelphia Drying Machinery Co.

Feed Water Circulators, Heaters, Heaters and Purifiers, etc.
(See Circulators, Heaters, Heaters and Purifiers, etc., Feed Water)

Feed Water Controllers
(See Regulators, Feed Water)

Feeders, Pulverized Fuel
Combustion Engineering Corp'n
* Fuller-Lehigh Co.
* Smidth, F. L. & Co.

Fibre, Vulcanized
* Continental Fibre Co.

Filters, Gravity
* Permutit Co.

Filters, Oil
Elliott Co.
* General Electric Co.
* Richardson-Phenix Co.

Filters, Pressure
* Permutit Co.

Filters, Water
* Braun, C. F. & Co.
Elliott Co.
* H. S. B. W.-Cochrane Corp'n
* Permutit Co.
* Scaife, Wm. B. & Sons Co.

Filtration Plants
* H. S. B. W.-Cochrane Corp'n
International Filter Co.
* Scaife, Wm. B. & Sons Co.

Fire Brick, Fire Hydrants, etc.
(See Brick, Hydrants, Fire, etc.)

Fire Tube Boilers
(See Boilers, Return and Vertical Tubular)

Fittings, Ammonia
* Crane Co.
* De La Vergne Machine Co.
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Fittings, Compression
* Richardson-Phenix Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1921 Volume*

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 112

Fittings, Flanged
* Central Foundry Co.
* Crane Co.
* Dougherty, M. J. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Valve & Fittings Co.
* United States Cast Iron Pipe & Fdry. Co.
* Vogt, Henry Machine Co.

Fittings, Hydraulic
* Crane Co.
* Hydraulic Press Mfg. Co.
* Reading Valve & Fittings Co.
* Vogt, Henry Machine Co.

Fittings, Pipe
* Barco Mfg. Co.
* Central Foundry Co.
* Crane Co.
* Dougherty, M. J. Co.
* Lunkenheimer Co.
* Reading Valve & Fittings Co.
Steere Engineering Co.
* Vogt, Henry Machine Co.

Fittings, Steel
* Crane Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Reading Valve & Fittings Co.
Steere Engineering Co.
* Vogt, Henry Machine Co.

Flanges
American Spiral Pipe Wks.
* Crane Co.
* Lunkenheimer Co.
* Reading Valve & Fittings Co.
* Vogt, Henry Machine Co.

Floor Stands
* Crane Co.
* Jones, W. A. Fdry. & Mach. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Schutte & Koerting Co.
* Wood's, T. B. Sons Co.

Flour Milling Machinery
* Allis-Chalmers Mfg. Co.

Fly Wheels
* Medart Patent Pulley Co.
* Wood's, T. B. Sons Co.

Forges
* Best, W. N. Furnace & Burner Corp'n

Forges, Oil
* Rockwell, W. S. Co.

Forges, Rivet
* Rockwell, W. S. Co.

Forgings, Alloy Steel
* American Forge & Machine Co.

Forgings, Drop
* American Forge & Machine Co.
* Vogt, Henry Machine Co.

Forgings, Heavy
* American Forge & Machine Co.

Forgings, Iron and Steel
* American Forge & Machine Co.

Forming Machines, Hydraulic
* Hydraulic Press Mfg. Co.

Foundry Equipment
* Northern Engineering Works

Friction Clutches, Hoists, etc.
(See Clutches, Hoists, etc., Friction)

Friction Drives
Rockwood Mfg. Co.

Frictions, Paper and Iron
* Caldwell, H. W. & Son Co
Rockwood Mfg. Co.

Fuel Economizers
(See Economizers, Fuel)

Furnace Construction
Furnace Engineering Co.

Furnace, Down Draft
* O'Brien, John Boiler Works Co

Furnace Linings
(See Linings, Furnace)

Furnaces, Annealing and Tempering
* Best, W. N. Furnace & Burner Corp'n
* General Electric Co.
* Rockwell, W. S. Co.

Furnaces, Boiler
* American Engineering Co.
American Spiral Pipe Wks.
* Babcock & Wilcox Co.
* Best, W. N. Furnace & Burner Corp'n
Combustion Engineering Corp'n
Green Engineering Co.
* Murphy Iron Works
* Riley, Sanford Stoker Co.
Roach Stoker Co.
* Washburn & Granger (Inc.)

Furnaces, Electric
* Rockwell, W. S. Co.

Furnaces, Gas
* Rockwell, W. S. Co.

Furnaces, Heat Treating
* Best, W. N. Furnace & Burner Corp'n
* General Electric Co.
* Rockwell, W. S. Co.

Furnaces, Melting
* Best, W. N. Furnace & Burner Corp'n
* General Electric Co.
* Rockwell, W. S. Co.

Furnaces, Non-Ferrous
* Maxon Furnace & Engrg. Co.
* Rockwell, W. S. Co.

Furnaces, Oil
* Best, W. N. Furnace & Burner Corp'n
* Rockwell, W. S. Co.

Furnaces, Smokeless
* American Engineering Co.
* Babcock & Wilcox Co.
Combustion Engineering Corp'n
Green Engineering Co.
Herbert Boiler Co.
* Illinois Stoker Co.
* Murphy Iron Works
* Riley, Sanford Stoker Co.
Roach Stoker Co.

Fuses
* General Electric Co.
* Johns-Manville (Inc.)

Gage Boards
* Ashton Valve Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.

Gage Glasses
* Schaeffer & Budenberg Mfg.Co.

Gage Testers
* Ashton Valve Co.
* Crosby Steam Gage & Valve Co.
* Schaeffer & Budenberg Mfg. Co.

Gages, Altitude
* Ashton Valve Co.
* Crosby Steam Gage & Valve Co.
* Schaeffer & Budenberg Mfg. Co.

Gages, Ammonia
* Ashton Valve Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.

Gages, Ball
* S K F Industries (Inc.)

Gages, Differential Pressure
* Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Foxboro Co. (Inc.)
* Precision Instrument Co.
* Schaeffer & Budenberg Mfg. Co.
* Uehling Instrument Co.

Gages, Draft
* Ashton Valve Co.
* Bacharach Industrial Instrument Co.
* Bailey Meter Co.
Brinckerhoff, H. Gordon Co.
* Bristol Co.
* Foxboro Co. (Inc.)
* Precision Instrument Co.
* Schaeffer & Budenberg Mfg. Co.
* Uehling Instrument Co.

Gages, Hydraulic
* Ashton Valve Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* Hydraulic Press Mfg. Co.
* Schaeffer & Budenberg Mfg. Co.

Gages, Measuring (Surface, Depth, Dial, etc.)
* Pratt & Whitney Co.
Rogers, John M. Works (Inc.)
* S K F Industries (Inc.)
* Starrett, L. S. Co.

Gages, Pressure
* Ashton Valve Co.
* Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Bristol Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* Precision Instrument Co.
* Schaeffer & Budenberg Mfg. Co.
* Uehling Instrument Co.

Gages, Vacuum
* Ashton Valve Co.
* Bacharach Industrial Instrument Co.
Brinckerhoff, H. Gordon Co.
* Bristol Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* Precision Instrument Co.
* Schaeffer & Budenberg Mfg. Co.
* Uehling Instrument Co.

Gages, Water
* Ashton Valve Co.
* Bristol Co.
* Crane Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Pratt & Cady Co. (Inc.)

Gages, Water Level
* Bristol Co.
* Foxboro Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.

Gas Analysis Apparatus
* Precision Instrument Co.

Gas Burners, Compressors, Engines, Exhausters, Producers, etc.
(See Burners, Compressors, Engines, Exhausters, Producers, etc., Gas)

Gas Burning Equipment
* Rockwell, W. S. Co.

Gas Collectors
* Precision Instrument Co.

Gas Plant Machinery
* Cole, R. D. Mfg. Co.
* Rockwell, W. S. Co.
Steere Engineering Co.

Gas Plants, Gasoline
Tirrill Gas Machine Lighting Co.

Gaskets
* Goetze Gasket & Packing Co.
* Jenkins Bros.
* Johns-Manville (Inc.)
* Sarco Co. (Inc.)

Gasoline
Texas Co.

Gates, Blast
* Caldwell, H. W. & Son Co.
* Rockwell, W. S. Co.
* Washburn & Granger (Inc.)

Gates, Cut-Off
* Caldwell, H. W. & Son Co.

Gates, Hopper
* Washburn & Granger (Inc.)

Gates, Sluice
Chapman Valve Mfg. Co.

Gear Cutting Machines
Bilton Machine Tool Co.
* Jones, W. A. Fdry. & Mch. Co.

Gear Generators
* Niles-Bement-Pond Co.

Gear Hobbing Machines
Bilton Machine Tool Co.
* Jones, W. A. Fdry. & Mch. Co.

Gear Shapers
* Fellows Gear Shaper Co.

Gears, Cut
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Caldwell, W. E. Co. (Inc.)
* De Laval Steam Turbine Co.
* Fawcus Machine Co.
* Foote Bros. Gear & Machine Co.
* Hill Clutch Co.
Hindley Gear Co.
* James, D. O. Mfg. Co.
* Johnson, Carlyle Machine Co.
* Jones, W. A. Fdry. & Mch. Co.
Mackintosh-Hemphill Co.
* Medart Patent Pulley Co.
* Northern Engineering Works

Gears, Fibre
* Caldwell, W. E. Co. (Inc.)
* Continental Fibre Co.
* General Electric Co.
* James, D. O. Mfg. Co.

Gears, Machine Molded
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Caldwell, W. E. Co. (Inc.)
* Hill Clutch Co.
* Jones, W. A. Fdry. & Mch. Co.

Gears, Rawhide
* Caldwell, W. E. Co. (Inc.)
* James, D. O. Mfg. Co.

Gears, Speed Reduction
* De Laval Steam Turbine Co.
* Fawcus Machine Co.
* Foote Bros. Gear & Machine Co.
* General Electric Co.
* James, D. O. Mfg. Co.
* Jones, W. A. Fdry. & Mach. Co.
* Kerr Turbine Co.
* Moore Steam Turbine Corp'n

Gears, Worm
* Caldwell, H. W. & Son Co.
* Cleveland Worm & Gear Co.
* Fawcus Machine Co.
* Foote Bros. Gear & Machine Co.
* Gifford-Wood Co.
Hindley Gear Co.
* James, D. O. Mfg. Co.
* Jones, W. A. Fdry. & Mach. Co.

Generating Sets
* Allis-Chalmers Mfg. Co
* American Blower Co.
* De Laval Steam Turbine Co
* General Electric Co
* Kerr Turbine Co.

Generators, Electric
* Allis-Chalmers Mfg. Co.
* De Laval Steam Turbine Co.
* General Electric Co.
Mechanical Appliance Co.

Governors, Pump
Davis, G. M. Regulator Co.
* Ford Regulator Corp'n
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
Plant Engrg. & Equip. Co. (Inc.)
* Richardson-Phenix Co.

Governors, Water Wheel
* Worthington Pump & Machinery Corp'n

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* Smidth, F. L. & Co.

Grate Bars
* Casey-Hedges Co.
Combustion Engineering Corp'n
* Erie City Iron Works
* Titusville Iron Works Co.
* Vogt, Henry Machine Co.
* Washburn & Granger (Inc.)

Grate Bars (for Overfeed and Underfeed Stokers)
Furnace Engineering Co.

Grates, Dumping
* Brownell Co.
Combustion Engineering Corp'n
Roach Stoker Co.
* Titusville Iron Works Co.
* Vogt, Henry Machine Co.
* Washburn & Granger (Inc.)

Grates, Rocking
* Brownell Co.

Grates, Shaking
* Brownell Co.
* Casey-Hedges Co.
Combustion Engineering Corp'n
* Erie City Iron Works
Roach Stoker Co.
* Springfield Boiler Co.
* Titusville Iron Works Co.
* Vogt, Henry Machine Co.
* Washburn & Granger (Inc.)

Grease Cups
(See Oil and Grease Cups)

Grease Extractors
(See Separators, Oil)

Greases
* Royersford Foundry & Machine Co.
Texas Co.

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* Brown, A. & F. Co.
* Niles-Bement-Pond Co.
* Smidth, F. L. & Co.

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* Landis Machine Co. (Inc.)
* Niles-Bement-Pond Co.

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Le Blond, R. K. Mach. Tool Co.

Grinding Machines, Disc
* Niles-Bement-Pond Co.

Grinding Machines, Floor
* Royersford Foundry & Machine Co.

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* Heald Machine Co.

Grinding Machines, Surface
* Heald Machine Co.
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Grinding Machines, Tool
Le Blond, R. K. Mach. Tool Co.
* Niles-Bement-Pond Co.

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* American Metal Treatment Co.

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* Bliss, E. W. Co.
* Long & Allstatter Co.
* Niles-Bement-Pond Co.

Hammers, Pneumatic
* Ingersoll-Rand Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1921 Volume*

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Title	Author	Order No.	Prices To Members	Prices To Non-Members
Spur Gearing on Heavy Railway Motor Equipments	Norman Litchfield	1219	.25	.40
Tooth Gearing	J. D. Steven	1292	.25	.35
Interchangeable Involute Gearing	Wilfred Lewis	1292b	.25	.35
Discussion on Papers 1292a-b		1292d	.25	.35
Investigation of Efficiency of Worm Gearing for Automobile Transmission	William H. Kenerson	1371	.25	.40
Gears for Machine Tool Drives	John Parker	1415	.25	.35
The Strength of Gear Teeth, 2d paper	G. H. Marx and L. E. Cutter	1494	.25	.40
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* Caldwell, W. E. Co. (Inc.)
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
* Jones, W. A. Fdry. & Mch. Co.
* Medart Patent Pulley Co.
* Royersford Foundry & Machine Co.
* Wood's, T. B. Sons Co.

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* S K F Industries (Inc.)

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* Rockwell, W. S. Co.

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* Rockwell, W. S. Co.

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* Brownell Co.
* Erie City Iron Works
* Schutte & Koerting Co.
* Walsh & Weidner Boiler Co.
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* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Heaters, Feed Water, Locomotive (Open)
* Worthington Pump & Machinery Corp'n

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* Braun, C. F. & Co.
* Lockett, A. M. & Co. (Ltd.)
* Maxon Furnace & Engrg. Co.

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* H. S. B. W.-Cochrane Corp'n
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* Wickes Boiler Co.
* Worthington Pump & Machinery Corp'n

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* H. S. B. W.-Cochrane Corp'n

Heating Systems, Vacuum
* Illinois Engineering Co.

Plant Engrg. & Equip. Co. (Inc.)

Heating and Ventilating Apparatus
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* Brown Hoisting Machinery Co.

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* Lidgerwood Mfg. Co.
* Northern Engineering Works
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Hoists, Air

Curtis Pneumatic Machy. Co.
* Ingersoll-Rand Co.
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Clyde Iron Works Sales Co.
* Lidgerwood Mfg. Co.

Hoists, Chain
* Northern Engineering Works
* Reading Chain & Block Corp'n
* Yale & Towne Mfg. Co.

Hoists, Electric
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* Brown Hoisting Machinery Co.

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* Lidgerwood Mfg. Co.
* Niles-Bement-Pond Co.
* Northern Engineering Works
* Pawling & Harnischfeger Co.
* Reading Chain & Block Corp'n
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Hoists, Gas and Gasoline

Flory, S. Mfg. Co.
* Lidgerwood Mfg. Co.

Western Machinery Co.

Hoists, Head Gate

Smith, S. Morgan Co.

Hoists, Mine

Flory, S. Mfg. Co.
* Lidgerwood Mfg. Co.

Western Machinery Co.

Hoists, Skip
* Beaumont, R. H. Co.
* Brown Hoisting Machinery Co.

Flory, S. Mfg. Co.
* Lidgerwood Mfg. Co.
* Washburn & Granger (Inc.)

Hoists, Steam

(See Engines, Hoisting)

Hoists, Telescopic Ash
* Washburn & Granger (Inc.)

Hose, Flexible Metallic

Breeze Metal Hose & Mfg. Co.

Hose, Metallic
* Johns-Manville (Inc.)

Humidifiers
* American Blower Co.
* Carrier Engineering Corp'n

Humidity Control
* American Blower Co.
* Carrier Engineering Corp'n

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* Pratt & Cady Co. (Inc.)
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Mackintosh-Hemphill Co.
* Niles-Bement-Pond Co.
* Worthington Pump & Machinery Corp'n

Hydraulic Rams, Presses, Turbines, etc.

(See Rams, Presses, Turbines, etc., Hydraulic)

Hydrokineters
* Schutte & Koerting Co.

Hygrometers
* Foxboro Co. (Inc.)

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* De La Vergne Machine Co.
* Johns-Manville (Inc.)
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

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* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.

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* Smidth, F. L. & Co.

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* Washburn & Granger (Inc.)

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* Crane Co.
* Pratt & Cady Co. (Inc.)

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Brinckerhoff, H. Gordon Co.
* Foxboro Co. (Inc.)
* Precision Instrument Co.
* Uehling Instrument Co.

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* Bacharach Industrial Instrument Co.
* Crosby Steam Gage & Valve Co.
* Schaeffer & Budenberg Mfg. Co.

Indicators, Sight Flow
* Richardson-Phenix Co.

Indicators, Speed
* Foxboro Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.

Veeder Mfg. Co.

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* Lunkenheimer Co.

Manning, Maxwell & Moore (Inc.)
* Schutte & Koerting Co.

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* General Electric Co.
* Republic Flow Meters Co.

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* Ashton Valve Co.
* Bacharach Industrial Instrument Co.
* Bailey Meter Co.

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* Bristol Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* General Electric Co.
* Precision Instrument Co.
* Republic Flow Meters Co.
* Schaeffer & Budenberg Mfg. Co.
* Uehling Instrument Co.
* Yarnall-Waring Co

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Keuffel & Esser Co.
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* Spray Engineering Co.

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* Braun, C. F. & Co.
* Crane Co.
* Illinois Engineering Co.
* Lunkenheimer Co.
* Wheeler, C. H. Mfg. Co.

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* Crane Co.
* Dougherty, M. J. Co.

Mitchell, W. K. & Co. (Inc.)

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* Barco Mfg. Co.

Joints, Swing and Swivel
* Barco Mfg. Co.

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* Cole, R. D. Mfg. Co.
* Titusville Iron Works Co.

Keys, Machine
* Whitney Mfg. Co.

Keyseating Machines
* Whitney Mfg. Co.

Kilns, Dry (Brick, Lumber, Stone, etc.)
* American Blower Co.

Ladles
* Northern Engineering Works

Lamps, Incandescent
* General Electric Co.
* Johns-Manville (Inc.)

Land-Clearing Machinery

Clyde Iron Works Sales Co.

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LeBlond, R. K. Mch. Tool Co.

Lathes, Automatic
* Jones & Lamson Machine Co.

Lathes, Brass
* Warner & Swasey Co.

Lathes, Chucking
* Jones & Lamson Machine Co.
* Niles-Bement-Pond Co.

Lathes, Engine

LeBlond, R. K. Mach. Tool Co.
* Niles-Bement-Pond Co.
* Pratt & Whitney Co.

Lathes, Speed

LeBlond, R. K. Mach. Tool Co.
* Niles-Bement-Pond Co.

Lathes, Turret
* Jones & Lamson Machine Co.
* Niles-Bement-Pond Co.
* Pratt & Whitney Co.
* Warner & Swasey Co.

Leather Belting, Packing, etc.

(See Belting, Packing, etc., Leather)

Levers, Flexible (Wire)
* Gwilliam Co.

Lightning Arresters
* General Electric Co.

Lining, Brake
* Johns-Manville (Inc.)

Lining, Furnace
* Best, W. N. Furnace & Burner Corp'n

Brinckerhoff, H. Gordon Co.
* Celite Products Co.
* Crescent Refractories Co.
* Johns-Manville (Inc.)
* Washburn & Granger (Inc.)

Lining, Stack
* Johns-Manville (Inc.)

Liquid Fuel Equipment
* Best, W. N. Furnace & Burner Corp'n

Loaders, Wagon
* Gifford-Wood Co.

Lockers, Metal

Lyon Metallic Mfg. Co.

Locomotives, Electric
* General Electric Co.

Locomotives, Storage Battery
* General Electric Co.

Logging Machinery

Clyde Iron Works Sales Co.
* Lidgerwood Mfg. Co.

Lubricants
* Royersford Fdry. & Mach. Co

Texas Co.

Lubricating Systems
* Greene, Tweed & Co.
* Richardson-Phenix Co.

Lubricators, Cylinder
* Greene, Tweed & Co.
* Lunkenheimer Co.
* Richardson-Phenix Co.

Lubricators, Force-Feed
* Greene, Tweed & Co.
* Lunkenheimer Co.
* Richardson-Phenix Co.

Lubricators, Hydrostatic
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.

Lubricators (Sight Feed)
* Crosby Steam Gage & Valve Co.

Machine Work

Bay View Foundry Co.
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Hill Clutch Co.
* Johnson, Carlyle Machine Co.
* Jones, W. A. Fdry. & Mch. Co.
* Lammert & Mann Co.
* Washburn & Granger (Inc.)

Machinery

(Is classified under the headings descriptive of character thereof)

Magnesia Products
* Magnesia Assoc. of America

Manometers
* Bacharach Industrial Instrument Co.
* Republic Flow Meters Co.

Mechanical Draft Apparatus
* American Blower Co.
* Green Fuel Economizer Co.

Power Turbo-Blower Co.

Mechanical Stokers

(See Stokers)

Metal Cutting Machines

(See Cutting-off Machines, Metal)

Metal Reclaiming Mills

(See Mills, Metal Reclaiming)

Metal Treating
* American Metal Treatment Co.
* Rockwell, W. S. Co.

Metals, Bearing
* General Electric Co.

Metals, Perforated
* Hendrick Mfg. Co.

Meters, Air and Gas
* Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* Foxboro Co. (Inc.)
* General Electric Co.
* Republic Flow Meters Co.

Meters, Boiler Performance
* Bailey Meter Co.

Meters, Electric
* General Electric Co.

Meters, Feed Water
* Bailey Meter Co.
* Foxboro Co. (Inc.)
* General Electric Co.
* H. S. B. W.-Cochrane Corp'n
* Precision Instrument Co.
* Republic Flow Meters Co.
* Worthington Pump & Machinery Corp'n
* Yarnall-Waring Co.

Meters, Flow
* Bacharach Industrial Instrument Co.
* Bailey Meter Co.
* General Electric Co.
* Republic Flow Meters Co.
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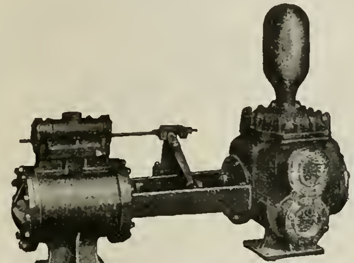

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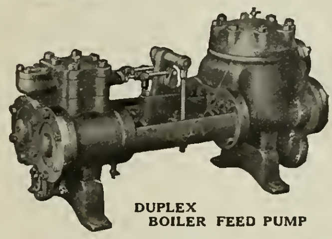

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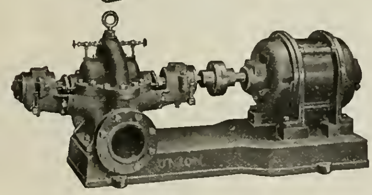

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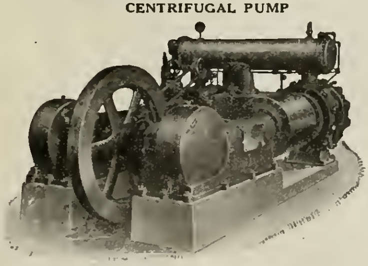

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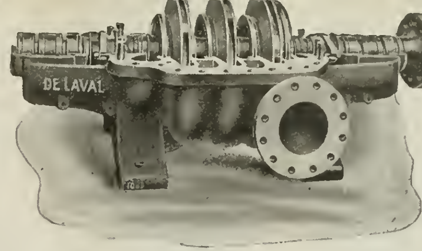

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Trenton, N. J.

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CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued) FOR ALPHABETICAL INDEX, SEE PAGE 112

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 112

Pumping Systems, Air Lift
* Ingersoll-Rand Co.

Pumps, Acid
* Titusville Iron Works Co.

Pumps, Air
* Goulds Mfg. Co.
Plant Engrg. & Equip. Co. (Inc.)

Pumps, Ammonia
* Worthington Pump & Machinery Corp'n

Pumps, Boiler Feed
* Allis-Chalmers Mfg. Co.
* Dayton Dowd Co.
* De Laval Steam Turbine Co.
* Goulds Mfg. Co.
* Kerr Turbine Co.
Plant Engrg. & Equip. Co. (Inc.)
Twinvolute Pump & Mfg. Co.
* Union Steam Pump Co.
* Wheeler, C. H. Mfg. Co.
* Worthington Pump & Machinery Corp'n

Pumps, Centrifugal
* Allis-Chalmers Mfg. Co.
* Braun, C. F. & Co.
Buffalo Steam Pump Co.
* Cramp, Wm. & Sons Ship & Engine Bldg. Co.
* Dayton-Dowd Co.
* De Laval Steam Turbine Co.
* Goulds Mfg. Co.
* Kerr Turbine Co.
* Lammert & Mann Co.
* Morris Machine Works
Plant Engrg. & Equip. Co. (Inc.)
* Taber Pump Co.
Twinvolute Pump & Mfg. Co.
* Union Steam Pump Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Pumps, Condensation
Plant Engrg. & Equip. Co. (Inc.)

Pumps, Deep Well
* Allis-Chalmers Mfg. Co.
* Goulds Mfg. Co.
* Morris Machine Works
* Worthington Pump & Machinery Corp'n

Pumps, Dredging
* Morris Machine Works
* Worthington Pump & Machinery Corp'n

Pumps, Dry Vacuum
(See Pumps, Vacuum)

Pumps, Electric
* Allis-Chalmers Mfg. Co.
* Dayton-Dowd Co.
* Goulds Mfg. Co.
* Morris Machine Works
Plant Engrg. & Equip. Co. (Inc.)
Twinvolute Pump & Mfg. Co.
* Worthington Pump & Machinery Corp'n

Pumps, Elevator
* Dayton-Dowd Co.
Twinvolute Pump & Mfg. Co.
* Worthington Pump & Machinery Corp'n

Pumps, Filter Press
* Hydraulic Press Mfg. Co.

Pumps, Fire
* Dayton-Dowd Co.

Pumps, Hand
* Goulds Mfg. Co.

Pumps, Hydraulic
* Union Steam Pump Co.

Pumps, Hydraulic Pressure
* Dayton-Dowd Co.
* Goulds Mfg. Co.
* Hydraulic Press Mfg. Co.
* Morris Machine Works
* Worthington Pump & Machinery Corp'n

Pumps, Measuring (Gasoline or Oil)
* Richardson-Phenix Co.

Pumps, Oil
* Goulds Mfg. Co.
* Lunkenheimer Co.
* Maxon Furnace & Engrg. Co.
Plant Engrg. & Equip. Co. (Inc.)
* Richardson-Phenix Co.
* Worthington Pump & Machinery Corp'n

Pumps, Oil, Force-Feed
* Greene, Tweed & Co.
* Lunkenheimer Co.
* Richardson-Phenix Co.

Pumps, Oil (Hand)
* Richardson-Phenix Co.

Pumps, Power
* Allis-Chalmers Mfg. Co.
Buffalo Steam Pump Co.
* Goulds Mfg. Co.
* Union Steam Pump Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Pumps, Rotary
* Goulds Mfg. Co.
* Lammert & Mann Co.
* Taber Pump Co.

Pumps, Steam
* Allis-Chalmers Mfg. Co.
* Braun, C. F. & Co.
Buffalo Steam Pump Co.
Plant Engrg. & Equip. Co. (Inc.)
* Union Steam Pump Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Pumps, Sugar House
* Allis-Chalmers Mfg. Co.
* Dayton-Dowd Co.
* Union Steam Pump Co.
* Worthington Pump & Machinery Corp'n

Pumps, Sump
* Dayton-Dowd Co.
* Goulds Mfg. Co.
* Morris Machine Works
* Smidth, F. L. & Co.

Pumps, Tank
* Goulds Mfg. Co.
Twinvolute Pump & Mfg. Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Pumps, Turbine
* Allis-Chalmers Mfg. Co.
* Braun, C. F. & Co.
* De Laval Steam Turbine Co.
* General Electric Co.
* Kerr Turbine Co.
* Morris Machine Works
Plant Engrg. & Equip. Co (Inc.)
Power Turbo-Blower Co.
Twinvolute Pump & Mfg. Co.
* Worthington Pump & Machinery Corp'n

Pumps, Vacuum
* Goulds Mfg. Co.
* Ingersoll-Rand Co.
* Lammert & Mann Co.
Plant Engrg. & Equip. Co. (Inc.)
* Union Steam Pump Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.
* Worthington Pump & Machinery Corp'n

Punches, Multiple
* Bliss, E. W. Co.
* Long & Allstatter Co.
Mackintosh-Hemphill Co.
* Niles-Bement-Pond Co.

Punches, Power
* Bliss, E. W. Co.
* Royersford Fdry. & Mch. Co.

Punches and Dies
* Bliss, E. W. Co.
* Pratt & Whitney Co.
* Royersford Fdry. & Mch. Co.

Punching and Coping Machines
* Long & Allstatter Co.

Punching and Shearing Machines
* Bliss, E. W. Co.
* Long & Allstatter Co.
* Niles-Bement-Pond Co.
* Royersford Fdry. & Mch. Co.

Purifiers, Oil
Elliott Co.
* Richardson-Phenix Co.

Purifying and Softening Systems, Water
International Filter Co.
* Scaife, Wm. B. & Sons Co.
* Yarnall-Waring Co.

Pyrometers, Electric
* Bristol Co.
* Crosby Steam Gage & Valve Co.
* Foxboro Co. (Inc.)
* Schaeffer & Budenberg Mfg. Co.
* Superheater Co.

Pyrometers, Pneumatic
* Uehling Instrument Co.

Racks, Cut
* Brownell Co.
* James, D. O. Mfg. Co.

Radiators, Steam and Water
* Smith, H. B. Co.

Rams, Hydraulic
* Goulds Mfg. Co.
* Worthington Pump & Machinery Corp'n

Reamers, Adjustable & Expansion
Rogers, John M. Works (Inc.)

Receivers, Air
* Brownell Co
* Ingersoll-Rand Co.
* Scaife, Wm. B. & Sons Co.
* Walsh & Weidner Boiler Co.
* Wheeler Condenser & Engineering Co.

* Worthington Pump & Machinery Corp'n

Recording Instruments
(See Instruments, Recording)

Reducing Motions
* Crosby Steam Gage & Valve Co.

Refractories
* Crescent Refractories Co.
* King Refractories Co. (Inc.)

Refrigerating Machinery
* De La Vergne Machine Co.
* Johns-Manville (Inc.)
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Refuse Destructors
(See Destructors, Refuse)

Regulators, Blower
Davis, G. M. Regulator Co.

Regulators, Damper
Davis, G. M. Regulator Co.
* Kieley & Mueller (Inc.)
Plant Engrg. & Equip. Co. (Inc.)
Power Turbo-Blower Co

Regulators, Electric
* General Electric Co.

Regulators, Feed Water
Elliott Co.
* Kieley & Mueller (Inc.)
Plant Engrg. & Equip. Co. (Inc.)

Regulators, Flow (Steam)
Davis, G. M. Regulator Co.
* Schutte & Koerting Co.

Regulators, Pressure
Davis, G. M. Regulator Co.
* Ford Regulator Corp'n
* General Electric Co.
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
Plant Engrg. & Equip. Co. (Inc.)

Regulators, Pump
(See Governors, Pump)

Regulators, Temperature
* Bristol Co.
* Foxboro Co. (Inc.)
* Kieley & Mueller (Inc.)
* Powers Regulator Co.
* Sarco Co. (Inc.)

Regulators, Time
* Foxboro Co. (Inc.)

Regulators, Water Level
* Ford Regulator Corp'n

Reservoirs, Aerating
* Spray Engineering Co.

Resistance Material (Electrical)
Driver-Harris Co.

Revolution Counters
(See Counters, Revolution)

Rivet Heaters, Electric
* General Electric Co.

Riveters, Hydraulic
Mackintosh-Hemphill Co.

Riveters, Pneumatic
* Ingersoll-Rand Co.

Riveting Machines
Bilton Machine Tool Co.
* Long & Allstatter Co.

Rivets
* Reed & Prince Mfg. Co.

Rods, Fibre
* Continental Fibre Co.

Roller Bearings
(See Bearings, Roller)

Rolling Mill Machinery
Mackintosh-Hemphill Co.

Rolls, Crushing
* Worthington Pump & Machinery Corp'n

Rolls, Steel
Mackintosh-Hemphill Co.

Roofing
* Johns-Manville (Inc.)
Texas Co.

Roofing, Asbestos
* Johns-Manville (Inc.)

Rope Drives
* Allis-Chalmers Mfg. Co.
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
* Medart Patent Pulley Co.
* Wood's, T. B. Sons Co.

Rope, Hoisting
Clyde Iron Works Sales Co.
* Roebling's, John A. Sons Co.

Rope, Transmission
* Caldwell, H. W. & Son Co.
* Roebling's, John A. Sons Co.

Rope, Wire
Clyde Iron Works Sales Co.
* Roebling's, John A. Sons Co.

Rubber Goods, Mechanical
* Jenkins Bros.

Safety Guards
Cleveland Blow Pipe & Mfg.

Sand Blast Apparatus
* De La Vergne Machine Co.
Hoevel Mfg. Corp'n
* Lunkenheimer Co.
* Panghorn Corporation

Sand Blast Equipment
Hoevel Mfg. Corp'n
* Pangborn Corporation

Saw Blades, Hack
* Starrett, L. S. Co.

Saw Mill Machinery
* Allis-Chalmers Mfg. Co.

Saws, Circular (Metal)
* Niles-Bement-Pond Co.

Scales, Fluid Pressure
* Crosby Steam Gage & Valve Co

Screens, Perforated Metal
* Hendrick Mfg. Co.

Screens, Revolving
* Allis-Chalmers Mfg. Co.
* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.
* Hendrick Mfg. Co.
* Smidth, F. L. & Co.

Screens, Shaking
* Allis-Chalmers Mfg. Co.
* Caldwell, H. W. & Son Co.
* Gifford-Wood Co.
* Hendrick Mfg. Co.

Screw Cutting Dies
(See Dies, Thread Cutting)

Screw Machines, Hand
* Jones & Lamson Mch. Co.
* Warner & Swasey Co.

Screw, Steel
* Union Drawn Steel Co.

Screws, Cap & Set
Allen Mfg. Co.
* Reed & Prince Mfg. Co.

Screws, Machine
* Reed & Prince Mfg. Co.

Screws, Safety Set
Allen Mfg. Co.
* Bristol Co.

Screws, Wood
* Reed & Prince Mfg. Co.

Separators, Ammonia
* De La Vergne Machine Co.
Elliott Co.

Separators, Oil
* Crane Co.
* De La Vergne Machine Co.
Elliott Co.
* H. S. B. W.-Cochrane Corp'n
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
Plant Engrg. & Equip. Co. (Inc.)

Separators, Steam
* Crane Co.
Elliott Co.
* H. S. B. W.-Cochrane Corp'n
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
Plant Engrg. & Equip. Co. (Inc.)

Shafting
* Allis-Chalmers Mfg. Co.
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Falls Clutch & Mchy. Co.
* Hill Clutch Co.
* Union Drawn Steel Co.
* Wood's, T. B. Sons Co.

Shafting, Cold Drawn
* Medart Patent Pulley Co.

Shafting, Flexible
* Gwilliam Co.

Shafting, Flexible Metallic
Breeze Metal Hose & Mfg. Co.

Shapers
* Niles-Bement-Pond Co.
* Pratt & Whitney Co.

Shapes, Cold Drawn Steel
* Union Drawn Steel Co.

Shears, Alligator
* Long & Allstatter Co.
* Royersford Foundry & Machine Co.

Shears, Hydraulic
Mackintosh-Hemphill Co.

Shears, Plate
* Long & Allstatter Co.
Mackintosh-Hemphill Co.
* Niles-Bement-Pond Co.

Shears, Squaring
* Bliss, E. W. Co.
* Niles-Bement-Pond Co.

Sheaves, Rope
* Brown, A. & F. Co.
* Caldwell, H. W. & Son Co.
* Caldwell, W. E. Co. (Inc.)
Clyde Iron Works Sales Co.
* Falls Clutch & Machinery Co.
* Hill Clutch Co.
* Jones, W. A. Fdry. & Mch. Co.
Mackintosh-Hemphill Co.
* Medart Patent Pulley Co.
* Wood's, T. B. Sons Co.

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1921 Volume*

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CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 112

*Catalogue data of firms marked * appear in the A. S. M. E. Condensed Catalogues of Mechanical Equipment, 1921 Volume*

CLASSIFIED LIST OF MECHANICAL EQUIPMENT (Continued)

FOR ALPHABETICAL INDEX, SEE PAGE 112

* General Electric Co.
* Kerr Turbine Co.
* Moore Steam Turbine Corp'n
  Power Turbo-Blower Co.
* Terry Steam Turbine Co.

Turbo-Blowers
  Brinckerhoff, H. Gordon Co.
* General Electric Co.
* Ingersoll-Rand Co.
* Kerr Turbine Co.
* Moore Steam Turbine Corp'n
  Power Turbo-Blower Co.

Turbo-Compressors
* Ingersoll-Rand Co.

Turbo-Generators
* Allis-Chalmers Mfg. Co.
* De Laval Steam Turbine Co.
* General Electric Co.
* Kerr Turbine Co.
* Moore Steam Turbine Corp'n
* Terry Steam Turbine Co.

Turbo-Pumps
* Kerr Turbine Co.
* Moore Steam Turbine Corp'n
* Terry Steam Turbine Co.
* Wheeler Condenser & Engineering Co.

Turntables
* Northern Engineering Works
* Washburn & Granger (Inc.)

Turret Machines
* Jones & Lamson Machine Co.
  LeBlond, R. K. Mch. Tool Co.
* Warner & Swasey Co.

Underfeed Stokers
  (See Stokers, Underfeed)

Unions
* Crane Co.
* Lunkenheimer Co.

Unions, Flange
* Hydraulic Press Mfg. Co.

Unloaders, Air Compressor
* Ingersoll-Rand Co.
* Worthington Pump & Machinery Corp'n
* Yarnall-Waring Co.

Unloaders, Ballast
* Lidgerwood Mfg. Co.

Vacuum Dryers, Pans, Pumps, Traps, etc.
  (See Pans, Pumps, Traps, etc., Vacuum)

Valve Discs
* Goetze Gasket & Packing Co.
* Jenkins Bros.
* Pratt & Cady Co. (Inc.)

Valves, Air, Automatic
  Davis, G. M. Regulator Co.
* Jenkins Bros.
  Plant Engrg. & Equip. Co. (Inc.)
* Smith, H. B. Co.

Valves, Air Relief
* Lunkenheimer Co.
* Schutte & Koerting Co.

Valves, Altitude
  Golden-Anderson Valve Specialty Co.

Valves, Ammonia
* Crane Co.
* De La Vergne Machine Co.
* Homestead Valve Mfg. Co. (Inc.)
* Jenkins Bros.
* Lunkenheimer Co.
* Pratt & Cady Co. (Inc.)
* Vilter Mfg. Co.
* Vogt, Henry Machine Co.

Valves, Back Pressure
* Crane Co.
  Davis, G. M. Regulator Co.
* H. S. B. W.-Cochrane Corp'n
* Illinois Engineering Co.
* Jenkins Bros.
* Kieley & Mueller (Inc.)
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Schutte & Koerting Co.

Valves, Balanced
* Crane Co.
  Davis, G. M. Regulator Co.
  Golden-Anderson Valve Specialty Co.
* Homestead Valve Mfg. Co. (Inc.)
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.
  Power Turbo-Blower Co.
* Schutte & Koerting Co.

Valves, Blowoff
* Ashton Valve Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
  Elliott Co.
* Homestead Valve Mfg. Co. (Inc.)
* Jenkins Bros.
* Lunkenheimer Co.
* Pratt & Cady Co. (Inc.)
* Richardson-Phenix Co.
* Yarnall-Waring Co.

Valves, Butterfly
* Crane Co.
* Lunkenheimer Co.
* Schutte & Koerting Co.

Valves, Check
  Chapman Valve Mfg. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Richardson-Phenix Co.
* Schutte & Koerting Co.
* Vogt, Henry Machine Co.
* Worthington Pump & Machinery Corp'n

Valves, Electrically Operated
  Golden-Anderson Valve Specialty Co.
* Pratt & Cady Co. (Inc.)

Valves, Exhaust Relief
* Crane Co.
  Davis, G. M. Regulator Co.
* H. S. B. W.-Cochrane Corp'n
* Illinois Engineering Co.
* Jenkins Bros.
* Kieley & Mueller (Inc.)
* Schutte & Koerting Co.
* Wheeler, C. H. Mfg. Co.
* Wheeler Condenser & Engineering Co.

Valves, Float
* Crane Co.
  Davis, G. M. Regulator Co.
* Ford Regulator Corp'n
  Golden-Anderson Valve Specialty Co.
* Homestead Valve Mfg. Co.(Inc.)
* Kieley & Mueller (Inc.)
* Schutte & Koerting Co.

Valves, Foot
* Crane Co.
* Worthington Pump & Machy. Corp'n

Valves, Gate
* Braun, C. F. & Co.
  Chapman Valve Mfg. Co.
* Crane Co.
* Dougherty, M. J. Co.
* Jenkins Bros.
  Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Schutte & Koerting Co.

Valves, Globe, Angle and Cross
* Crane Co.
* Crosby Steam Gage & Valve Co.
  Golden-Anderson Valve Specialty Co.
* Jenkins Bros.
  Kennedy Valve Mfg. Co.
* Lunkenheimer Co.
  Manning, Maxwell & Moore (Inc.)
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Richardson-Phenix Co.
* Vogt, Henry Machine Co.

Valves, Hose
* Crane Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)

Valves, Hydraulic
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Homestead Valve Mfg. Co. (Inc.)
* Hydraulic Press Mfg. Co.
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Schutte & Koerting Co.
* Vogt, Henry Machine Co.
* Yarnall-Waring Co.

Valves, Hydraulic Operating
* Hydraulic Press Mfg. Co.
* Lunkenheimer Co.
* Pratt & Cady Co. (Inc.)
* Schutte & Koerting Co.
* Yarnall-Waring Co.

Valves, Non-Return
* Crane Co.
* Crosby Steam Gage & Valve Co.
  Davis, G. M. Regulator Co.
* Ford Regulator Corp'n
  Golden-Anderson Valve Specialty Co.
* Illinois Engineering Co.
* Jenkins Bros.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Schutte & Koerting Co.

Valves, Plug
* Homestead Valve Mfg. Co. (Inc.)
* Pratt & Cady Co. (Inc.)

Valves, Pop Safety
* Ashton Valve Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.

Valves, Pump
* Goulds Mfg. Co.
* Jenkins Bros.
* Johns-Manville (Inc.)
* Richardson-Phenix Co.

Valves, Radiator
* Crane Co.
* Jenkins Bros.
* Lunkenheimer Co.
  Plant Engrg. & Equip. Co. (Inc.)
* Pratt & Cady Co. (Inc.)

Valves, Reducing
  Davis, G. M. Regulator Co.
  Elliott Co.
* Ford Regulator Corp'n
  Golden-Anderson Valve Specialty Co.
* Kieley & Mueller (Inc.)
  Plant Engrg. & Equip. Co. (Inc.)

Valves, Regulating
* Crane Co.
  Davis, G. M. Regulator Co.
* Ford Regulator Corp'n
  Golden-Anderson Valve Specialty Co.
* Illinois Engineering Co.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.
  Plant Engrg. & Equip. Co. (Inc.)

Valves, Relief
* Ford Regulator Corp'n
  Golden-Anderson Valve Specialty Co.

Valves, Relief (Water)
* Ashton Valve Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
  Golden-Anderson Valve Specialty Co.
* Lunkenheimer Co.

Valves, Safety
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Jenkins Bros.
* Lunkenheimer Co.

Valves, Stop & Check
  (See Valve, Non-Return)

Valves, Superheated Steam (Steel)
* Crane Co.
  Golden-Anderson Valve Specialty Co.
* Illinois Engineering Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Richardson-Phenix Co.
* Schutte & Koerting Co.
* Vogt, Henry Machine Co.

Valves, Throttle
* Crane Co.
  Golden-Anderson Valve Specialty Co.
* Jenkins Bros.
* Lunkenheimer Co.
* Nelson Valve Co.
* Pratt & Cady Co. (Inc.)
* Schutte & Koerting Co.

Valves, Vacuum
  Plant Engrg. & Equip. Co. (Inc.)

Ventilating Systems
* American Blower Co.
  Cleveland Blow Pipe & Mfg. Co.

Vibration Indicating Machines
  Vibration Specialty Co.

Vises, Bench
  Prentiss Vise Co.

Vises, Pipe
  Prentiss Vise Co.

Vises, Woodworking
  Prentiss Vise Co.

Voltmeters
* Bristol Co.
* Genera Electric Co.

Vulcanizers
* Bigelow Co.

Water Cinder Mills
  (See Mills, Cinder, Water)

Water Circulators, Filters, Gages Heaters, Meters, Strainers, etc.
  (See Circulators, Filters, Gages, Heaters, Meters, Strainers, etc., Water)

Water Columns
* Ashton Valve Co.
* Kieley & Mueller (Inc.)
* Lunkenheimer Co.

Water Purifying Plants
  International Filter Co.
* Scaife, Wm. B. & Sons Co.

Water Softeners
  Brinckerhoff, H. Gordon Co.
* H. S. B. W.-Cochrane Corp'n
  International Filter Co.
* Permutit Co.
* Scaife, Wm. B. & Sons Co.
* Yarnall-Waring Co.

Water Tube Boilers
  (See Boilers, Water Tube)

Water Wheels
  (See Turbines, Hydraulic)

Waterbacks, Furnace
  Green Engineering Co.

Waterproofing Materials
* Johns-Manville (Inc.)
  Texas Co.

Wattmeters
* Bristol Co.
* General Electric Co.

Welding and Cutting Work
  Linde Air Products Co.

Welding Equipment, Electric
* General Electric Co.

Wheels, Car
* Fuller-Lehigh Co.

Wheels, Polishing Paper
  Rockwood Mfg. Co.

Whistles, Steam
* Ashton Valve Co.
* Brown, A. & F. Co.
* Crane Co.
* Crosby Steam Gage & Valve Co.
* Lunkenheimer Co.

Winches
* Brown Hoisting Machinery Co.
* Lidgerwood Mfg. Co.

Wire, All Metals
  Driver-Harris Co.

Wire, Brass and Copper
* Roebling's, John A. Sons Co.

Wire, Flat
* Roebling's John A. Sons Co.

Wire, Iron and Steel
* Roebling's, John A. Sons Co.

Wire and Cables, Electrical
* General Electric Co.
* Roebling's John A. Sons Co

Wire Cloth
* Caldwell, H. W. & Son Co.

Wire Mechanism (Bowden Wire)
* Gwilliam Co.

Wire Rope
  (See Rope, Wire)

Wire Rope Fastenings
* Lidgerwood Mfg. Co.
* Roebling's, John A. Sons Co.

Wire Rope Slings
* Roebling's, John A. Sons Co.

Wiring Devices
* General Electric Co.

Wrenches
* Greene, Tweed & Co.
* Roebling's, John A. Sons Co.

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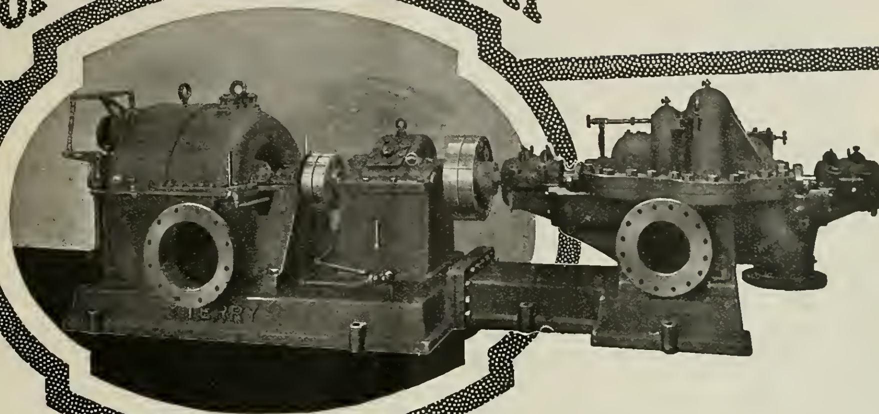
For Driving That PUMP



TURBINE drive permits extreme flexibility of control and also avoids provision against detrimental overloading which is necessary with motor driven centrifugal pumps. As it is impossible to overload a Terry Turbine, any difficulty of this sort is avoided for, as the power demand increases, the speed of the turbine is lowered, thereby automatically compensating for a decrease in the discharge head.

The above illustration shows a geared condensing turbo pump unit for water works service.

You will combine high efficiency, reliability, small space and low upkeep cost in your pump unit, if you specify—

T-740

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Alphabetical List of Advertisers

See Pages 94-110 for Classified List of Mechanical Equipment

Advertisements of Firms with page number marked "EI" appear in the Engineering Index Section.

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